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Are we ready for net zero in project management?

The challenges and strategies for project professionals in the delivery of UK major projects

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Because when projects succeed, society benefits

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Anonymous in accordance with Heriot-Watt University's research ethics guidelines.

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1. Executive summary

1.1 Project overview

Given current national strategies and pledges on the attainment of net zero by 2050, the significance of carbon as an increasingly prevalent parameter for successful project delivery appears unavoidable. Considering the importance of major projects and programmes in developing the national infrastructure, the delivery of these projects will be a key success factor in making sure that the UK is able to attain its net zero pledges. Addressing this, we investigate the readiness of the project management profession, by identifying challenges faced by project professionals when planning and delivering current major projects and programmes in the UK. Moreover, we explore the strategies and actions that enable the successful delivery of major projects aligned with net zero pledges over the next decades.

1.2 Key findings

- We explore the current roles and responsibilities of sponsors and project professionals, as well as actions they can undertake to ensure project and programme portfolios align with carbon reduction targets.
- Through the research study, 14 strategies and actions were identified that can facilitate the integration of carbon reduction measures at project and organisational levels.
- Some critical decarbonisation programmes are in a challenging position, with under-resourced project management teams and worrying gaps in programme and project management capabilities. This appears to be rooted in systemic and structural challenges.

1.3 Recommendations

1.3.1 For project sponsors and professionals

- Understand the drivers of carbon within organisations with large portfolios of capital projects.
- Appraise the carbon of multiple project options and target reductions on major carbon drivers in project portfolios.
- Integrate carbon mitigation as a key project benefit from the onset and ensure this is measured and monitored post-project.

1.3.2 Project-level actions

- Twelve actions have been identified to facilitate the integration of carbon reduction across the project life cycle, including:
  - Benefits management exercises where carbon reduction plays a significant role.
  - Implementation of robust carbon management systems, involving regular assessment, monitoring and control and reporting of carbon during the project.
  - A set of actions around procurement and contracting, to embed targets through major project supply chains.
- Two additional actions have been identified to implement at organisational level (within sponsor and project organisations). These are:
  - Establish continuous professional development (CPD) and training for project teams on carbon literacy (within a project context).
  - Promote a culture where carbon is a responsibility of the entire project team, encouraging and empowering project professionals to lead on the matter.

1.3.3 Public clients and local authorities

- As cities are major carbon emitters, they will be key to delivering major decarbonisation programmes in the next decades. However, as they are often not considered to be major programmes, we must ensure the establishment of robust project and programme governance structures to deliver these transformations.
- Building up the capability of major programme planning and delivery may be critical to attaining net zero targets. The "accidental project manager" phenomenon persists within the public sector.

1.4 Glossary of terms

Net zero emissions: This is the condition in which anthropogenic greenhouse gas (GHG) emissions are balanced by anthropogenic CO_2 removals over a specified period. Note that greenhouse gas emissions include CO_2, but also include damaging greenhouse gases (e.g. methane or nitrous oxide) (Möller *et al.*, 2022).

Climate neutrality: The term climate neutrality refers to the state in which human/anthropogenic activities have no net effect on the climate system. A prerequisite for this state is the attainment of net zero emissions (Möller *et al.*, 2022).

Climate positive: This is similar to previous terms but, in this context, the change, project or activity provides a positive effect by removing additional GHG emissions as well as those required for a balance.

Decarbonisation: This refers to the process by which countries or other entities aim to achieve a low-carbon economy, or by which individuals aim to reduce their carbon consumption. The term can also be used in relation to sectors of the economy (e.g. industrial sector, energy, aviation and transport) (Möller *et al.*, 2022).

2. Introduction

2.1 Background and significance of the study

The impact of greenhouse gas (GHG) emissions on our planet's climate is apparent, and is a concern that has gained considerable traction in recent years (Steffen *et al.*, 2015). In response, the global community has set a target to limit temperature rise to between 1.5–2.0°C to ensure a sustainable environment for future generations. As a result of the Paris and Glasgow Conferences of the Parties (COP 21 and 26), representatives from 196 countries set an ambitious goal of reaching net zero emissions by 2050, a move that resonates with a significant portion of the global economy.

The path to a carbon-neutral economy is complex. The scale of such socioeconomic transformation requires significant investments across various sectors, with estimates suggesting the need for a staggering annual global investment of $9.3tn by 2050 (McKinsey Global Institute, 2022).

Major projects (defined as projects over £100m), known for their magnitude and complexity, appear instrumental in this transition (Söderlund *et al.*, 2017; Flyvbjerg, 2014). These initiatives are at the forefront of converting carbon-intensive systems into sustainable alternatives, spanning sectors like energy (Andreoni *et al.*, 2022), housing (Lowes & Woodman, 2020) and transportation (Fenton & Richardson, 2021). Notably, the influence of major projects extends beyond technical objectives, often reshaping and transforming environmental and societal landscapes, a sentiment echoed in recent literature (Whyte & Mottee, 2022).

While there is extensive literature on the management challenges inherent to major projects, the exploration of carbon metrics in the context of major projects is still limited. Only a few number of studies (Kadefors et al., 2021; Lingegård et al., 2021) have attempted to explore the issue with regard to procurement implications, however, a comprehension understanding from project professionals' point of view is noticeably absent. This study aims to bridge that gap, focusing on the integration challenges faced by project professionals, and their strategies for navigating the challenge of delivering major projects under carbon reduction constraints.

2.2 Objectives of the research

This research aims to explore the challenges and best practices associated with integrating net zero carbon-related targets within major projects in the UK. As such, the study's objectives are as follows:

- To understand the perceptions of project professionals and project sponsors of national net zero targets and their implications for major projects in the UK.
- To uncover challenges faced by project professionals and project sponsors, and the strategies that can be implemented in to realise carbon reduction goals within the context of major projects in the UK.

2.3 Scope and limitations

- The study focused primarily on the major projects in the UK, drawing insights from senior project and programme managers across diverse sectors, particularly the infrastructure sector.
- The interviewee sample included 17 project management professionals who were part of sponsor organisations as well as project delivery teams.
- The perspectives are based on semi-structured interviews, making them subjective and reliant on the expertise and experiences of the interview participants.
- The research, while extensive, might not capture all nuances across every sector that executes major projects (for example, service transformation, research and development (R&D), military projects and ICT were not included within the sample).

2.4 Research methodology overview

To explore the links between carbon targets and major projects, the study employed a qualitative research methodology. Through 17 semi-structured interviews, project management professionals from a range of sectors and projects offered their insights, experiences and perspectives. A purposive sampling technique ensured a diverse yet informed pool of interviewees. A reflexive thematic analysis formed an inductive approach to analyse emergent themes from the collected data. This allowed the findings to be categorised into coherent themes that shed light on the relationship between net zero targets and major projects.

3. Research context

This section provides an overview of the existing literature on the implications of net zero transition on major projects. First, section 3.1 introduces the concept of net zero and its implications in general. Next, section 3.2 outlines the definitions of major projects and their evolving landscape in the UK. Section 3.3 discusses the implications of net zero transition on sustainable major project delivery. Finally, section 3.4, highlights three major UK projects that exemplify the successful integration of carbon measures and deliverables in their delivery.

3.1 Understanding the concept of net zero and the implications of the net zero transition

The discussions around climate change in recent years have placed a strong emphasis on the impact of GHG on our planet's climate and ecosystems. Globally accepted climate policies have highlighted the urgency of reducing anthropogenic (i.e. human-caused) emissions in the coming years to combat the ongoing global-warming crisis. Achieving a state of "net zero emissions" has thus become a central goal in these efforts. This is reflected by the following definition of net zero from the Oxford Net zero Initiative (2023):

"… a state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere (…) net zero is important because – for CO_2[1] at least – this is the state at which global warming stops…"

Over the past decade, the concept of net zero has evolved from its origins in climate science into a worldwide target that spans social, economic and political realms. As a result of international conferences (COP 21 and 26) in Paris and Glasgow, representatives from 196 countries committed to limiting global warming to an increase of 1.5°C. Moreover, in the field of global sustainable policies, net zero emissions and climate action are a core part of the well-established sustainable development goals (SDG 13), although the UN's recent report shows that progress towards the goal remains problematic (United Nations, 2023a).

Achieving this goal requires a collective commitment to reaching net zero GHG emissions by 2050. In 2019, the UK made history as the first major economy to legislate its net zero 2050 commitments through its Climate Change Act, later reinforcing this with interim targets for 2035 (HM Government, 2021a). As of 2023, numerous nations, accounting for 88% of global emissions, 92% of the world's gross domestic product (GDP) and 89% of its population (as illustrated in Figure 1), have pledged to achieve net zero emissions.

Figure 1: Summary of global pledges on net zero as of 2023 (Adopted from Net zero Tracker, 2023)

1 Net zero policies use carbon dioxide equivalents (CO_2e) as the standard unit for measuring emissions. CO_2e includes greenhouse gases (GHG), other than CO_2, known to have a global warming potential (GWP) effect, and gases such as methane (with a GWP 25 times higher than CO_2) and nitrous oxide (with a GWP 298 times higher GWP). The emissions resulting from these gases are converted into a CO_2e based on their GWP (Möller et al., 2022). For simplicity, in this report, we refer to CO_2e, without singling out specific GHG.

These commitments underscore the magnitude of the challenges involved in transitioning to a carbon-neutral global economy. Such a transition calls for an unprecedented transformation of our socioeconomic systems and infrastructure (United Nations, 2023b). According to a recent economic analysis by the McKinsey Global Institute (MGI), the net zero transition requires a staggering annual capital investment of $9.3tn from 2021 to 2050, totalling $275tn (MGI, 2022). This represents a remarkable 61% increase each year compared to 2020 levels of investment in low-carbon-intensive projects and initiatives (MGI, 2022). In the UK, additional investment (both public and private) would be required over the next decades, peaking at over £60bn by the mid-2030s (HM Treasury, 2021).

Having explored the concept of net zero emissions and its national and global implications, it becomes apparent that achieving such ambitious environmental goals is not only a matter of international policy but also hinges on the practical execution of projects across various sectors, including the built environment, transport and energy sectors. While the net zero transition is related to a wide range of initiatives, major projects stand out because of their substantial impacts and the unique challenges they present (Flyvbjerg, 2017). These projects, by virtue of their scale, complexity and significant capital investment, will play a critical role in operationalising the net zero aspirations discussed previously. They have the potential to translate high-level environmental targets into tangible outcomes, thereby acting as drivers for the realisation of net zero national objectives.

In the following sections, we delve into the realm of major projects, examining in more detail their characteristics, their relevance to net zero and the evolving dynamics that define their execution within the UK.

3.2 What are major projects? Definitions and the evolving landscape in the UK

In parallel with the aforementioned targets, the last few decades have witnessed a global surge in large-scale projects in terms of size, value and complexity. Known as major projects (worth over £100m) and megaprojects (over $1bn) this has led to the development of a subfield within project management research and practice (Söderlund *et al.*, 2017; Flyvbjerg, 2014).

The UK's Major Project Association (MPA) defines major projects as those characterised by:

"High monetary value. Time and schedule urgency. Organisational and managerial complexity – the extent to which there are a significant number of managerial interfaces to be managed; and/or a significant number of hierarchical layers either within the organisation or project structure to be managed, and/or a significant number of stakeholders to be managed. Technological complexity or high level of innovation." (MPA, 2023).

While this definition is widely accepted within the field, another term often used interchangeably with "major projects" is "megaprojects". These are defined as:

"large-scale, complex ventures that typically cost a billion dollars or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational and impact millions of people" (Flyvbjerg, 2017, p.1).

The latter definition not only underscores the scale and complexity of such projects but also highlights their potential to bring about transformative changes in society. For the purpose of this research, major projects were considered those with an estimated value exceeding £100m, aligning with the traditional megaproject threshold of (US) $1bn, as highlighted by Flyvbjerg (2017).

Within the UK, the Infrastructure and Projects Authority (IPA) provides annual reviews of the government portfolio of major projects and programmes. The 2023 report (IPA, 2023) highlights a total estimated life cycle cost of £805bn for the UK Government's Major Project Portfolio (GMPP), comprising 244 ongoing major projects. Over the past decade, the GMPP's value has surged by 227%, rising from its initial £354bn value back in 2013. The average life cycle costs of major projects have similarly increased by 176% between 2013 and 2023. Even after adjusting for inflation, this represents a 133% increase (Figure 2). These statistics corroborate research indicating that major projects are not only becoming more prevalent but are also growing in terms of complexity and scale (Flyvbjerg, 2014). It is important to note that these figures only represent a subset of major projects, as they do not include private investment initiatives or local (council and regional) projects and programmes.

The considerable research on major projects has long recognised their effects, which extend beyond traditional project performance criteria of time, cost, quality and scope. A particular focus has been on their significant environmental impacts, both positive and negative (Gellert & Lynch, 2004). Moreover, Whyte and Mottee (2022) have proposed viewing major projects as interventions in the environment, emphasising their substantial and long-lasting effects, which often involve transformations of the natural environment.

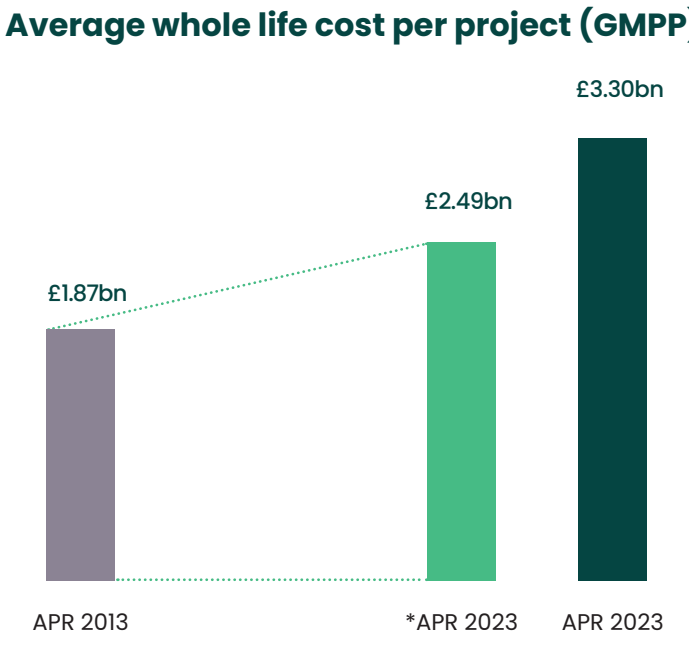


Figure 2: Average project value increase pf GMPPs (April 2013–April 2023) (Based on IPA, 2023)

3.3 Implications of net zero transition on sustainable major project delivery

Flyvbjerg (2014) suggests that decision-making in major projects is primarily influenced by technological, political, economic and aesthetic "sublimes". While these four sublimes are well established, Sankaran *et al.* (2020) argue that sustainability should be recognised as an additional major project driver, making the case for it to become a fifth sublime. In this context, it is apparent that ambitions for a net zero carbon transition are already spurring numerous major projects, which exemplify a focus on sustainability. The exploration of ways to integrate sustainability into projects has been extensive in recent decades, culminating in the emergence of new schools of thought in the field, such as sustainable project management. Sustainable project management sets itself apart from previous project management methods by its stakeholder management approach widening the view of the project's impacts on wider social systems, and considering social, environmental and economic impacts, as well as taking a pronounced value-driven approach (Silvius, 2017). Moreover, proponents of sustainable project management have also highlighted the two primary ways in which projects contribute towards sustainability (Huemann & Silvius, 2017; Locatelli *et al.*, 2023):

1) **Sustainability *of* the project**: This centres on the project's delivery methodologies, by ensuring strategies deployed on planning and delivery are rooted in sustainability. This encompasses areas like working conditions, economic ramifications and environmental considerations during project execution.
2) **Sustainability *by* the project**: Here, the emphasis is on a project's performance and its effects on surrounding systems after delivery. In other words, it considers the transformative value and benefits (social, economic and environmental) attained by the delivered projects.

When assessing projects from a carbon emission standpoint, it is evident that these are intertwined with project delivery activities, encompassing areas such as option appraisals, carbon tracking, procurement and the introduction of innovative low-carbon technologies (Lingegård *et al.*, 2021; Fenton, 2020). Equally important is acknowledging the effects of project decisions on the systems changed or transformed by the project, and their role in exacerbating or mitigating climate change. This involves, for instance, the efficacy of emerging low-carbon energy systems in curbing emissions, the effects of low-carbon transportation modes and the decarbonisation of heating systems. Thus, it can be concluded that, in terms of emissions resulting from the project, both the "carbon mitigation of the project" (i.e. mitigation *during* the project planning and delivery) and the "carbon mitigation *by* the project" (i.e. mitigation as a result of the project delivered) should be considered as instrumental in striving for net zero.

Looking ahead to the pipeline of major projects in the decarbonisation domain, Geels *et al.* (2023) highlight examples such as the multibillion-pound Zero Carbon Humber programme (£59.2bn). Major projects can thus be viewed as a unique category that goes beyond characteristics such as monetary value and timescale. They serve as valuable mechanisms to drive ambitious changes in existing systems, distinguishing them from simpler projects that aim to fit within current structures and systems. Hence, it is only natural that the extensive systemic changes needed to attain net zero objectives will rely on a range of major projects and programmes (Morris, 2017). In this vein, carbon emission mitigation efforts emerge as both a pivotal societal benefit and a determining factor for the successful delivery of the project.

Although a considerable amount of research has been conducted around the area of sustainable project management, no scholarly work has attempted to address how project management research could be refined by introducing another element – 'zero-carbon project management'[2]. This research addresses this gap and considers the importance of carbon as a significant parameter in the delivery of projects. It serves as the first attempt to identify the challenges faced by project management teams when embedding carbon reduction-related targets in ongoing and future major projects, and it explores the strategies available for project teams to enable the effective integration of carbon-related targets and requirements within major projects.

2 There is no commonly agreed definition for net zero project management. In this report, net zero project management refers to the practices, methods and actions undertaken at a project level that support the reduction of carbon emissions during project delivery and caused by the project itself.

3.4 Major projects and carbon: Illustrative cases

3.4.1 The past – London Olympics 2012: A first of a kind

Past research on major projects has extensively covered the delivery of the Olympic Games, revealing a consistent trend of cost overruns. The 2012 Summer Olympics in London were no exception, with initial estimates of £4.2bn in 2004 escalating to £8.44bn, resulting in a 101% cost overrun (Flyvbjerg and Stewart, 2012). While the financial performance of the project may seem underwhelming, the 2012 Olympics marked a significant advance in incorporating environmental considerations into major project planning and execution.

As part of various low-carbon initiatives, the 2012 Summer Olympics distinguished itself as the first project of its kind to undertake a comprehensive carbon footprint analysis. This study encompassed both embodied emissions (emissions linked to the construction of the venue and infrastructure) and operational emissions (emissions associated with the use of venues and transport during the event). The carbon footprint analysis included estimates of carbon emissions, to establish a reference baseline, followed by a post-event review of actual measured emissions. Considering GHG emissions falling under scopes 1 and 2 – emissions under the control of the organising bodies (ODA and LOCOG[3]) – the project achieved a reduction of 377,000 metric tons of CO_2 equivalents ($ktCO_2e$) from the established baseline, translating to a 17% reduction compared to the initial baseline (see Figure 3). The resulting emission reduction came close to the organisers' initial goal of 20%.

To achieve this goal, ODA and LOCOG employed ambitious strategies, including:

- **Pioneering a carbon assessment and management system**: The development of a "first of a kind" carbon assessment and management system was a pivotal achievement. This system was aligned with carbon emission accounting and reporting standards (LOCOG, 2012).
- **Encouraging innovative low-carbon technologies and solutions**: This involved initiatives such as reducing embodied carbon by using low-carbon concrete in venue construction (Henson, 2011) and exploring lower-carbon alternatives in venue design (Cullen *et al.*, 2011).
- **Guidelines and policy for sustainable sourcing**: The implementation of a sustainable sourcing code for the supply chain, along with a dispute resolution process to address code violations, ensured a commitment to sustainable practices (Bell *et al.*, 2012).

Graph 1: Original London 2012 reference footprint - $ktCO_2e$, (2009)

Graph 2: Actual measured London 2012 carbon footprint -$ktCO_2e$, (2012)

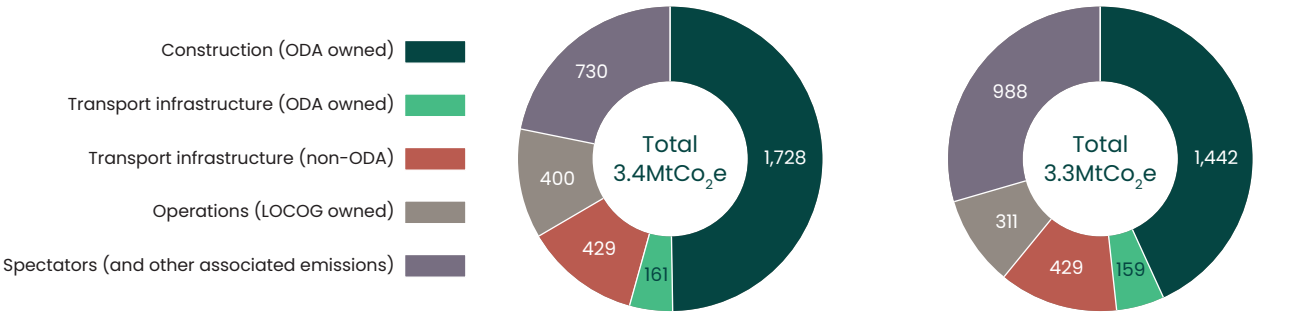


Figure 3: Reduction in carbon footprint of the 2012 London Olympics from the reference baseline. Adapted from the London 2012 Post-Games Sustainability Report (LOCOG, 2012)

3 ODA (Olympic Delivery Authority): Established to deliver the infrastructure and venues.
LOCOG (London Organising Committee of the Olympic and Paralympic Games): Established to oversee the planning and delivery of the event.

In conclusion, the 2012 London Olympics, despite cost overruns, made significant strides in addressing carbon requirements within the context of major projects. This case study serves as an example of how emission reduction considerations can be integrated into project planning and execution.

3.4.2 The present – HS2: Establishing the standard for managing carbon in major projects

High Speed Two (HS2) is one of the UK's most significant projects, involving the development of the UK's second high-speed railway infrastructure. Phase 1 aims to connect London and Birmingham, with extensions planned in subsequent phases. In October 2023, the UK government announced a reduction in the scope of HS2, with phases 2a and 2b, part of the original project's scope, being scrapped (DfT, 2023). While this is a substantial reduction of scope, the data presented and discussed below focuses on Phase 1 of HS2, which is currently under execution.

In the context of national emission reduction goals, HS2 can be considered a landmark project, as the transport sector accounts for around one-third of the UK's total carbon emissions. Consequently, HS2 has undergone a meticulous carbon footprint assessment, covering both emissions during project execution and emissions expected over a projected 120-year period. Notably, the methodologies employed for carbon assessment and management at HS2 are well established and mature compared to previous major projects (such as the London Olympics). These methodologies adhere to current national standards for carbon assessment in infrastructure projects and follow international standards (Fenton and Richardson, 2022). The project team also established a baseline scenario to calculate the carbon savings achieved through project delivery, representing "the emissions HS2 would produce if we did not carry out any carbon-cutting measures" (HS2, 2022a, p.8). The current target is a 50% reduction in construction-related emissions by 2030, with climate neutrality in the operation of phase 1 to be achieved in 2035 (HS2, 2022a).

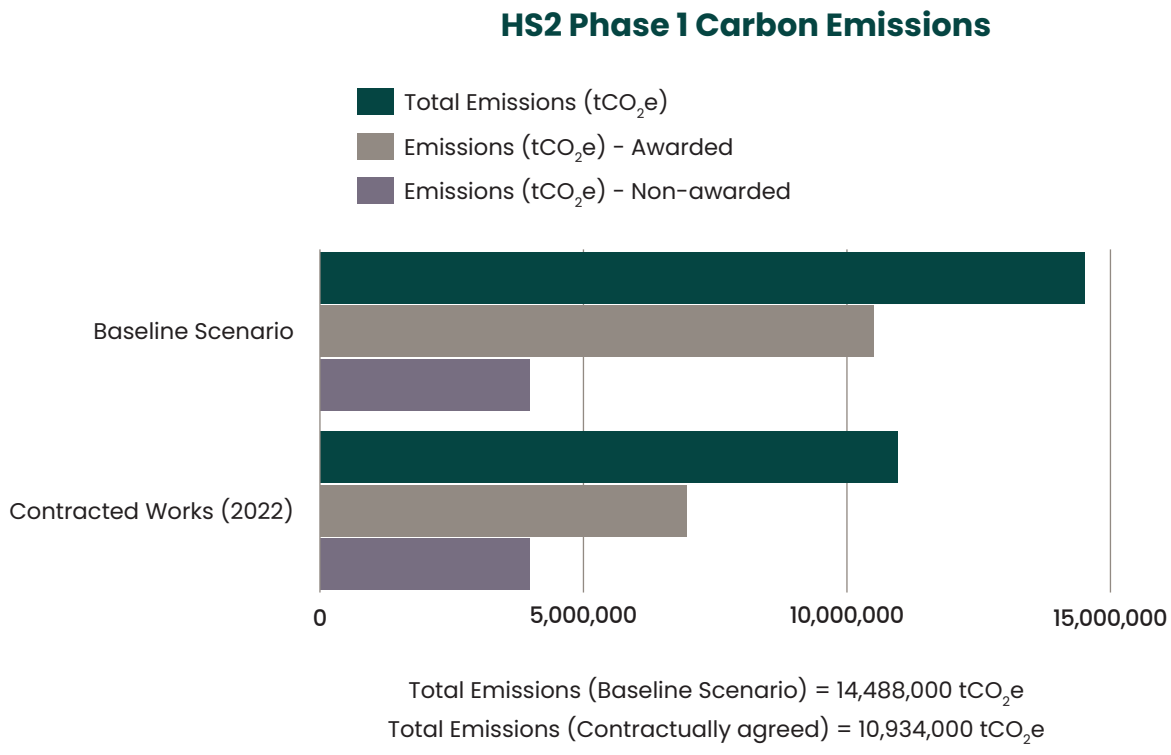


Figure 4: HS2 emissions (Phase 1): Baseline versus as-contracted. Adapted from HS2 Environmental Sustainability Progress Report Appendix: April 2021– March 2022 (HS2, 2022b)

Carbon reporting plays a central role in this strategy. 2022 environmental performance data indicates estimated reductions in carbon emissions of between 25% and 55% on current contracts, an average of approximately 34% for contracted packages (see Figure 4). These reductions encompass engineering enabling works, civil engineering projects, and the construction of main stations for the first phase (London to Birmingham link).

HS2 has implemented several key strategies to attain carbon reduction targets:

- **Robust carbon management systems**: A standardised carbon assessment method has been implemented, contributing to the establishment of current industry standards for carbon management and reporting. HS2 became the first UK transport client to implement the PAS 2080 standard for carbon management and reporting.
- **Learning, innovation and knowledge sharing**: This included, for instance, participation in collaborative initiatives focused on building accurate carbon databases for construction projects.
- **Use of contractual carbon requirements**: Carbon reduction targets are embedded in contracts within the supply chain.
- **Carbon literacy training**: A formal programme of CPD includes carbon literacy and skills development for project professionals in collaboration with the Carbon Literacy Project.

In conclusion, HS2 serves as a pivotal project where carbon reduction targets have been elevated as a crucial parameter for the project's success. By employing robust methodologies, sharing knowledge and integrating carbon requirements into contracts and professional development, HS2 sets a notable example for carbon management in major projects.

3.4.3 The future – Zero Carbon Humber: Paving the way for major decarbonisation challenges

Historically, the East Coast industrial clusters, encompassing the Humber and Teesside regions, have served as the beating heart of the UK's industry. In 2018, these regions were responsible for a substantial 38% of total industrial sector emissions in the UK (HM Government, 2021). They are home to traditionally carbon-intensive industries such as refining and steel, concrete and chemical production. The complex task of transforming these carbon-intensive industrial clusters into carbon-neutral entities exemplifies the kind of ambitious programmes needed to achieve the 2050 net zero transition.

While previous case studies, such as the London Olympics, focused on mitigating climate change impacts through innovative design, initiatives like the East Coast Cluster (comprising Zero Carbon Humber, Net Zero Teesside and Northern Endurance Partnership) are dedicated to implementing projects using cutting-edge adaptation technologies. These include low-carbon hydrogen utilisation and carbon capture and storage (CCS) in North Sea gas reservoirs. While no official cost estimates are available, Sovacool *et al.* (2023) have tentatively priced the currently announced Humber region projects at around £59.2bn. These early estimates give a sense of the magnitude of projects and programmes that are expected in the coming years. As of the present date, these major programmes and industrial interventions are in their infancy, aligning with the UK's industrial decarbonisation strategy. The Department for Energy Security and Net Zero has identified key projects in the East Coast Cluster's track 1 segment to serve as pilot initiatives.

However, the delivery of major decarbonisation programmes such as these will come with a unique set of challenges for the project profession (Geels *et al.*, 2023):

- **Structural complexity**: These programmes will encompass several multibillion-pound projects featuring various technologies and components. Integrating all these technical systems will be a significant challenge.
- **Technical novelty and uncertainty**: Large-scale implementation of technologies like CCS and large-scale hydrogen production for energy are an uncharted territory, with limited to no expertise at this scale. Demonstrator projects and publicly funded schemes will be vital, despite their uncertain outcomes.
- **Dynamic complexity**: These programmes will be highly dynamic, involving the concurrent development of technologies, coalitions and institutions. Unlike past megaprojects, they require the simultaneous construction of critical aspects (e.g. engineering, R&D, approvals, funding and regulatory frameworks) due to tight timelines.
- **Ambitious timelines and pace**: As these programmes are closely tied to national targets (e.g. 2035 and 2050 net zero goals), they will face stringent timelines for business case development, policy formulation or regulation, which might often result in lower scrutiny. Moreover, overlapping timescales will challenge the effective integration of lessons learned from pilot projects.
- **Socio-political complexity**: The involvement of numerous large organisations adds an inherent social complexity. Consortiums or ventures might help to coordinate stakeholders and mitigate risks (e.g. Zero Carbon Humber is a consortium of 12 partner organisations).

The Zero Carbon Humber initiative illustrates a pioneering adaptation effort in tackling challenges of decarbonisation at scale. These programmes are currently at inception stage but as they evolve and mature, they will offer valuable lessons and insights for addressing complex issues associated with decarbonisation on a national scale.

4. Research design and methodology

The previous section has set out the landscape of the net zero challenge and how this has affected the global policy landscape and influenced the delivery of major projects in the UK. Thus, the increasing prevalence of carbon reduction requirements, as well as the challenges of integrating them within major projects, provided the rationale for the two objectives underpinning this research:

- To understand the perceptions of project professionals and project sponsors of national net zero targets and their implications for major projects in the UK.
- To uncover challenges faced by project professionals and project sponsors, and the strategies that can be implemented in realising net zero related goals within the context of major projects in the UK.

4.1 Research design

To address these research questions, this research aimed to explore the net zero challenges and opportunities faced by project professionals working on current major projects. It aimed to establish strategies and pathways that will enable the successful delivery of major projects aligned with net zero pledges over the next decades.

Thus, the research adopted a qualitative research approach. Semi-structured interviews were selected as the appropriate data collection technique because they enable exploring participants' opinions about professional issues and opportunities, and eliciting detailed responses. This method was applied in this study to gather opinions from professionals involved in different major programmes or projects in the UK. The questions were structured to elicit their views and thoughts on the following aspects:

1. Views on current national net zero targets and how these translate into current and future projects.
2. Experiences of implementing net zero-related targets and deliverables in major programmes and projects, including the challenges faced and the actions and strategies used to integrate these.

4.2 Sampling strategy

In this study, a purposive sampling technique was employed. Purposive sampling is an effective technique when investigating a problem that requires in-depth information about the phenomenon under investigation. It is suitable for the investigation of multifaceted topics such as the exploration of complex issues, for example exploring issues around the integration of new project parameters within megaprojects (Di Maddaloni and Davis, 2018). Additionally, purposive sampling allows control over level of variance across interviewees selected, which in this case allowed the inclusion of stakeholders from different sponsor organisations and multiple major project types. The final sample (see Table 1) included a range of senior project and programme managers with extensive experience in the delivery of major projects across different organisations and sectors.

Table 1: Interview participant information

Participant ID	Role	Sector	Duration
Participant 01	Chairman and Project Management Consultant	Infrastructure and major events (sponsor and delivery experience)	41 minutes
Participant 02	Programme Manager	Major events (delivery)	41 minutes
Participant 03	Senior Director	Buildings: education and healthcare (delivery)	31 minutes
Participant 04	Senior Project Manager	Buildings: architectural and retrofit projects (delivery)	46 minutes
Participant 05	Major Projects Delivery Manager	Civil infrastructure: water (sponsor)	43 minutes
Participant 06	Project Director and Net zero Carbon Lead	Buildings: major retrofit projects (delivery)	39 minutes
Participant 07	Carbon Manager	Civil infrastructure: railways (Sponsor)	64 minutes
Participant 08	Director of Major Projects	Infrastructure: transport and roads (sponsor)	38 minutes
Participant 09	Senior Project Manager	Large retrofit programmes (sponsor/local authority)	45 minutes
Participant 10	Major Project Planning Lead	Construction contracting (delivery)	48 minutes
Participant 11	Deputy Director	Civil Service (infrastructure projects authority)	57 minutes
Participant 12	Director of Project Procurement	Infrastructure: transport – road and railways (sponsor)	64 minutes
Participant 13	Technical Lead – Major Projects	Infrastructure: railways and buildings (delivery)	62 minutes
Participant 14	Senior Project Officer	Energy and local authority (sponsor)	64 minutes
Participant 15	Energy Projects Manager	Energy regional hub (advisory role)	58 minutes
Participant 16	Programme Lead and Head of Net zero Carbon	Infrastructure: transport and roads (sponsor)	61 minutes
Participant 17	Project Manager	Banking, local authority, energy and R&D (sponsor and delivery)	41 minutes

4.3 Data collection and analysis

Online interviews were conducted using Microsoft Teams and involved two researchers – one interviewer and one observer. The interview questions were organised into two sections.

Section 1 focused on understanding the current prevalence of carbon mitigation-related targets and metrics within major projects, the challenges faced by the project managers when delivering projects under these carbon emission constraints, and the readiness of project management teams to incorporate carbon-related targets into project deliverables.

Section 2 centred on the project-level and strategic policy-level actions or steps that project management teams and other stakeholders can take to support project managers when delivering major projects under carbon constraints.

These interviews were recorded, transcribed verbatim and then analysed using thematic analysis with the help of NVivo 12 software. The analysis followed Braun and Clarke's (2006) steps for reflexive thematic analysis. This process ensures a thorough and systematic analysis of the data collected through the interviews. All results presented in the following sections were directly derived from the data collected through the interviews.

1. Review of transcripts: All interviews were transcribed verbatim and reviewed before the thematic analysis began.
2. Code generation: The research team separately reviewed the data to identify and label key points or ideas, with each researcher generating multiple codes.
3. Identifying themes: Similar codes were grouped together to derive initial themes. The research team then discussed and agreed upon these themes.
4. Reviewing themes: The derived themes were cross-checked against the original data, and an initial coding tree of the themes was created.
5. Finalising themes: The primary and secondary themes were then refined and were sorted into main categories as listed in Table 2.
6. Presenting results: The themes are summarised and discussed in the next section of the report – 5. Results and discussion of findings.

5. Results and discussion of findings

5.1 Findings from the thematic analysis

To gain a deeper understanding of the challenges and perspectives related to net zero targets in major project delivery, 17 semi-structured interviews with experienced project professionals were conducted. The selected professionals have played significant roles in the design, planning, execution and delivery of major projects, granting them a comprehensive view of the complexities and nuances involved. The thematic analysis of these interviews yielded insights that have been organised under four distinct themes and various sub-themes. The themes and sub-themes encapsulate the predominant sentiments, concerns and recommendations of the interviewed project professionals. The themes range from the understanding of net zero targets and their implications in relation to major projects to the external influences affecting project outcomes in a net zero-carbon-focused landscape.

Table 2 below presents a structured summary of the recurring themes and opinions voiced during the interviews. By reviewing these results, project teams and other stakeholders can better appreciate the multifaceted challenges and opportunities when aligning major project delivery with low-carbon practices.

Table 2: Resulting themes derived from the qualitative analysis.

Theme	Sub-theme	Description
Net zero transition challenge – refers to the challenges for projects regarding the net zero targets.	Unknown technologies and solutions	Net zero targets introduce high risks for large-scale projects due to many untested technologies.
	Unclear implications of net zero targets	The translation of net zero targets to individual projects is often murky. Yet, many sponsor organisations align their targets with national goals, based on their emissions assessments.
	Unrealistic and non-credible targets	While initial emission reduction seems achievable, the final 30–40% post-2035 lacks credible strategies at present.
Project professional readiness – includes a range of challenges faced by project teams when integrating carbon mitigation as a project deliverable.	Limited carbon data	The scarcity of reliable carbon data affects the credibility of project assessments (a widely acknowledged challenge for project management teams).
	Under-resourced project management teams	Recruitment and retention challenges exist, especially in the public sector and local authorities. The "accidental project manager" is a frequent phenomenon.
	CPD and training	Both formal and informal training in carbon literacy is pivotal. CPD needs are widely acknowledged, but the content differs across sectors and project types.
	Limitations of current carbon estimating tools for projects	Current project management methodologies and tools relating to carbon estimation are inadequate, especially outside of infrastructure projects.

Theme	Sub-theme	Description
Effective project management strategies and actions – addresses the effective carbon reduction-related actions and strategies to be implemented during the project life cycle.	Project inception	Early project actions should prioritise carbon mitigation, for example, setting a financial case for carbon reduction or treating reduced carbon as a primary benefit.
	Project planning and design	Emphasise setting carbon baselines and promote option appraisal with carbon as a crucial factor.
	Project delivery and execution	Incorporate carbon reduction considerations in procurement and maintain stringent carbon tracking, as per the carbon management system.
	Post-project	Measure outcomes against set baselines and targets, especially if carbon mitigation was established as a key benefit.
External barriers – refers to the barriers arising from the external environment that can hinder the effectiveness of the actions and strategies mentioned above.	Capability of supply chains	Capability concerns extend to supply chains, especially regarding advanced technologies. As such, carbon mitigation requirements can also hinder competitive procurement, with subsequent cost premiums.
	Societal and political net zero momentum	The societal and political drive for net zero has made the requirement more prominent recently. This is evident when contrasted against previous major transformation initiatives (e.g. digitalisation, sustainability, equality, diversity and inclusion and health and safety) which have failed to achieve similar momentum.
	Misaligned incentives	Some existing systems fail to properly incentivise carbon reductions. Biases towards funding and technological innovation, rather than carbon efficiency, might exist.

5.2 Implications and discussion of key findings

In this section, we discuss and reflect on the key findings and observations derived from the opinions of the project professionals and sponsor representatives who participated in the study.

5.2.1 Effective project-level actions in integrating carbon reduction targets in major projects

This section presents an overview of the findings, drawing insights from a combination of the interviews and the literature examining recent major projects to identify effective practices and strategies employed by project professionals for integrating carbon considerations. Figure 5 highlights a total of 14 actions that emerged from the interviews and the review of pertinent literature and case studies. These actions are pivotal for integrating carbon emission reduction goals into major projects and project management practices.

When looking at the dychotomy presented by Huemann and Silvius (2017), where sustainability can be viewed as an outcome of the project ("sustainbility *by* the project") or as a core element of the project delivery itself ("sustainability *of* the project"), a number of strategies are key in attaining both these goals. In both cases, initiation and planning emerge as the most important project phases, and the strategies and goals they establish can drive their effective attainment during project execution and post-project phases. Based on the interviews, primarily from professionals involved with infrastructure and building projects, the distinction between emissions resulting from the project and post-project has been clearly established. In this regard, the sector appears to have developed a mature approach to carbon emission assessment and tracking (LOCOG, 2012; HS2, 2022a).

For the emissions resulting from the project (i.e. during the post-project and use phases; also known as operational emissions), benefit realisation and management exercises undertaken in the early inception phase emerged as a key activity for sponsors (Action 2). Impacts of the project on systems over its life cycle can be estimated, enabling clear and measurable targets to be established. Benefit realisation exercises also require action in the post-project stage, where the attainment of earlier established benefits (including emission mitigation) can be assesed (Action 11). Similarly, a series of actions is primarily linked with the reduction and management of carbon emissions during the project delivery phases (planning and execution). In this regard, an early establishment of these into initiation phases and early planning stages remains paramount.

Some of the strategies identified in the research emphasise the importance of sponsors in leading carbon mitigation efforts. These can be embedded into the project organisation through key strategies such as optioneering, procurement practices and implementating robust carbon management systems (actions 3–9). Moreover, as seen in Figure 5, many of these actions can be integrated into separate phases of the project life cycle. Nonetheless, it is important to note that certain initial actions are often prerequisites for the effective implementation of subsequent ones. For instance, within the project's initiation phase, establishing a robust carbon management system – capable of quantification, control, assessment and reporting – proved to be an essential enabler. This was indicated by one of the interviewees:

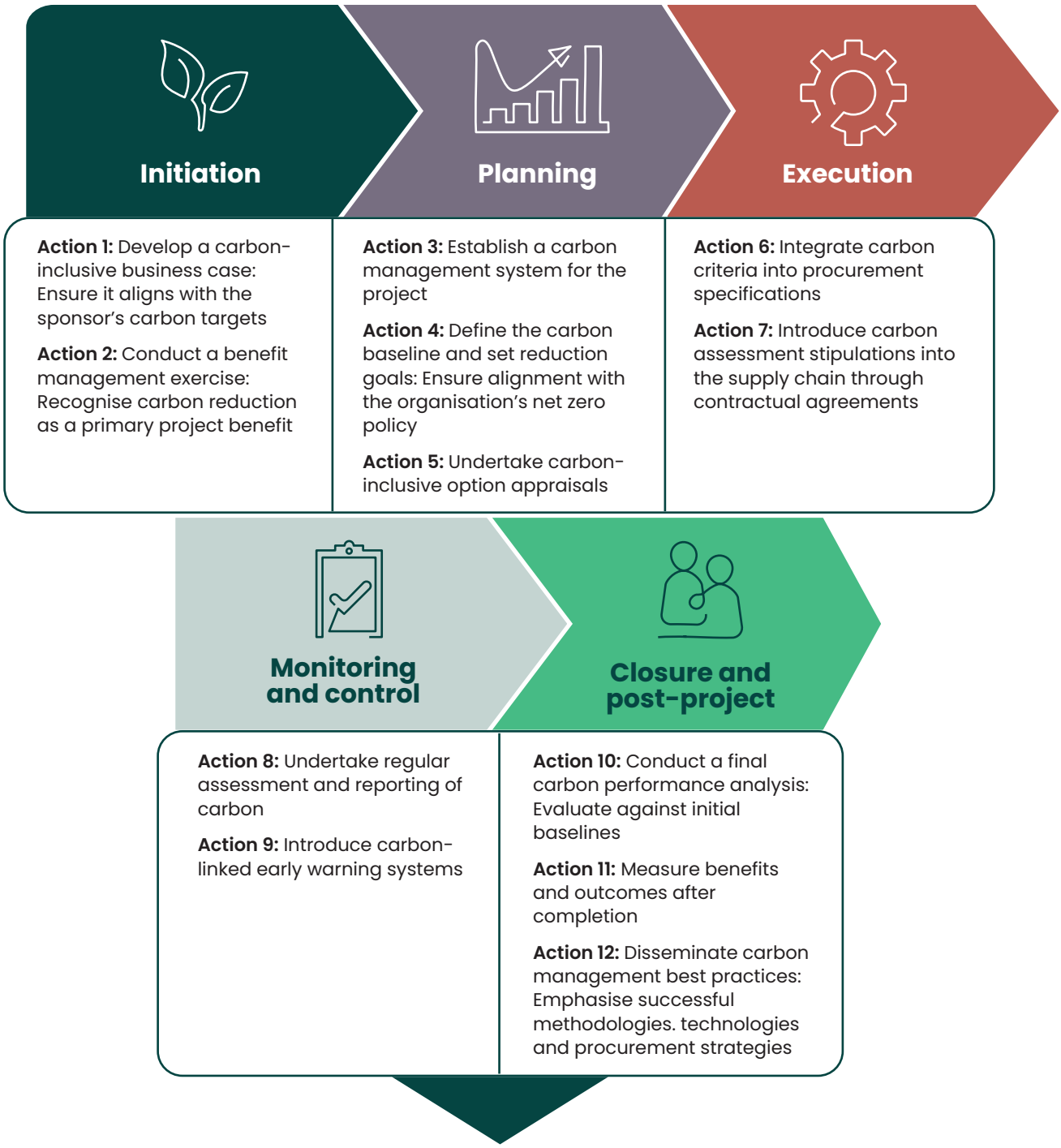
"At the early stages of the project life cycle, there is greater possibility to achieve a significant carbon reduction" – Participant 12

This approach is currently being championed in major infrastructure projects and programmes, by using a standardised methodology for carbon measurement, monitoring, reporting and facilitating long-term improvement (e.g. PAS 2080:2022) (Fenton and Richardson, 2022). To return to the dichotomy (Huemann and Silvius, 2017), these standardised carbon management systems can be key to attaining the mitigation of carbon during the project (i.e. attaining sustainability of the project). While these standards may have been developed with infrastructure major projects in mind, various other sectors which constitute a substantial portion of the UK GMPP (IPA, 2023), such as ICT, service change and defence, could stand to gain valuable insights from the lessons learned in the years to come.

Furthermore, our interviews revealed two additional actions that transcend all phases of the project life cycle. Firstly, while project professionals themselves may not need an in-depth technical understanding of carbon assessment methods, CPD and training in carbon-related aspects concerning project decisions – such as carbon literacy, particularly as it pertains to the project at hand – emerged as crucial facilitators for effectively integrating carbon considerations into the project life cycle. Additionally, while formal training and CPD initiatives were prominently endorsed and effectively utilised in several major projects, interviewees also highlighted the value of "informal" and short-form events, such as webinars or lunch meetings, focused on the topic of carbon in the project.

Finally, another significant factor influencing net zero considerations was the prevailing organisational and project culture and leadership. The integration was better where carbon reduction was viewed as an integral aspect of the project and a collective responsibility of all team members, not just of a designated carbon manager. To foster this perspective, exercises undertaken by the sponsoring organisation to establish clear organisational carbon targets, alongside their translation into the capital project portfolio, emerged as key. This includes transparent communication regarding the implications of individual projects in advancing the organisation's strategic emission reduction targets.

Figure 5: Project-level actions to effectively integrate carbon reduction as a key deliverable in major project



Transversal actions (applicable across all phases):

Action 13: Organise comprehensive continuous professional development and training sessions on carbon literacy: Involve the supply chain and familiarise them with the project's carbon management plan.

Action 14: Foster a positive project organisational culture: Promote inclusive ownership and avoid compartmentalising responsibilities (e.g. avoid views such as "carbon is the responsibility of the carbon manager"). Use methods like seminars, informal events and the appointment of carbon champions.

5.2.2 Nurturing carbon integration: The role of sponsors and current incentive structures

While the importance of carbon reduction in current and future major projects was recognised, the interviews with project professionals underscored a recurring practical disconnect. In practice, carbon reduction targets are still often regarded as a project constraint or relegated to a secondary role, rather than being recognised as an integral determinant of project success. It is noteworthy, however, that this perspective is not universal across all projects. Three of the interviewees emphasised that aspects regarding carbon mitigation had assumed a significant role in some of their current projects, comparable in importance with factors such as time and cost. This is an encouraging yet rare occurrence. In this study, project professionals at both sponsor organisations and project delivery organisations were interviewed. A consensus emerged that underscored the pivotal role of project sponsors in championing carbon mitigation efforts as a key deliverable. The extent to which sponsors consider carbon reduction during project inception, and incorporate these into the outline and full business cases, was identified as determining the effective integration of carbon reduction considerations into major projects. Interviewees also emphasised the need for sponsors to perceive carbon mitigation as a tangible benefit and stressed the importance of robust benefit realisation exercises, not only during project inception but also in the post-project phase.

As such, sponsor organisations must possess a comprehensive understanding of how their current and forthcoming project portfolios impact carbon reduction targets. Our observations revealed that sponsor organisations, particularly those involved in infrastructure, have embarked on multi-year reviews to determine the implications of carbon reduction targets on their major project portfolios. This practice serves a dual purpose. First, it helps identify areas where carbon reductions can be achieved and, secondly, it uncovers potential tensions with other strategic objectives, such as social goals and benefits. This insight enables sponsors to account for these tensions when outlining realistic programme benefits, including carbon reduction, during the development of strategic business cases. Managing this delicate equilibrium among various strategic goals presents a significant challenge.

Another issue identified pertains to current incentive structures and systems. Many current low-carbon major projects may not primarily be incentivised by the objective of carbon reduction, but rather by the appeal of technological novelty. As articulated by one of the participants (P16), "you get headlines" for adopting cutting-edge technological or innovative solutions within a project. Although these innovations may yield certain benefits for carbon reduction, better outcomes could often be achieved by reducing project scope or a focus on efficiency in project design. This challenge is captured in the following quote:

"The way in which you get rewarded, the way in which you're incentivised, creates a system that inherently prioritises the adoption of new, flashy technological solutions over the fundamental aspects of getting the basics right and embedding efficiency into projects." – Participant 16.

This raises concerns about the structures that incentivise current major projects, including those central to low-carbon ambitions. These incentive and project drivers are well established in major project research. For instance, Flyvbjerg's (2017) proposed "technological sublime" would explain many of the technologies that currently drive major projects, including those aiming to implement innovative solutions such as carbon capture and storage (CCS) or hydrogen as alternative sources of energy (Geels *et al.*, 2023). While technical accomplishments can drive carbon reductions, project sponsors should remain aware of these dynamics when establishing project scopes in early phases, as fostering a genuine commitment to sustainability within major projects will be paramount. As Sankaran *et al.* (2020) indicate, a true "sustainability sublime" rooted in established global and national policy and targets (e.g. the Sustainability Development Goals or the UK's Carbon Budget) could yield more effective outcomes. This would entail emphasising emission avoidance, even if it needs decisions to be made regarding such matters

as scoping adjustments or extending the project's operational lifespans. These options may be less appealing than successfully deploying novel "first of a kind" technologies.

5.2.3 Treating major decarbonisation challenges as major projects: Challenges ahead

Decarbonisation challenges refer to the process of transforming current carbon-intensive systems and sectors (e.g. energy, heating systems and transportation) into ones with a reduced (or even neutral) carbon emission contribution. The research team examined various project and programme contexts central to the UK's net zero strategy. Several interviews centred on large-scale retrofits and low-carbon domestic heating local and regional programmes, where a series of challenges was noted. First, the scale of these is not very different in terms of financial value or complexity to megaprojects such as the London 2012 Summer Olympics, as confirmed by the following quote from a project professional within a major UK metropolitan area:

"The value of the whole decarbonisation activity is estimated to between £6bn to £8bn in (city name) at the moment." – Participant 9

However, it was apparent that these programmes are rarely endowed with the same level of resourcing and organisational structures as the former megaprojects. To surmount this obstacle, the government might be required to provide high-level strategic guidance and support to regional and local authorities, which are often responsible for delivering these programmes. Success in this context relies on an appropriate blend of national and local collaboration. This synergy is essential not only for delivering the national net zero strategy, but also in securing appropriate programme funding and embedding goals that also resonate with the nuances of local contexts.

Moreover, another significant hurdle is the gap between the scale of the programme and the availability of financial resources. Current funding structures often fall short, relying on short-term or stop-and-go funding models that only allow for a handful of project professionals to be allocated to these projects full-time.

Another phenomenon that seems to be sustained by under-resourcing is the well-known "accidental project manager[4]". In this context, concluding thoughts from Darrell *et al.* (2010, p.62) still ring true for many public clients: "the lack of project management tools, techniques and methodologies should be of concern to public organisations and senior managers. Without these, an organisation does not have a strong foundation from which to build skilled project managers, an organisational culture of project management, and, ultimately, better business outcomes".

We previously indicated that carbon literacy CPD for project professionals is a key action; however, in the context of local authorities, CPD and mentoring resources might be better allocated towards developing expertise in project and programme management techniques and methodologies.

Overall, to effectively navigate the complexities inherent in such programmes, it becomes imperative to treat these major transformation challenges as major programmes rather than run-of-the-mill projects. This requires the establishment of robust governance structures tailored to the unique demands of net zero challenges, spanning domains such as housing or industrial decarbonisation. Finally, it is also necessary to ensure that these programmes are resourced and funded adequately.

4 Refers to individuals who are called upon to undertake project management responsibilities with little or no formal project management preparation, often based on their technical expertise (Darrell *et al.*, 2010).

6. Conclusion and recommendations

6.1 Concluding remarks

As the effects of climate change become increasingly obvious, there has been a marked global shift towards the net zero transition, prioritising national plans for the reduction of carbon emissions. The project profession, usually entrusted with the delivery of significant systemic changes and transformations, stands at the crossroads of this transition. Major projects, especially within sectors such as transport, energy and buildings, will be instrumental in this transition.

Our research underscores the significant influence of net zero targets on the delivery and strategy of major projects in the UK. Promisingly, several major projects have adopted successful strategies, resulting in appreciable carbon reduction compared to initial baselines. An evident trend in our findings is the greater significance given to net zero considerations within project outlines and full business cases, with this responsibility often resting on the shoulders of sponsors. However, a concern raised by our research is the current inclination towards projects that might focus on technological novelty at the expense of genuine carbon efficiency pursuits. This calls for a deeper comprehension of organisational carbon drivers to ensure that project portfolios are genuinely aligned with carbon reduction targets.

The exploratory study has highlighted the importance of CPD in carbon literacy for project professionals, in the form of both formal training and informal events such as webinars. Equally vital is a supportive organisational culture where net zero and carbon-related considerations are a collective responsibility and are woven into the project's core objectives, enhanced by transparent communication of the organisation's broader emission reduction goals.

Nevertheless, challenges persist, especially concerning resource constraints. Public clients and local authorities face issues of recruitment and retention, often inadvertently relying on professionals from technical carbon backgrounds for management roles – the "accidental project manager" is still a common recurrence. While these professionals bring valuable technical knowledge and expertise, there appears to be a gap in portfolio and programme delivery skillsets. Interestingly, while major local decarbonisation programmes are central to attaining national targets, the challenges their project teams face could hinder net zero efforts from the start. For national targets to be realised, it is imperative that the challenges confronting project teams within these carbon-intensive sectors be addressed promptly.

As the project management profession continues its journey through this changing landscape, the findings of this study highlight the importance of both strategic and capability-focused adjustments to truly drive the net zero transition forwards.

6.2 Recommendations

6.2.1 Role of sponsors

- Begin by understanding organisational carbon drivers within existing and future project and investment portfolios.
- Strategically integrate carbon reduction considerations, addressing potential conflicts with other primary strategic objectives.
- Position carbon reduction as a central project and programme benefit when developing the outline and full business cases.
- Prioritise genuine sustainability by emphasising carbon efficiencies before resorting to capital-intensive solutions. Focus on actual carbon mitigation over technological novelty.

6.2.2 Effective integration of net zero considerations into major projects

- Embed carbon mitigation considerations right from the feasibility and project inception phases.
- Set up comprehensive carbon management systems, addressing assessment methodologies, continuous monitoring and control, and regular reporting throughout the project life cycle.
- Ensure CPD for the project team, covering both the specific carbon management systems in place as well as broader carbon literacy.
- Cultivate a project culture that values carbon reduction and emphasises strong leadership in driving net zero goals.

6.2.3 Addressing worrying gaps

- Recognise future decarbonisation challenges and manage them as major programmes with appropriate governance.
- Re-evaluate the current funding models for decarbonisation projects and investigate alternative financing strategies.
- Ensure professional bodies and government provide support (through CPD) to local clients and authorities (and to other areas where gaps in programme governance skills can be identified).

6.3 Areas for future research

The work carried out in this study serves as an initial qualitative exploration of the challenges and dynamics faced by project professionals in the context of carbon emissions. While our insights provide valuable direction, there is a clear need for deeper investigation. Some recommended avenues for future research are outlined below.

6.3.1 Expand project and geographical perspectives

We focused on specific types of major projects when examining carbon emissions. While this is understandable, given the significant emissions from sectors like infrastructure, transport and energy, achieving net zero will require broader attention to other sectors. Investigating carbon considerations in additional industries and project types will, therefore, provide a more comprehensive picture.

The current findings have a notable Western orientation. To address the global challenge of net zero, it is crucial to include perspectives from the Global South and major economies such as China or India. It should be noted that, while individual nations make pledges, the path to net zero is ultimately a global challenge.

6.3.2 Further investigate the extent of the “accidental project manager”

An intriguing observation from our study is the significant role that “accidental project managers” play in many climate-centric programmes. While these professionals often possess a deep and instrumental technical understanding, further exploring support strategies for tackling skills gaps in project, portfolio and programme delivery can be central to achieving national climate objectives.

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