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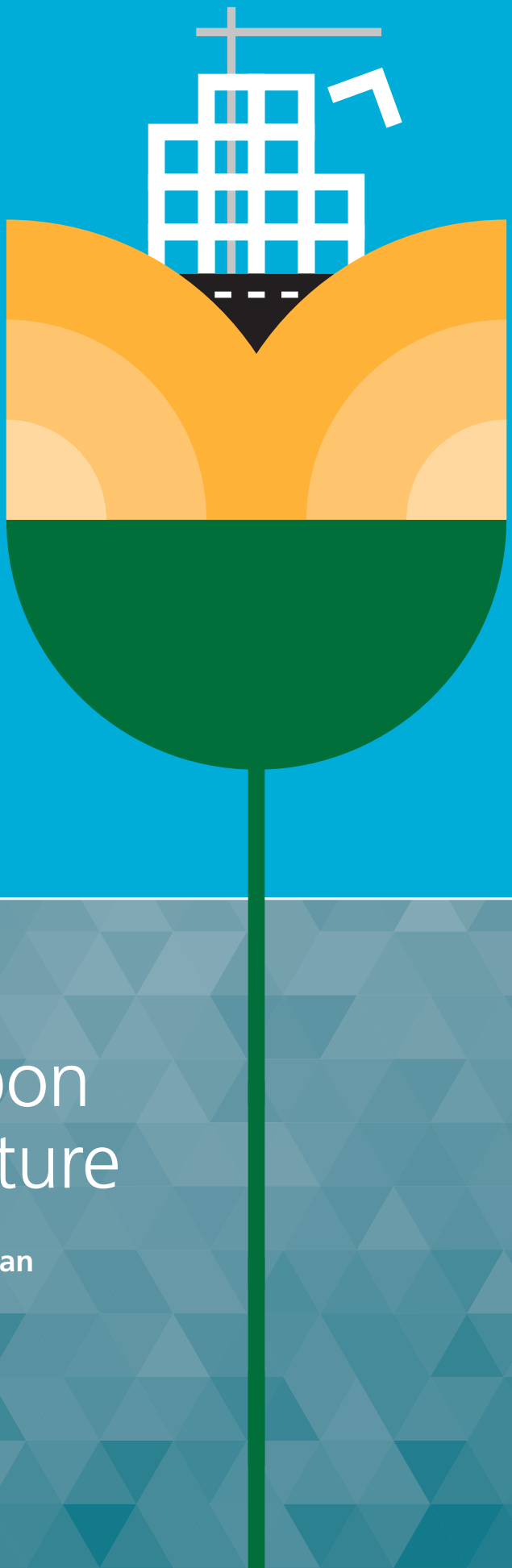

Financing Low-Carbon Infrastructure

What civil engineers can bring to the table

NOVEMBER 2022

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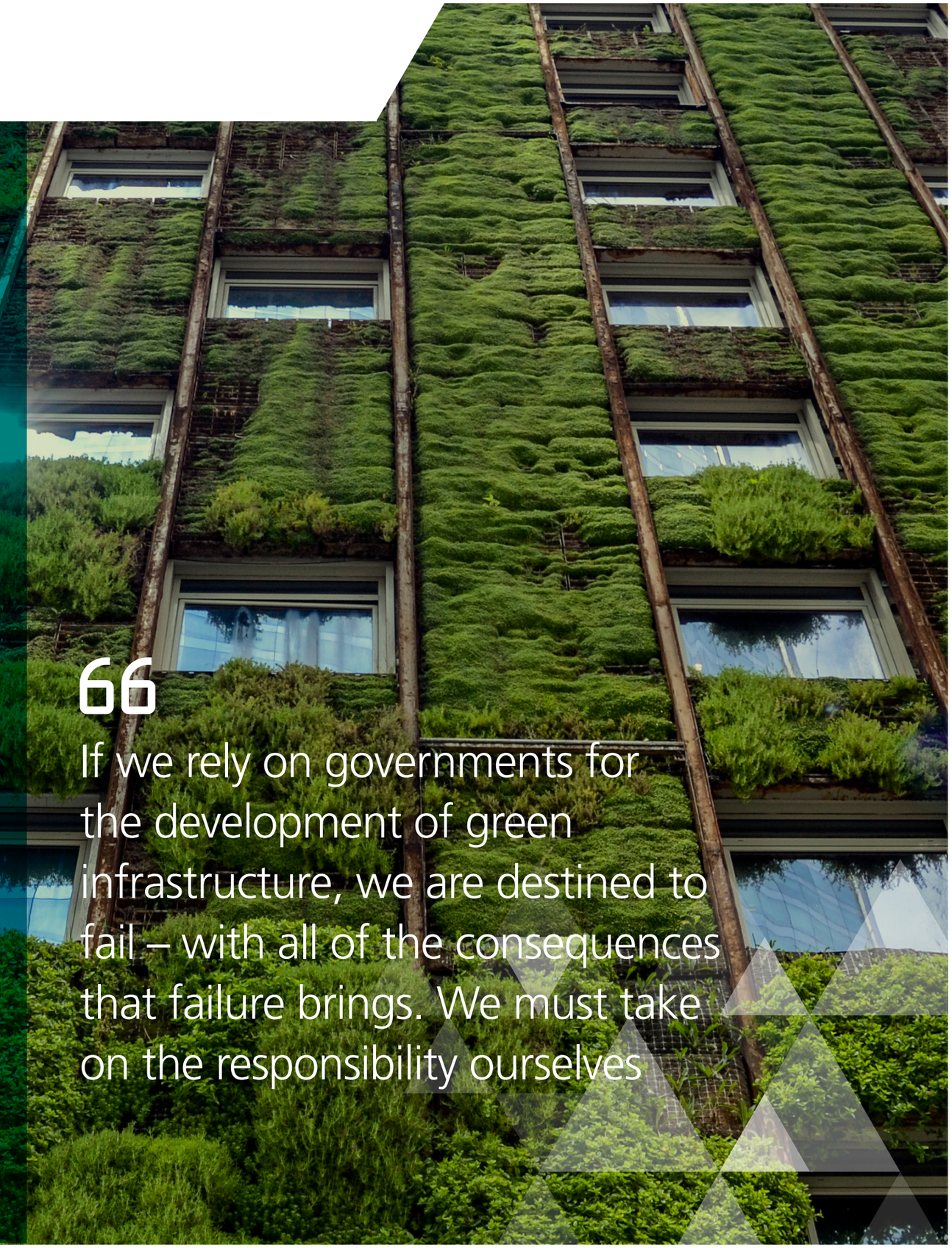

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If we rely on governments for the development of green infrastructure, we are destined to fail – with all of the consequences that failure brings. We must take on the responsibility ourselves

Foreword

Andy Milner CEng FICE
Executive chairman,
Matrix Networks Group

There is no doubt that if the decarbonisation ambitions of societies around the world are to be achieved, new, clean infrastructure, and the reconfiguration of existing infrastructure, is critical.

This is the case whether it is the development of green power-generation facilities, battery storage, gigafactories or retrofitting transport networks for net-zero travel.

Civil engineers have always played a leading role in infrastructure development. As we look to the future, we need to innovate and harness our skills to help achieve net zero. This is an exciting challenge, and one that will test the boundaries of technology, science and engineering in perpetuity.

Still, infrastructure is a significant capital cost. Many projects fail to progress because of a lack of available finance. If we rely on governments for the development of green infrastructure, we are destined to fail – with all of the consequences that failure brings. We must take on the responsibility ourselves.

Governments face competing demands for state investment to resolve poverty, to improve social care and services and to deal with health crises, civil unrest and conflict. There will always be a limit to how much infrastructure funding can come from the public purse. While public financing plays a critical role in infrastructure development globally, investment from the private sector needs to be maximised as well.

Engineers can play an active role in ensuring the success of green infrastructure initiatives by considering how they can be financed and working with investors and financiers to bring these essential schemes to life. Knowing what information is needed to deliver an investment is a fundamental skill that engineers need to develop. This will help to make investment as attractive as possible and underpin the development of the infrastructure we need.

In compiling this paper, the project team engaged a unique group of stakeholders. We talked with engineers and client bodies but also consulted institutional investors, economists and legal and financial advisers. We believe large-scale decarbonisation will only happen if all sectors work together to achieve it.

The research, information and advice in this report represents a significant step towards developing a collaborative approach to engineering and financing the infrastructure projects needed to achieve net zero.

Together, we can enable an era of confidence in the delivery of green solutions.

About this report

To produce this paper, the project team interviewed members of the finance community; infrastructure project developers; government agencies; ICE regional representatives; construction contractors; the legal profession; and stakeholders from the transport, water and energy sectors, among others. The questions included:

- Civil engineers currently have a limited commercial input – there is a separation between the technical and investment communities. Do civil engineers need to know about green financing? If so, why? If not, why not?

- How can engineers de-risk the low-carbon infrastructure sector for investors, making it a more attractive and viable proposition?

- What are the factors behind one low-carbon infrastructure initiative failing to attract investment and another succeeding? Can civil engineering expertise help to get more projects over the line?

Their answers informed this report.

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Our sincere thanks to all of those who gave their time and expertise to help guide this report.

We view this paper not as a one-off document but as the start of a conversation about the role of civil engineers in supporting the financing of low-carbon infrastructure. This is a fast-moving arena, and what is relevant today may have changed in even a year.

We therefore invite ICE members, industry stakeholders, the finance community and anyone interested in the role of civil engineers in decarbonisation and the path to net zero to ask questions about, or provide feedback on, this report – email knowledge@ice.org.uk

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> What role should the profession play in this new green industrial revolution?

01 Introduction

In October 2021, as the UK prepared to host the UN Climate Change Conference (COP26) in Glasgow, then-Chancellor of the Exchequer (now Prime Minister) Rishi Sunak outlined the Government's plans for a "green industrial revolution".

The plan set out the Government's intentions to make hydrogen a major transport fuel; expand and decarbonise public transport; build greener buildings; make zero-emission vehicles the norm; and for the industry and finance sectors to prioritise these advancements.[1]

Civil engineers were critical to the first Industrial Revolution, driving social change and prosperity. What role should the profession play in this next green industrial revolution – one that is focused on decarbonising infrastructure, equitable economic growth and mitigating climate change?

This question needs to be asked. If it isn't, civil engineering will get left behind. Other sectors are asking existential questions about their purpose and priorities as they transition towards net zero – a world where our total carbon emissions are equal to the amount of carbon that is removed from the environment. The following is a summary of what's happening:

- In the private sector, environmental, social and governance expectations are becoming more ambitious, while corporate disclosure rules on carbon emissions are increasingly mandated.

- In the finance sector, money is flowing towards infrastructure assets with lower carbon emissions. The share of sustainably invested assets among investors worldwide was 18% in 2020 – this figure is set to more than double to 37% by 2025.[2]

- At government level, new regulations are quantifying and benchmarking the performance of the private and finance sectors to help them meet their goals. Legally-binding goals are being set for collective action and decarbonisation. The UK, France, Spain and Denmark are among the nations that have committed to achieving net-zero carbon emissions by 2050. Germany and Sweden have legislated to become net zero earlier, by 2045.[3]

- At a societal level, COP26 was an inflection point in the conversation about climate change and the need to drastically reduce global emissions, marking a shift in public perception and media coverage.[4,5]

Civil engineers will be critical to the next industrial revolution. Achieving net zero, meeting government targets and creating opportunities for the finance sector to invest in low-carbon infrastructure means embracing new technologies, from battery-powered rail to decarbonised road networks. Bringing emerging technologies into practical use requires the skills and expertise of the civil engineering industry.

The financial challenge

Just like the first Industrial Revolution, the green industrial revolution is a century-defining technical and financial challenge. In economic terms, global spending on physical assets to achieve net zero by 2050 is estimated to require US$275trn between 2021 and 2050, or about US$9.2trn per year on average.[6]

These are vast sums, but the financial sector is beginning to view business-as-normal as more of a risk than transitioning towards a decarbonised economy.

As a result, significant new commitments were made at COP26. The Glasgow Financial Alliance for Net Zero, a global coalition of 450 financial institutions, pledged to utilise their collective US$130trn of private-sector capital to transition emerging and developing economies towards net zero by 2050.[7]

> Making the investment case for low-carbon infrastructure is now an essential skill

These announcements sound impressive, but the task now is to take commitments and turn them into action.

The ICE wants to help close the gap between intent and action by equipping engineers with knowledge and understanding of the issues at play and shedding light on how the profession can accelerate the development and financing of decarbonising both existing and new infrastructure.

The technical challenge

Achieving net zero will mean using new and emerging technologies and approaches to both engineering and finance. Money alone will not solve the challenge – the technical expertise of engineers is required. They will need to adopt open, innovative mindsets and be willing to incorporate new materials, approaches and technologies into their work.

If the success of such projects is now defined by how low impact an office retrofit, a new power plant, a small bridge in a town centre or a road refurbishment is on the environment, how can the profession ensure it contributes to this?

The ICE and its members have a responsibility to help deliver cleaner, safer, more efficient infrastructure. Understanding and making the investment case for low-carbon infrastructure is now an essential skill. Failing to advocate for change will mean that the 2050 net-zero target will be missed and the chance to create a meaningful reduction in emissions will be lost.

We hope this paper provides useful, actionable information for the civil engineering community to ensure we can be proud of our contribution to solving one of the biggest problems facing society today.

1 HM Government (2020) The ten-point plan for a green industrial revolution: www.bit.ly/GIR10PointPlan
2 Statista (2022) Share of sustainably invested assets among investors 2020-2025, by region: www.bit.ly/StatistaSIA
3 House of Commons Library (2021) Global net-zero commitments: www.bit.ly/CommsLibGNZC
4 Climate Outreach (2022) COP26: what the public heard: www.bit.ly/ClimateOutreach
5 Media and Climate Change Observatory (2022) 2004-2022 world newspaper coverage of climate change or global warming: www.bit.ly/MeCCOWorldNews
6 McKinsey (2022) The net-zero transition: what it would cost, what it could bring: mck.co/3WmxGt3
7 Glasgow Financial Alliance for Net Zero (2021) Amount of finance committed to achieving 1.5C now at scale needed to deliver the transition: www.bit.ly/GFANZFinance

> Decarbonised infrastructure is essential to achieving a green economy that works. But what questions will investors have before they feel confident enough to commit their capital?

02 Aims of this paper

This report intends to:

■ Provide ICE members and key stakeholders with a practical guide to green investment tools and methods. These will be backed by examples and case studies that will promote a basic understanding of financing lower-carbon infrastructure projects.

■ Outline what civil engineers can bring to the table when financing the transition to net zero, by designing and building decarbonised infrastructure as the rule, not the exception.

Decarbonised infrastructure is essential to achieving a green economy that works. But what questions will investors have about potential low-carbon infrastructure investments before they feel confident enough to commit their capital? Civil engineers can help to answer these questions.

The project team wants to:

■ Highlight the fact that many infrastructure projects are abandoned at the planning stage, or cannot attract finance, because they have failed to adequately assess and make provisions for climate change risk and the need to achieve net zero. Planning will increasingly take a project's low-carbon credentials into account, as will financiers. Civil engineers possess the design and asset performance information that can de-risk projects and attract green finance.

■ Start a discussion among the engineering community. Green finance and the transition to net zero by 2050 are fast-moving topics that will only become more pressing and relevant, both to the profession and to society. We want to ensure that civil engineers are part of the conversation – and the solutions.

■ Argue that meaningful carbon reduction and consistent delivery of high-quality, decarbonised infrastructure will not happen in silos. We need to collaborate with other sectors to design and deliver infrastructure that enhances the decarbonisation efforts of surrounding assets, communities and stakeholders – a systems-based approach.

This paper offers guidance on the opportunities and challenges of financing lower-carbon projects and makes the case for civil engineers to play a key role in ramping up investment.

As we will explore, this could mean:

■ Working closely with other parts of the infrastructure ecosystem to develop a more holistic approach to decarbonising new and existing assets

■ Advocating at international, national, regional and micro levels when delivering projects to ensure that they are designed with carbon reduction as a defining principle from the outset

■ Developing and providing accurate data on the carbon profile and impact of projects, to help de-risk future investments

■ Asking challenging questions of ourselves and our industry. What needs to change to ensure we are keeping up with the rapid shift towards net zero? Are we adopting low-carbon principles fast enough and across all disciplines? What are the industry's strengths, and what do we need to improve?

The primary focus is on financing models and examples used in the UK, but we also look further afield for knowledge and inspiration. The ICE's membership is international and decarbonising infrastructure is a global challenge.

It is important to view decarbonisation in an international context. Developing nations are the most vulnerable to the economic, social and political impacts of the climate crisis. The shift to lower-carbon infrastructure needs to be global and systemic if it is to be effective at mitigating climate change.

03 Why now?

Why is now the right time to be talking about civil engineering and financing low-carbon infrastructure?

The ICE believes the time is right for civil engineers to participate in the conversation about driving capital into decarbonising infrastructure. It makes the following points to back this up:

■ At COP26, large banks, pension funds, finance institutions and governments collectively committed billions of dollars in investment into low-carbon infrastructure. The summit marked a turning point in the conversation about climate change and the need to drastically reduce global carbon emissions.

■ Still, the world has moved on since then. We are now dealing with rising inflation, interest rates and major geopolitical conflict. This is changing how we consume energy and operate our economies. The impacts on global supply chains could be long-term and may make achieving net-zero emissions by 2050 harder.

■ Against this volatile backdrop, there is a clear need to design, finance and construct infrastructure that delivers stability and growth. This could be through cleaner, cheaper energy; more efficient infrastructure that reduces energy demand; or transport systems that support improved socioeconomic outcomes.

■ The conversation now is around the practical considerations of getting money into projects. The pledges made at COP26 will not necessarily progress into action. One of the principal themes of the COP27 summit taking place this month in Sharm el-Sheikh in Egypt is to discuss how these financial promises will be translated into spades in the ground.[8]

■ The relationship between the carbon intensity of nations and their economies is becoming more closely scrutinised. For example, the Office for National Statistics now publishes UK carbon emissions statistics alongside quarterly GDP figures and is charting their correlation.[9]

■ Civil engineers design infrastructure that powers economies. They may not be sat at the table when a financing deal is taking place but it is the very asset they have designed that is up for discussion, to either be invested in or abandoned.

■ Civil engineers have a significant role to play in the coming months and years to design and advocate for viable, well-designed, data-backed low-carbon infrastructure projects that will meet the criteria and attract the interest of investors.

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> Those big financial announcements we heard at COP26? They were encouraging, but we look forward to both firm plans and the fine print on the road to COP27. We must see these plans as soon as possible
>
> **Patricia Espinosa, UN climate change executive secretary**

8 The Guardian (2022) Egypt says climate finance must be top of agenda at COP27 talks: www.bit.ly/GuardianCOP27
9 Office for National Statistics (2022) Looking beyond GDP and providing insights on climate change: www.bit.ly/ONSBeyondGDP

Viewpoint: Merging engineering and investment

Mark Crouch, decarbonisation discipline lead at Mott MacDonald, outlines the challenge in understanding the finance sector's approach to risk.

"We've got used to the investment community saying, 'There's no shortage of money – we just need to have confidence in the risk profile of the projects we invest in.' The challenge for us is creating that confidence – giving the right information, and the right assurances that projects are going to deliver lower-carbon outcomes over the long term. In the current economic climate, giving investor confidence becomes even more important.

"That's why the industry needs to shift carbon management and climate change skills from being the preserve of niche sustainability professionals to being part of everything that we do.

"For engineers, this is about understanding the role of the infrastructure they design in delivering a system-wide transition to net zero. This applies to all infrastructure, from district heating networks to national highways, road programmes to bridges. It's going to be increasingly incumbent on every sector to justify what its role is in moving the economy towards net zero.

"Demonstrating net-zero alignment is going to become more nuanced. The maturity of the methods we use to demonstrate sound decarbonisation principles is going to evolve, including new standards and digital solutions. The further we can get ahead of that curve, the better.

"Another thing financiers say is that they need scale to be able to invest. This scale does not have to come from designing one-off megaprojects. When it comes to smaller initiatives, think about how a portfolio of projects can be aggregated to make them more attractive to an investor.

"For example, we've been working with local and combined authorities to help them understand the carbon impact across a portfolio of potential projects, so that they can then bundle them and provide the scale that investors need. Engineers can provide the information that means financiers can bring them into a portfolio and characterise them across the board.

"Mainstreaming climate change and carbon management approaches through all projects, large or small, helps to give the quality assurance and credibility that investors need for them to know that decarbonisation and climate risks are being managed consistently."

04 What is low-carbon infrastructure?

Existing infrastructure is the largest part of the decarbonisation puzzle

Much of the decarbonisation challenge surrounds existing, not new, infrastructure. It is estimated that 80% of buildings that will exist in the UK in 2050 have already been constructed.[10]

Decarbonising our existing built environment is harder than decarbonising future infrastructure that can utilise new technologies, materials and construction methods more easily. Other developed countries, where infrastructure and the built environment is already well established, face a similar challenge.

Engineers face a huge task in retrofitting existing infrastructure to support net zero. It is also an exciting opportunity for the profession to do what it does best – create innovative solutions to problems that affect the whole of society.

New infrastructure as a considered investment in carbon

While the carbon emissions of the built environment can be improved by powering it with lower-carbon forms of energy once it is operational, reducing its embodied carbon needs to happen from the pre-design stage.

Embodied carbon is the carbon dioxide emissions associated with materials and construction processes throughout the whole lifecycle of a building or asset. It includes, for example, carbon created during the manufacturing of building materials, the transport of those materials to the job site, and the construction practices used.[11]

Even with projects that use large amounts of carbon-intensive elements such as concrete or steel, engineers can make their design and performance as carbon-efficient as possible.

Individual assets as part of a whole

The concept of infrastructure that supports the transition to a decarbonised economy – for example, a port that services offshore wind farms – being 'green' is gaining traction. This systems-based approach to delivering decarbonised infrastructure – requiring an asset not just to perform well on its own but to be an active part of wider systems and communities, enabling a regional or nationwide transition to net zero – is necessary to decarbonise rapidly and comprehensively.

TAKEAWAYS

- When people think of 'green' infrastructure, solar or wind farms typically spring to mind – but the definition of what constitutes a sustainable asset is evolving.
- Civil engineers are deeply involved both in infrastructure that is easy to classify as green and the less obvious enabling infrastructure that will be key to supporting the transition to net-zero economies.
- For civil engineers, the task is to design with low-carbon principles in mind, whatever the project, and to be able to explain why this is important.
- All infrastructure should now strive to become as low-carbon as is technically possible. While this is a huge challenge, it opens opportunities for financiers to support improvements to both new and existing assets.

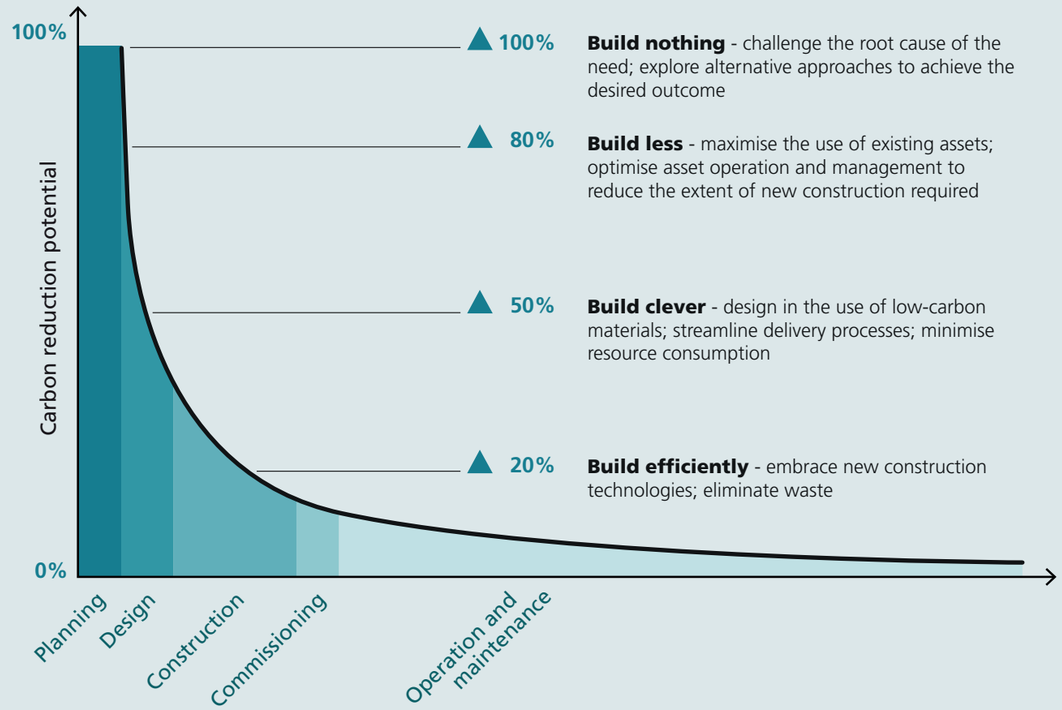
Do we really need it?

Embodied carbon cannot be eliminated completely. However, the retrofit of existing infrastructure, or the creation of any new asset, must strive to remove as much as is safely possible (see Fig 1, facing page). Questions must be asked about the necessity of the infrastructure before it is designed and built. Is it worth the carbon it will embody and produce? Will it deliver long-term outcomes not just for users but the wider systems it is a part of?

This is where tools such as the low-carbon design hierarchy, as set out in the Infrastructure Carbon Review in 2013 and re-emphasised in PAS 2080 (see panel, facing page), can be useful. Focus needs to shift towards designing assets that transform our behaviours as an economy and as a society.

Infrastructure is a system of systems: each asset is an important cog in a complex environment. Systems thinking is therefore essential to achieving meaningful decarbonisation, rather than looking at one asset at a time.

Fig 1: Tackle carbon early – carbon reduction curve



Source: Green Construction Board

Encouraging behaviour change

Engineers have a huge role to play in designing for systemic lower-carbon outcomes for society. It is about behaviour change. Take transport – this is one of the most difficult infrastructure sectors to decarbonise in the UK, part of the reason being an ingrained culture that favours cars and private transport. This needs to change. How can a station, or a transport interchange node, be designed so that users – whether commuters or freight – take the lowest-carbon option by default?

As engineers, we are problem solvers – but the problems are shifting. We need to retrain. It is now about designing to facilitate behavioural change instead of enabling high-carbon transport modes such as roads to remain king.

We need to be specific about the outcomes we want from projects. The amount of new carbon we are putting into existing systems must be minimised. We should treat any new asset as a carbon investment that helps to achieve overall system decarbonisation.

10 UKGBC (2022) Climate change: www.bit.ly/UKGBCClimate
11 World Green Building Council (2019) Bringing embodied carbon upfront: www.bit.ly/WGBCEmbodied
12 Carbon Trust (2022) PAS 2080: carbon management in infrastructure: www.bit.ly/CTPAS2080

PAS 2080: carbon management in infrastructure

Standards that support a holistic approach to designing out carbon in all sectors are available – PAS 2080, for example, is the global standard for managing infrastructure carbon.

The framework looks at the whole value chain, aiming to reduce carbon and cost through more intelligent design, construction and use.

PAS 2080 also ensures carbon is consistently and transparently quantified at key points in infrastructure delivery, which encourages sharing of data along the value chain.[12]

The ICE is leading a revision of PAS 2080 that is scheduled for publication in early 2023. The specification will cover buildings as well as infrastructure and themes that have emerged since it was initially launched, such as the role of infrastructure in a system, net zero, resilience and the role of offsetting.

Case study: Reopening Devon's Dartmoor Line

The Dartmoor Line demonstrates how a project that does not have 100% 'green' credentials – it is currently using diesel trains – can nevertheless attract investment aimed at decarbonising transport.

NETWORK RAIL

This is a public financing, but there is no reason why similar projects could not attract private investment. The railway line is taking cars off the road, improving local decarbonisation outcomes. It also illustrates how projects need to be considered and designed in the context of local socioeconomic factors.

A disused railway line between Exeter and Okehampton in Devon reopened in November 2021, the first to be reinstated under the Department for Transport (DfT)'s Restoring Your Railway initiative.

First opened in 1871, by 1972 the line had largely been abandoned. After years of local campaigning, a working partnership of Network Rail, Great Western Railway and Devon County Council secured funding from the DfT to purchase and upgrade the line, at a total cost of more than £40m. In less than nine months, the railway line was brought back into use.

The project was overseen by Christian Irwin OBE, director of Network Rail's Rail Investment Centre of Excellence. He says: "The business case for reopening the Dartmoor Line was about improving outcomes for an isolated community that was facing economic deprivation and poor access to education. It was about stimulating the economy of that area via growing connectivity."

Another driver of the scheme was the huge local reliance on cars and a heavy amount of carbon-emitting congestion going along the A30 into Exeter.

"We reopened the railway with diesel trains because that is the rolling stock we've got," Irwin says. "But we're now seeing a deficit in carbon emissions as a result of investing in this railway, as it's taking cars off the road. This is a brilliant stepping-stone to reducing carbon collectively in the local area."

He adds: "The reopening was a great success, and we did it quickly. Our longer-term strategy for the branch line is that once diesel trains disappear, they will be replaced by battery-powered trains, which will reduce carbon emissions even further.

"As long as each project has a strategy to allow it to decarbonise as it goes forward, we've got to make sure that we don't let perfection stifle progress."

13 Department for Transport (2021) Transport and environment statistics annual report: www.bit.ly/DfTTES2021

Case study: National Highways' Net-Zero Highways Plan

Roads can be a tough sell as a low-carbon infrastructure option. Nevertheless, forward projections show that, in the coming decades, road travel could decarbonise quickly and, by 2035, could approach the carbon intensity of rail travel.

In a net-zero world, most travel will still be by road. National Highways argues that "there is also no net-zero economy without net-zero roads".

Road investment must be delivered in a way that reflects future demand and carbon prices and that supports the transition to the net-zero economy.

The transport sector is the largest emitter of greenhouse gases in the UK, with road traffic the largest source of emissions. Total UK annual domestic emissions have fallen 44% compared with 1990 levels, largely down to the shift from coal to gas and renewables.[13] Annual domestic transport emissions decreased by only 5% over the same period.

Given that roads are essential to the functioning of the country, integrating them into a net-zero economy needs to become a reality between now and 2050. Financing road decarbonisation is an example of an 'enabling' green infrastructure investment.

National Highways launched an ambitious net-zero programme in July 2021 that is aligned with recommendations from the Climate Change Committee. The plan commits to three key targets:

Corporate emissions to be net zero by 2030
This covers its network lighting, roadside equipment, travel and offices. Key actions include:
- Switching 70% of its network lights to low-emission LED
- 100% of its electricity purchased from certified renewable energy, with 10% generated on its own land
- 75% of its car and vans to be electric or hybrid by 2025
- Planting at least 3 million trees on or near its land.

Maintenance and construction emissions to be net zero by 2040
This covers the greenhouse gases emitted from the manufacture and transport of products, and the equipment used on National Highways sites. Key actions include:
- Launching a near-zero construction roadmap in 2022 for key materials such as asphalt, steel, cement and concrete
- Working closely with the supply chain to integrate carbon in buying decisions and in systematic innovation
- All construction plant and compounds to be zero emission by 2030
- Using digital technologies to make the most of existing network capacity.

70%
of network lights are to be switched to low-emission LED by 2030

100%
of electricity is to be purchased from certified renewable energy, with 10% generated on its own land

3m
trees to be planted on or near National Highways land

Supporting net-zero road user emissions by 2050
While much of the influence of this area lies with government, key actions for National Highways include:
- Investing in electric vehicle charging networks at motorway service stations
- Supporting government trials with zero-emission HGVs
- Integrating greenhouse gas emissions into RIS3 (road investment strategy) and beyond.

Globally, similar national schemes are emerging.

Major roads are typically government-funded in the UK and thus the private finance sector is less involved than in other infrastructure sectors. Sub-elements of highways investment – such as enabling modal shift to coach or active travel; investments in zero-emission charging networks; and digital roads – directly support the zero-carbon economy.

Whichever way they are financed in the future, engineers designing, maintaining and retrofitting roads will need to meet ambitious decarbonisation objectives.

- Visit www.nationalhighways.co.uk/netzerohighways

TAKEAWAYS

- The features that make a project qualify as low carbon are broadening, but strict benchmarks and assessment criteria are coming that will require civil engineers to clearly account for the carbon output and sustainability of the infrastructure they design.
- Engineers have a key role to play in making sure projects comply with environmental criteria and can secure sources of finance that have a green remit or agenda, or that must report against a taxonomy.

05 What is low-carbon finance?

The words 'green' and 'sustainable' are vague and can be hard to define. It's important to be clear about what is meant when we discuss green and low-carbon financing. At present, there is no one singular definition of 'green' or sustainable finance. Some external definitions include:

"At its simplest, green finance is any structured financial activity – a product or service – that has been created to ensure a better environmental outcome. It includes an array of loans, debt mechanisms and investments that are used to encourage the development of green projects, or minimise the impact on the climate of more 'regular' projects. Or a combination of both."
World Economic Forum[14]

"Sustainable finance refers to the process of taking environmental, social and governance considerations into account when making investment decisions in the financial sector, leading to more long-term investments in sustainable economic activities and projects."
European Commission[15]

"Greening finance: ensuring current and future financial risks and opportunities from climate and environmental factors are integrated into mainstream financial decision-making, and that markets for green financial products are robust in nature."
UK Government[16]

The lack of specificity of the words 'green' and 'sustainable' means they can be vulnerable to being applied to projects, companies and activities that do not make any significant contribution to decarbonisation. This is known as greenwashing and has serious negative impacts on both businesses accused of the practice, and on decarbonisation efforts.

However, projects to create clear, legally binding definitions and benchmarks of what can be classed as sustainable are being carried out by governments and institutions worldwide. These criteria will be applied to developers and their projects when investors are deciding whether to commit capital.

Ultimately, whatever the upcoming changes, it is important to remember that green finance is the same as any other type of financial activity – it is focused on investing in good-quality assets that make a profit.

Over time, the distinction of green finance will become less relevant. All finance decisions will use climate change as an important criterion.

Green taxonomies

To create a taxonomy is to classify something. Many countries and political unions are developing 'green taxonomies', which set out the criteria that specific economic activities must meet to be considered environmentally sustainable.

To help investors to make sound investments in decarbonisation that are backed by evidence, the UK and the EU are in the advanced stages of creating frameworks that will define and classify green activities.

Civil engineers will be vital to ensuring that an infrastructure project complies with increasingly strict environmental criteria and can therefore secure sources of finance that have a green remit or agenda, or that must report against a taxonomy.

14 World Economic Forum (2020) What is green finance and why is it important?: www.bit.ly/WEFGreenFinance
15 European Commission (2022) Overview of sustainable finance: www.bit.ly/ECSustFinance
16 HM Government (2021) Greening finance: a roadmap to sustainable investing: www.bit.ly/GovGreenFinance

06 Financing a project: the basics

This section is intended as a practical guide to who the players typically are in a transaction, and the most common structures for financing an infrastructure project.

Globally, most major infrastructure projects are government-funded. Many others are funded by corporates, using money from their own balance sheets. However, projects seeking external investment are often financed using what is known as a project finance model.

What is project finance?

This is a standard method of financing an infrastructure asset, under which it is financed against the security of its future revenue stream.

Building new infrastructure is extremely expensive – and for that reason, it is rare for major assets to be financed solely by their developers. Oil and gas assets are an exception, with the majority funded by their developers.

Third-party debt and equity must typically be taken on to fund a project's development and construction phases. Once the asset is operational, the finance is repaid, with a return, using the money generated by the asset. This could be the electricity a solar farm sells, the fares paid to use a train line, or the fees paid by users of toll roads, for example. Developers may seek financial support from the government via grants, loans, guarantees or subsidies.

Developers not funding a project solely off their balance sheet will usually create a new legal entity, called a special purpose vehicle (SPV), that is dedicated to financing the project.

Why do developers use this financing model?

Convincing lenders that an asset is a desirable investment can be difficult. Infrastructure investment requires a deep understanding of the underlying risks and how they can be mitigated. Infrastructure projects have high upfront costs during the construction phase and often use new, relatively untested technologies. In addition, projects regularly overrun, have unforeseen issues or exceed their budget, and it can be hard to predict how an asset will perform once it comes into operation.

It can also take a long time to reach the point where the investment starts to be repaid. Payback is often long term

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- Public infrastructure can cost billions of pounds and, as a result, it is often governments that fund their development. However, state funding can be scarce, and policies and availability of funding can change quickly.
- Infrastructure projects are therefore often financed using a mix of public and private capital. There are a host of institutions available to provide private financing, ranging from banks to sovereign wealth and pension funds.
- The risk of an infrastructure project's technology, delivery and operations failing to perform as expected are key concerns to investors and lenders, who need certainty on the technical capability of an asset.
- Civil engineers are vital to designing projects that lenders believe will perform well. They will increasingly be called upon to communicate the features of projects that will further the decarbonisation agenda.

> 66
> Infrastructure investment requires a deep understanding of the underlying risks and how they can be mitigated

Case study: Dogger Bank Wind Farm

This globally significant clean energy initiative uses a classic project finance model.

Located 130km off the north-east coast of England, Dogger Bank Wind Farm will be the largest offshore wind farm in the world. When complete in 2026, it will generate enough electricity to power 6 million UK homes.[17]

The developers have reached financial close on the first two phases of the three-phase project, Dogger Bank A and Dogger Bank B. Dogger Bank C is being developed on a different timescale with financial close to follow at a later stage.

Each phase costs approximately £3bn, including £800m to construct the offshore transmission assets. Despite raising the financing during the Covid pandemic, Dogger Banks A and B secured debt on competitive terms from a group of lenders comprising 29 commercial banks and three export-credit agencies.

These first two phases are being constructed in tandem to make the most efficient use of technology, materials and contractors. It also means lenders can lend to both phases at the same time.

The total senior debt facilities across the two phases is £4.8bn, plus ancillary facilities of about £0.7bn. Dogger Banks A and B are being project financed with a debt-to-equity ratio of between 65% and 70%.

The first two phases have already generated 320 new skilled jobs for the north-east of England to develop and operate the wind farm. More jobs are set to be created as construction on the project ramps up.

17 doggerbank.com (2022) Building the world's largest offshore wind farm

JAN DE NUL

> Low-carbon assets may be perceived as even riskier if they are ‘first of a kind’ – deploying new and untested materials, technologies, companies or state support schemes. Investors look at risk like engineers do – the higher the risk, the greater the need to mitigate it in some way

and is dependent on public demand for the service the asset provides. This can make it harder to predict whether the asset will make the returns its developers are projecting.

Low-carbon assets may be perceived as even riskier if they are ‘first of a kind’ – deploying new and untested materials, technologies, companies or state support schemes. Investors look at risk like engineers do – the higher the risk, the greater the need to mitigate it in some way.

Project finance is also known as ‘limited recourse’ financing. This means should the owner of the asset default on their repayments, the lenders can only make a claim on the asset and the SPV they have lent to. They typically cannot seek to get their money back via the parent company’s balance sheet.

This means the quality of a proposed asset, and the information available to investors about its features and performance, is fundamental to whether a potential financier will want to invest in it. Investors want certainty that the project can generate cashflows that will repay the debt used to build it.

How this works in practice: a wind farm

A company wants to boost its renewable energy output and decides to develop a new wind farm.

The company creates an SPV dedicated to developing it. The SPV will go out to the market and approach contractors, building up a team that will conduct feasibility studies, and eventually design, build and operate the wind farm.

This SPV will use a mixture of debt sourced from external investors and internal equity from the company to finance the project. The external investors lending to the SPV will eventually want their money back, plus a profit.

Once all of the equity and debt has been arranged and all financing deals have been signed, the project reaches ‘financial close’. The SPV can now use the debt and start the most capital-intensive part of the project: construction.

Once operational and making returns, the risk profile of the wind farm lowers significantly. It has been proven that it can be built and operated successfully. The company might decide to sell the wind farm, refinance it to seek cheaper debt, or bring more shareholders on board.

The parties involved in financing a project

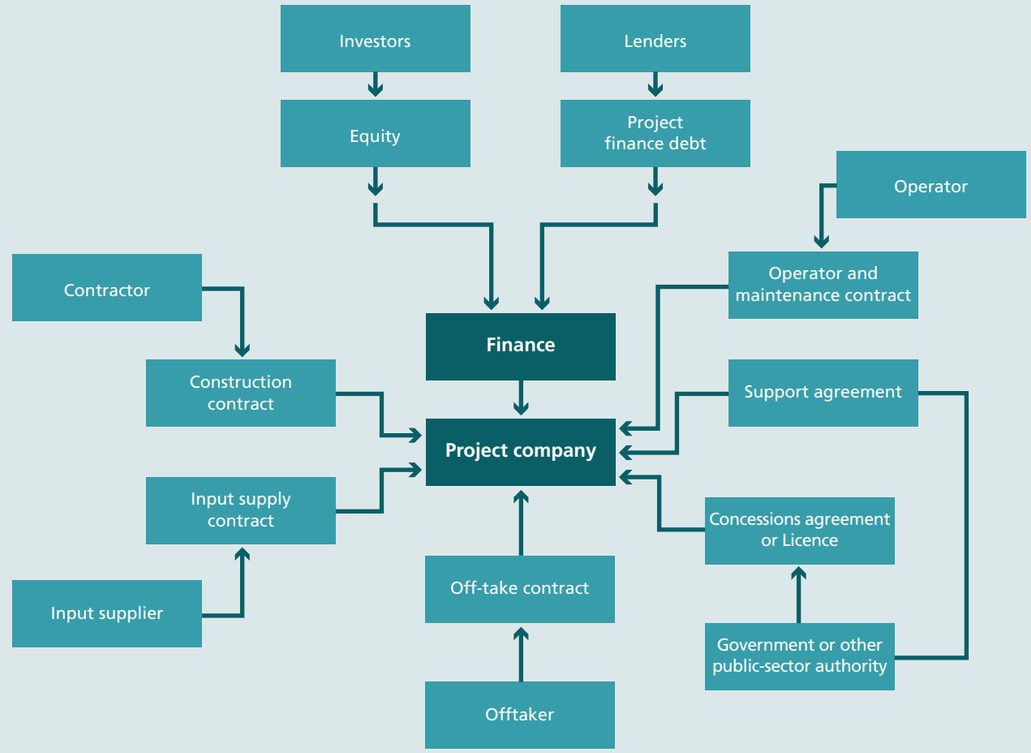
Special purpose vehicle (SPV)/Project developer – The legal entity created to raise funding for the project. It is responsible for the development, construction and operation of the project. The SPV can be spun out of a single business or be made up of several parties who wish to co-develop the project.

Equity providers – Akin to the deposit paid to help secure a mortgage. This cash may be used to finance the early development stages, with equity and external debt sought for the construction phase. The money often comes from the balance sheet of the SPV’s parent company, but external investors or development banks may also invest in the project and become shareholders in the SPV. Early-stage development is often a high-risk phase for a project, so finding equity providers can be a challenge.

Debt providers – Lenders for a project could include:

- *Commercial banks:* These include household-name global banks, down to smaller niche banks. A single major infrastructure project can cost billions of pounds: this means a group of banks typically lends to a project rather than just one. This is known as a ‘syndicated’ loan, with several banks each providing a portion of the debt. There is typically a ‘lead arranger’: one bank that leads the others and arranges the financing, often taking on the largest portion of the debt.
- *Development banks:* These are designed to lend to riskier projects and emerging technologies that cannot access traditional commercial bank lending. They also support projects in developing nations that may struggle to attract commercial finance. Also known as ‘multilateral’ banks, examples include the World Bank, the European Investment Bank, the European Bank for Reconstruction and Development, and the Asian Development Bank.

Fig 2: Simplified project finance structure



Source: Sihombing L et al (2018) Civil Engineering and Architecture: Project financing models for toll road investments: A state-of-the-art-literature review

IIGCC

The Institutional Investors Group on Climate Change (IIGCC) is the European membership body for investors wanting to reduce climate change through their investments. The IIGCC has more than 375 members, mainly pension funds and asset managers, across 23 countries, with more than €51trn in assets under management.

It has recently published a framework for institutional investors to align and manage their infrastructure portfolios with the goal of achieving global net-zero emissions by 2050 or sooner.

The guidance covers a range of issues and characteristics most pronounced within the infrastructure asset class. This includes their physical nature and direct real-world impact and the complete lifecycle emissions.

Equator principles (EP4)

Most global development banks are signed up to the Equator Principles (EP4) – a financial industry standard for environmental and social risk management in projects.

Financial institutions adopt the EP4 to ensure that the projects they finance are developed in a socially responsible manner and reflect sound environmental management practices. They avoid providing finance to projects that could have a negative impact on ecosystems, communities and the climate.

The EP4 requires all projects above certain thresholds to conduct a climate change risk assessment, including physical and transition risks, using categories stipulated by the Task Force on Climate-related Financial Disclosures (TCFD).

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In the UK, ‘green’ gilts are a new government bond that have raised £16bn to date. The money will be used to help finance low-carbon projects. The US, Germany, France and Poland have also issued similar green bonds

■ *Institutional investors:* These invest money for a group of people, such as a pension fund investing the contributions of its clients, or an insurance company investing the contributions of its members. They are typically risk averse. However, institutional investors such as pension funds have a well-established appetite for infrastructure investment. The timeframes that such investors work to are bringing climate issues to the top of their concerns. For example, a pension fund that won’t pay out until the 2050s must consider the risks that can materialise over the next 25 years and make investments that mitigate or avoid them. Climate impacts are expected to become more severe as we approach 2050 – and this is also the date when all assets will need to function in a net-zero environment. Many are also responding to shareholder activism and financial market regulations by divesting from fossil fuel and ‘dirty’ investments.

■ *Bonds:* Developers could access cash raised from a bond issue. In the UK, ‘green’ gilts are a new government bond that have raised £16bn to date. The money will be used to help finance low-carbon projects. The US, Germany, France and Poland have issued similar green bonds. Corporations can also issue bonds to finance projects.

■ *Export credit agencies:* ECAs may be privately owned or government-backed. Their aim is to help domestic companies export their products or services overseas, by providing loans, insurance and debt guarantees. They can help to attract international finance and technology providers to domestic projects, or to export domestic skills to overseas projects.

Offtakers – The businesses or public entities purchasing the output of the project. While they rarely provide cash up front to fund construction, securing an agreement for the output helps to cement its business case. An example is Microsoft’s offtake agreement with the Orca carbon capture and storage asset in Iceland: Orca will remove 10,000 tonnes of carbon emissions from the environment on Microsoft’s behalf over 10 years, charging up to €1,000 for every tonne removed (see case study opposite).[18, 19]

Other players – Additional key parties involved in making a project finance transaction run smoothly include legal teams representing the developer and the lenders; insurers; and technical advisers, who advise the lenders and developers on the feasibility and technical elements of the project. Design, engineering and construction firms also come on board during the development and construction phases.

A typical project finance structure can be seen in Fig 2 (see previous page).

What are the key elements of a transaction?

Debt-to-equity ratio

Developers must often provide a significant amount of the total project cost up front as equity to secure debt. Depending on the project, this could be 10%, 20% or 30% of the total cost or more. The amount of equity required compared with debt is known as the debt-to-equity ratio, or ‘gearing’.

Debt pricing

This is the interest rate applied to the debt on the project. It is usually set at a rate above SONIA (Sterling Overnight Index Average), the benchmark interest rate at which major global banks lend to one another. For example, debt priced at 60 basis points over SONIA bears interest at 0.60% per year. Different tranches of debt can have different pricing, and, just like a mortgage, developers can refinance projects to access better interest rates further down the line or once major milestones have been hit, for instance once an asset becomes operational. The pricing of debt is influenced by several factors, including:

■ Market conditions

■ The technology used – is it well-proven, or relatively untested?

■ Competition – are lots of lenders competing for few assets?

■ The reputation and financial strength of the project sponsors and the companies involved in the project – for example, construction contractors

■ The regulatory stability of the country the asset is located in. Is the project located in a country with a track record of providing long-term, clear rules around decarbonisation or infrastructure development?

18 Business Green (2022) Microsoft inks 10-year CO_2 removal deal with Climeworks: www.bit.ly/BusinessGreenClimeworks

19 Financial Times (2021) World’s biggest ‘direct air capture’ plant starts pulling in CO_2: on.ft.com/3NxomhV

Case study: Orca carbon capture and storage project, Iceland

This headline-grabbing emerging technology has attracted big-name clients – still, it’s important to note that its decarbonisation impact is minimal at the moment and contributes to the trend of offsetting carbon, rather than eliminating carbon production in the first place.

The US$15m Orca plant in Iceland draws in surrounding air. It uses chemicals that react with CO_2 in the air, leaving the air’s other gases to return to the atmosphere.

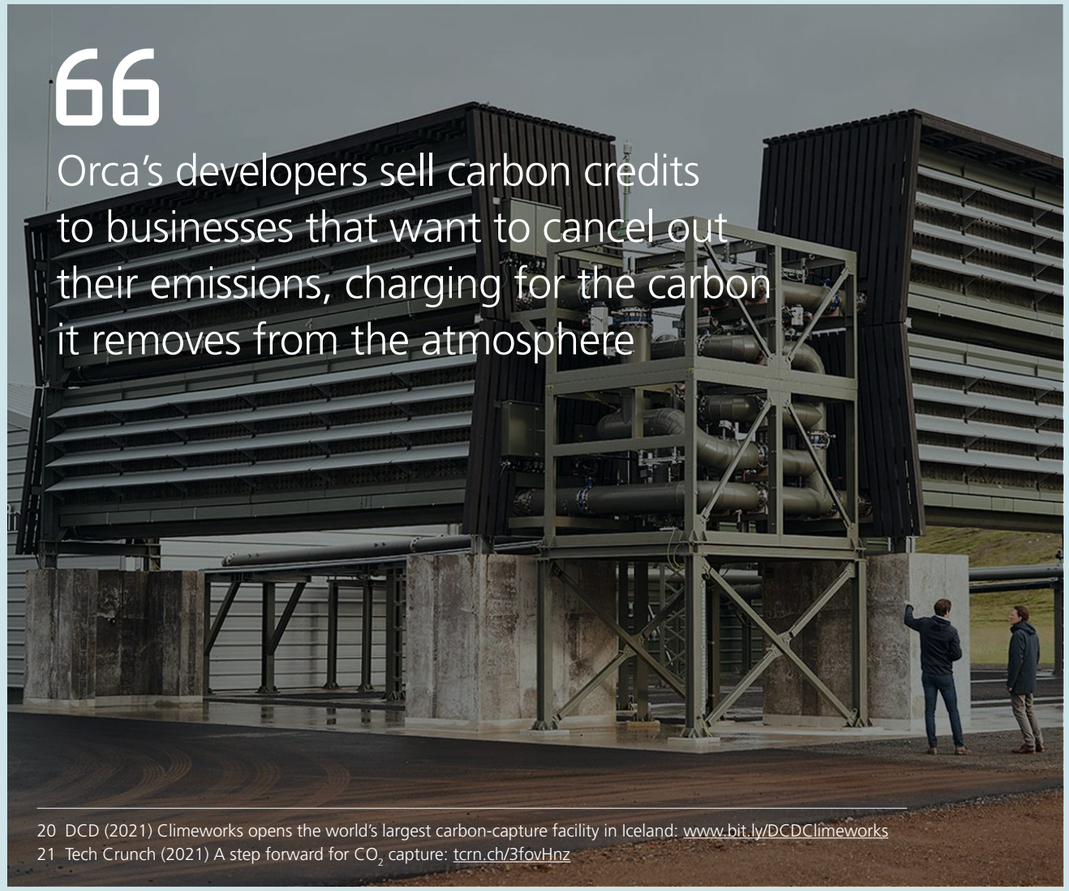
Chemical filters are heated to release the CO_2, which is then dissolved in water and injected into rock 1,000m below ground. The CO_2 crystallises into a mineral that permanently holds it.[20]

Orca’s developers then sell carbon credits to businesses that want to cancel out their own emissions, charging for the carbon it removes from the atmosphere. It currently costs more than US$1,200 per tonne of carbon removed to operate the plant, making it a costly solution.

The technology is constantly being updated and refined. Despite only being viable in countries with abundant low-carbon energy – the plant consumes large amounts of energy itself to operate – it has attracted major global clients such as Microsoft.

Orca’s developers used a project finance model to bring in private capital to get the project built. While it did not disclose the names of its financiers, it has stated that no fossil fuel firms were involved.

Oil and gas majors have, however, invested in other carbon-capture projects, particularly in the US, leading to criticism that the technology could support ongoing use of high carbon-emitting activities.[21]



20 DCD (2021) Climeworks opens the world’s largest carbon-capture facility in Iceland: www.bit.ly/DCDClimeworks

21 Tech Crunch (2021) A step forward for CO_2 capture: tcrn.ch/3fovHnz

■ Credit rating of the sponsors. Banks produce their own internal credit ratings based on the above factors and can also seek information from external credit rating agencies.

The combination of all of these factors will drive investors' returns and appetite for deals and the returns they require.

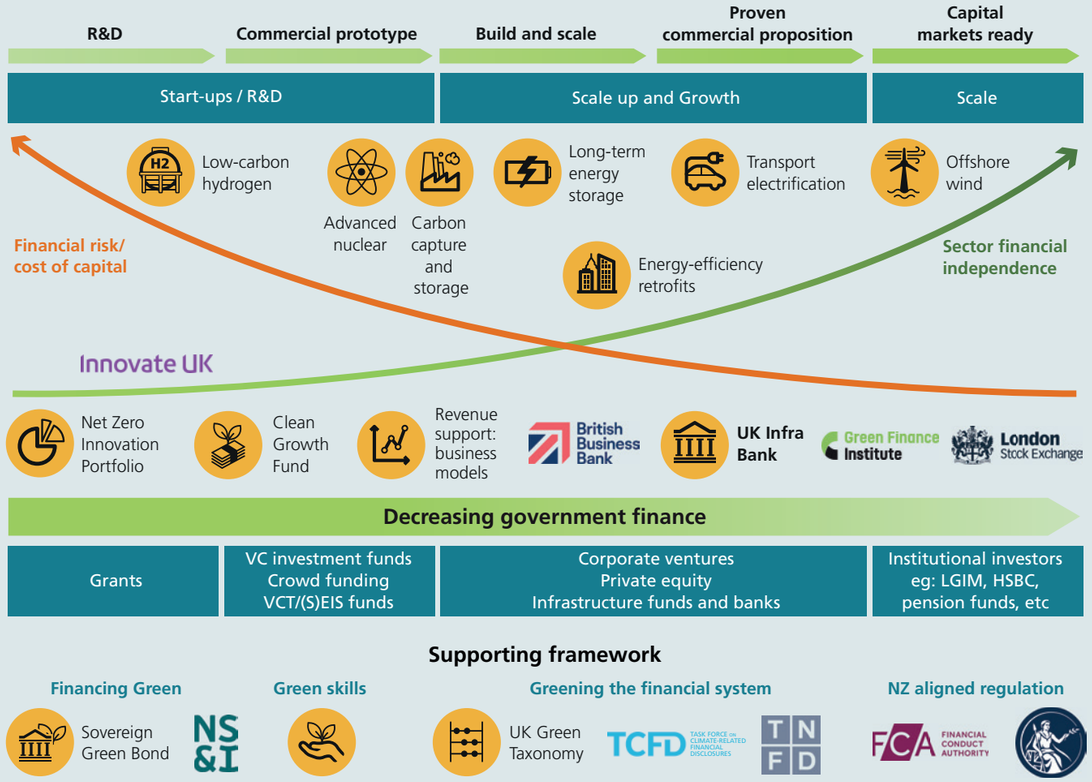
How long does it take to repay the debt? Given the scale of the debt, it is often issued in tranches. The length of the payback period is known as its 'tenor', and subsequent tranches may be repaid over different time periods. Tenor is often linked to key milestones associated with the project and its anticipated lifespan. There is a science to this: in general, the tenor of the debt will be a balance of the life of the asset, the revenue risk in the long term, and the sponsor objectives.

What is the role of government here? Given that many lower-carbon infrastructure technologies are emerging or without a long track record of stable performance, governments often get involved in the procurement stage to encourage and incentivise the private sector to lend. This can be done through:

■ Providing subsidies or revenue support. Government revenue support has been key in making some low-carbon technologies, such as solar and offshore wind, viable commercial prospects. These subsidies are often accessed by competing in state-run auctions, which are intended to create competition between private-sector developers, driving down subsidy costs. This cost to the government is then passed on to the consumer, for example through electricity bills. This is more common in developed markets, where consumers are more likely to be able to bear the additional costs. Sustainable aviation fuel is an example of a nascent industry that is calling for access to state support to help it achieve commercial viability.

■ Running competitions. State competitions and auctions can also be run for the right to develop, own or maintain projects – for example, the UK Government runs a competitive bidding process for the right to own offshore power transmission lines under the UK's seabeds.

Fig 3: The interaction of developing technology and market models with different forms of capital



Source: Department for Business, Energy and Industrial Strategy (2021) Net Zero Strategy: Build Back Greener

■ Creating a stable regulatory climate. Governments can reassure the private sector by establishing regulations that support or mandate decarbonisation, or create specific targets or rules for the private sector to adhere to.

■ Providing guarantees. Governments can provide financial guarantees that they will repay the debt if a project sponsor defaults on repayments. They can also provide performance guarantees covering political risk, demand risk, or risks such as the early termination of a contract. State guarantees can help to lower the perceived riskiness of a project and can also make the debt pricing lower.[22]

■ Providing debt. Government can provide debt and equity to infrastructure projects via state-funded financial institutions, such as the European Investment Bank (EIB) or the newly formed UK Infrastructure Bank. In the case of the EIB, the interest is typically lower than commercial debt and can provide confidence and help to draw in more lenders to the project.

As shown in Fig 3 (see facing page), the stage of maturity a new technology is at will influence the types of capital it can access.

The government and public infrastructure: PPPs

This report focuses on private capital providers such as banks and pension funds that want to invest in low-carbon infrastructure assets developed primarily by the private sector. But other, related models are in use worldwide.

For example, in a public-private partnership (PPP) financing model, project development is a collaboration between local, regional or national governments and the private sector.

The private sector finances and delivers the asset, for example a hospital. The asset is then handed over for the public entity to use. The borrower is responsible for repaying the capital spent, plus providing a profit. This is achieved either through the cashflows the asset generates or through taxes, with the public entity eventually getting ownership of the asset after an agreed period.

> 66
> Government revenue support has been key in making some low-carbon technologies commercially viable

22 World Bank Blogs (2020) Using government guarantees carefully as the private sector redefines bankability: www.bit.ly/WBBGovGuarantees

Case study: UK Coal Authority's mine water heat programme: Seaham Garden Village, Durham

Seaham's mine water heat programme is an example of how existing coal-based infrastructure can be regenerated and of how state cash can help to usher in private financing for emerging technologies.

Keeping the UK's homes warm during the winter as heating bills rise is a major concern for citizens and the Government alike. Keeping cool during the summer is another growing problem, as heatwaves become more common.

Heating accounts for 40% of energy use in the UK.[23] Finding lower-carbon methods to heat and cool buildings will therefore have a significant impact on the nation's carbon emissions.

It is estimated that 25% of homes and businesses in the UK are located above disused coal mines – a legacy of our former dependence on coal-fired power.[24] When mines are abandoned, the pumps that kept them dry are no longer in use and they become flooded with water.

This water is warmed naturally by geological processes and remains at a steady temperature year-round. By driving boreholes into the mines and extracting the water, it can provide a steady loop of heating and cooling for buildings above the mine area (see Fig 4).

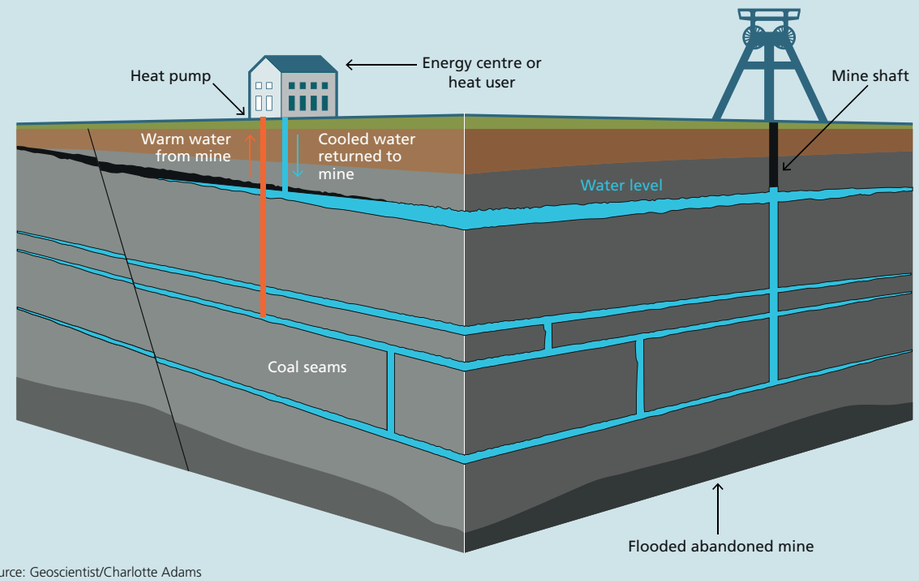
This use of geothermal heat is estimated to produce 75% less carbon emissions than gas-fired heating. It is also cheaper than gas,[25] and could help to regenerate former mining regions.

In Seaham Garden Village, a housing redevelopment in the mining town of Seaham, County Durham, a project is under way to tap into the mine water underneath the development.

Durham County Council, the Coal Authority and a housing developer joined to carry out initial feasibility studies. In 2020, they were awarded government funding of £570,000 to develop the business case and commercial structures. A further £3.2m of state funding has since been granted to fund construction.[26] Developer connection charges and private-sector investment will be used to complete the funding required.

This is a little-used technology in the UK, but internationally, operational mine water heating projects include the Heerlen scheme in the Netherlands, which has cut the former mining town's carbon emissions from heating by almost 75%.[27]

Fig 4: Schematic diagram of a mine water heat pump system



Source: Geoscientist/Charlotte Adams

23 Coal Authority (2021) Mine water heat: www.bit.ly/GovMWH
24 Coal Authority (2021) Mine water heat: www.bit.ly/GovMWH
25 BBC (2021) How flooded coal mines could heat homes: bbc.in/3NsIRfE
26 LGC (2021) Our garden village will use Industrial Revolution's legacy to power green revolution: www.bit.ly/LGCGardenVillage
27 Energy Procedia (2014) Minewater 2.0 project in Heerlen, the Netherlands: transformation of a geothermal mine water pilot project into a full-scale hybrid sustainable energy infrastructure for heating and cooling: www.bit.ly/Minewater

The benefit for the public sector is that the initial risk associated with the creation and operation of the asset is transferred to the private sector, and the model opens up access to private financing.

In the UK, recent PPP models have faced scrutiny for the returns private companies can make from developing public infrastructure assets, particularly when it is the taxpayer repaying the debt. However, the UK has a long history of PPPs that have resulted in significant infrastructure being built. The UK has retained a lot of expertise that can be deployed on future financing structures. Internationally, successful PPP projects have been carried out in many different countries and it remains a key method to get infrastructure financed.

It is important to note that project finance can be structured in different ways from the method outlined above, and other structures exist that are designed to meet the specific needs of one-off or unique projects. However, the basic tenet of needing to find and repay equity and debt via the operational success of the project usually remains the same.

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> Recent PPP models have faced scrutiny for the returns private companies can make from developing public infrastructure assets

Viewpoint: Three key questions

Rohit Das, executive director at climate change investment and advisory firm Pollination and former green finance senior advisor at the Environment Agency, outlines what potential investors will want to know before signing on the dotted line – and the key role of civil engineers in informing them.

"We've got governments, banks and multilateral financial institutions all announcing that they are committing billions of dollars to decarbonising infrastructure. But when it comes to moving from talk to signing a financing agreement, these investors are going to ask three key questions:

- Is this project technically feasible?
- Is it environmentally beneficial?
- How do we make money out of it?

"The first two questions will need engineers to answer them. Engineers can calculate and confirm that, yes, this new technology, or low-carbon concrete, or new manufacturing process will work. They can demonstrate how a lower-carbon cement has the same strength as a traditional cement, for example.

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> The financing community has less of an understanding of the possibilities of an infrastructure project than engineers do

"Being able to provide investors with accurate data and information is how we can get a new bridge that has 30% less carbon emissions, or a new district heating system that can reduce a town's dependence on gas boilers, financed and built.

"The importance of the role of engineers in the green finance space is often overlooked. Financial decision-makers are not often from a technical background. The financing community has less of an understanding of the possibilities of an infrastructure project than engineers do.

"For civil engineers, a key competency in the future will be the ability to justify, calculate and communicate the costs and benefits of designing in resilience and decarbonisation to non-technical people. This is how these projects will be understood by the finance community. This is a core competency that needs to be developed.

"The civil engineering community really needs to start thinking about this – from graduates all the way to senior leadership. It is a huge challenge we face."

07 Green finance and risk: what can civil engineers bring to the table?

Civil engineers are vital to alleviating climate change risk

Engineers provide immense value by de-risking investments. More data, more efficient design, designing in low-carbon features from the outset, and being able to communicate and promote these benefits to planners and investors – these are the ways that both new projects and the retrofitting and improvement of existing infrastructure become easier to finance.

Climate change risk is under rising scrutiny in the financial markets

As explored already, investors and lenders want reassurance that their debt will be repaid, with interest. This is not exclusive to green finance and infrastructure – it is a core concern of anyone in the business of lending money.

The more unknowns and variables there are, the riskier an investment becomes – or the greater the chance the debt will not be repaid. Climate change is a major risk to financial markets because it injects instability and unpredictability into how society and global economies operate. Climate change risk is being split into three categories:

Physical risk – This is the risk of more severe, frequent weather events such as droughts, flooding, heatwaves and storms caused by rising global temperatures. These events can cause physical and economic damage to infrastructure and society.

Transition risk – This is the risk that the shift towards a lower-carbon economy will cause the value of assets or the cost of doing business to change faster than businesses are able to keep up with, or adapt to. For example, the value of fossil fuels could fall in line with government policies to cut usage. To try to mitigate this risk, investors may favour companies and investments that are more likely to be compatible with a decarbonised future economy.[28]

Litigation risk – Projects that ignore decarbonisation are potentially open to future litigation. We are yet to see where these cases play out in terms of liability, but it is an emerging area that is likely to continue to develop quickly. There is a potential liability arising from failure to mitigate foreseeable, preventable climate damage as a result of carbon emissions. There are also risks around making false or unsupportable claims about climate benefits – greenwashing.

Banks and the private sector are measuring their exposure to climate risk

Governments are also exerting pressure on banks to account for the sustainability of their investments. Requirements on investors to account for the carbon intensity of their portfolios are more stringent than the requirements on companies at present. Lenders and insurers are stress-testing their portfolios to work out where their climate risk is.

As a result, the global banking market is bringing in rules and frameworks to benchmark and measure how exposed potential investments are to climate change risk. This means if a proposed or existing infrastructure asset does not meet accepted criteria for being sustainable, it may struggle to access financing. Or it could become a 'stranded asset', of little monetary value because it has failed to keep up with the times. An example would be a coal mine that has to close early owing to coal being phased out.

Carbon reporting to become a matter of course

To remain attractive to investors, the pressure is therefore on for the private sector – including the infrastructure industry – to be able to measure and account for its carbon-related activities.

28 Bank of England (2019) Climate change: what are the risks to financial stability?: www.bit.ly/BofEClimateChange

TAKEAWAYS

- The financial markets are highly sensitive to risk. Investors price the money they lend in part according to how risky they perceive the factors surrounding an infrastructure asset to be.
- Climate change risk is now recognised by the financial markets as a core risk factor.
- The data and information civil engineers generate while designing a project is vital to de-escalating this risk for lenders. This means providing lenders with the reassurance that the project is resilient to climate change-related shocks such as flooding and temperature rises.
- To attract investment for a project, companies will need to show not only how the asset is resilient to climate change scenarios but also how it helps to mitigate them. They will have to show how the asset can meet the decarbonisation standards and expectations not just of today, but decades from now. Failure to do so means a project may not attract investors seeking green or low-carbon assets.
- Civil engineers need to be conscious of the criteria used to define a low-carbon, resilient asset and design with these principles in mind.

Viewpoint: The lender's case

French bank Société Générale has lent billions to low-carbon infrastructure projects around the world. Allan Baker, a chartered engineer and a financier, has been involved in arranging debt for several €1bn-plus offshore wind projects in Europe as well as developing business models for new clean energy technologies such as hydrogen and carbon capture and storage.

"As an engineer working in finance, my general observation is that there could be a lot more engagement between the engineering community, other stakeholders and the finance world to create a better understanding of what makes a project financeable, and why certain elements of project design and commercial contracts can have a material impact on the ability to raise financing for major infrastructure projects or the terms and conditions of the financing.

"Often, we find that if we don't get involved in large-scale infrastructure projects at an early enough stage, we end up going back a few steps to amend aspects of the project commercial structure or design to address specific bankability issues.

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> With the new technologies coming out of the energy transition, the case for early engagement is even stronger

"This can lead to the need to reopen construction or supply contracts, or to amend previously agreed terms – such as performance guarantees or damages provisions. If this is not possible, it can result in an increased cost of funds or sub-optimal risk allocation for the sponsors.

"With the new technologies coming out of the energy transition, the case for early engagement is even stronger. Commercial and debt structuring for first-of-a-kind transactions requires close cooperation between project sponsors and the finance community to ensure that the technology is bankable.

"Engineers have a critical role in this engagement to help financiers fully understand the risks and deliver optimal financing solutions."

The international banking sector is adopting disclosure requirements such as those from the Task Force on Climate-Related Financial Disclosures (TCFD). This requires companies to provide information to governments and potential investors about the work they are doing to ensure they are mitigating climate change.

Investors can then use this information to assess how exposed to climate change risk they would be if they were to invest money with a company.

TCFD requirements are now mandatory for the largest UK-registered companies and financial institutions. This includes the UK's largest traded companies, banks and insurers, as well as private companies with more than 500 employees and £500m in turnover.[29] Major construction and engineering firms will be included in this.

It is only a matter of time before other countries follow suit – and smaller companies are asked to provide data and information about their exposure to climate risk. When international finance is involved in a project, green lending principles such as the EP4 (Equator Principles) come into play – which require a transition risk assessment. (See page 23 for our explainer on the EP4.)

The incoming wave of carbon frameworks, rules and disclosures can seem confusing. The most important thing to remember is that those involved in developing infrastructure should make carbon reporting integral to the design process, gathering accurate data that enables projects to meet increasingly strict emissions criteria.

29 Gov.uk (2021) UK to enshrine mandatory climate disclosures for largest companies in law: www.bit.ly/GovClimateDisclosures

Case study: South Bank Quay development at Teesworks, Teesside

South Bank Quay is an example of an 'enabling' infrastructure asset that directly facilitates more low-carbon infrastructure to be built. It has been developed as part of a wider local decarbonisation effort, demonstrating a systemic, collaborative, cross-sector approach to cutting carbon emissions in an economically deprived area. It is an example of how government can support local authorities by providing affordable loans with flexible repayment terms.

The South Bank Quay development is a project to rehabilitate part of the former Redcar Steelworks site along the River Tees, creating a 450m quay to service the offshore wind sector. Once complete, it will provide port and servicing facilities for the Dogger Bank wind farm (see page 21), which is set to become the world's largest offshore wind farm once complete.

The project is part of Teesworks, a freeport area that has offshore wind, manufacturing, chemicals, shipping and green energy projects onsite or in development. It already hosts companies such as British Steel and Hanson. Despite the carbon-intensive nature of many of the businesses operating here, Teesside aims to deliver the UK's first zero-carbon industrial cluster.

South Bank Quay will provide opportunities in the area for manufacturing, storage and mobilisation of wind technology, as well as supporting 800 jobs in the region, with the potential to unlock thousands more.

In October 2021, the UK Infrastructure Bank (UKIB) provided a £107m loan to the Tees Valley Combined Authority (TVCA) in support of the South Bank Quay project. The UKIB is the new UK Government-owned policy bank that provides loans to local authorities to support infrastructure projects that align with its mandate to help tackle climate change or boost local and regional economic growth. As part of its support for local authorities, the bank can offer loans of up to 50 years with flexible repayment terms.

The UKIB provided the loan to the TVCA at a fixed rate of gilts plus 60 basis points (bps), which is 20bps cheaper than the Public Works Loan Board rate. The loan repayments have been structured to align with project demands, offering the TVCA a pre-credit period to match the construction phase.

Viewpoint: Improving climate risk profiles

Alex Doyle, deputy chief impact officer at the UK Infrastructure Bank (UKIB), describes how important engineers are to improving the climate risk profile of a project.

"The 2008 financial crisis was about not knowing where the risks of subprime debt were in the financial system. Imagine how little data there is about where climate risk is. Internationally, financial regulators see this is a financial stability issue. There is a lot to do to ensure that we in the financial sector know where our climate risk is, and, equally, environmental risk.

"Investors will need to know, for example, whether their investments meet the requirements of the EU's green taxonomy in the future. In the green taxonomy, every infrastructure asset that is going to exist for longer than 10 years needs to have state-of-the-art climate scenario planning. It needs to show how it is resistant to 30-year temperature rise scenarios and how it is designed to respond to them.

> Ultimately everything comes back to the asset, and the asset is always designed with an engineer

Investments cannot be labelled as green if they haven't done this.

"Given that green funds and investments will have to target a level of green taxonomy compliance, failure to factor in this kind of thinking will give investors pause when considering a project. Yet for engineers, this planning and forecasting is something that can be done relatively easily early in the design process.

"If the UKIB wants to invest in an infrastructure project, we will look at the engineers' reports. If the engineers did not define that the project met a certain environmental standard, or did not design it to be resilient and compatible within a lower-carbon system, then it is hard to amend these standards at the point of financing.

"Engineers are one of the most important parts of the green finance story – because ultimately everything comes back to the asset, and the asset is always designed with an engineer."

Viewpoint: An issue ready to ignite

Euan McVicar, senior climate advisor at law firm Pinsent Masons, explains why the present scenario feels akin to the time of the early tobacco cases – when the argument was being made that tobacco companies could no longer maintain that they weren't aware of the health implications of smoking.

"There are clear parallels in relation to the consequences of climate change and of not mitigating carbon.

"That position, that an emitter has no responsibility, is increasingly untenable in terms of what is reasonably foreseeable.

"Likewise, there are clear consequences to investors and others of making climate benefits claims that are unsupportable.

"Infrastructure projects that fail to deliver what people could reasonably expect them to in terms of decarbonisation may well be opening themselves to climate litigation risks.

"Those who make false or careless claims are opening themselves up to a greenwashing risk.

"To whom and how those risks get allocated contractually is going be interesting. Contracts are already starting to grapple with these issues."

Case study: South Africa's Renewable Energy Independent Power Producer Procurement Programme

This programme is an example of how a government competition has led to the private sector developing and financing hundreds of new renewable energy projects. It has also provided a template for other African nations to use.

GLOBELEQ

South Africa has long been fuelled by coal, which is used for at least 80% of the nation's electricity production.[30] However, as ageing coal-fired plants are decommissioned, the government wants to replace them with cleaner solar, wind and natural gas plants.

The country's state energy utility, Eskom, estimates that its electricity generation capacity will drop by a third over the next decade as it shuts down its coal plants.[31] Power blackouts are already common owing to unreliable infrastructure.

The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), introduced in 2011, is an example of a highly successful public-private partnership. It has resulted in significantly more clean energy generation in South Africa. It has deployed multiple technologies, including wind, solar and geothermal, lowered energy prices, and increased competition in the energy sector.

Under the REIPPPP, project developers submit bids in waves of funding rounds, with Eskom agreeing to purchase the power that the projects produce, feeding it into the national grid. This provides reassurance to investors that they will make a return – and brings clean power and new infrastructure into South Africa's electricity grid.

In turn, project developers must prove they have sufficient finance on board when submitting their bid, forcing them to be realistic and proactive in securing finance.

Engineers have been tasked with designing and delivering viable clean energy projects that are often the first of their kind in their local communities.

The scheme also drives more equitable outcomes for South African citizens by mandating that shareholding in projects and contractors is at least 49% South African, with minimum ownership of 25% Black people and 5% Black women.[32]

Completed projects include the 138MW Jeffreys Bay wind farm, which is owned by a consortium of international developers, South African investors and the local community.

Just over a decade on, the scheme has delivered gigawatts of new renewable energy production to the grid. That said, this makes up only about 7% of total generation in the country.[33] South Africa is a long way from weaning itself off coal. But it has proved that it is capable of procuring, financing and delivering green infrastructure projects.

The REIPPPP has become a template for other countries in Africa that are seeking to increase their renewables generation and to attract large-scale private investment.

At COP26, the UK, Germany, France and the US collectively pledged US$8.5bn to help South Africa deliver more clean energy infrastructure, demonstrating growing international confidence in the country's decarbonisation abilities.[34]

30 Bloomberg (2022) Eskom may use coal for longer as South Africa develops renewables: bloom.bg/3fq88uC
31 Power Technology (2021) Eskom plans to reduce its coal power generation over next decade: www.bit.ly/PowerTechEskom
32 PV Magazine (2021) REIPPPP: one of the world's best renewable energy tenders, but there's room for improvement: www.bit.ly/PVMagREIPPPP
33 IRENA (2020) Energy profile: South Africa: www.bit.ly/IRENASouthAfrica
34 BBC (2021) Can South Africa embrace renewable energy from the sun?: bbc.in/3SXsQzx

08 Conclusion

The UK Government has made clear that the first step to delivering a green industrial revolution is "ensuring that the information exists to enable every financial decision to factor in climate change and the environment".[35]

This report has looked at some of the ways in which the finance community is reacting to climate change, and the questions they want answered before they lend money to an infrastructure project. Our industry has a vital part to play in ensuring that low-carbon projects are there to invest in, whether this be new assets or the more impactful – but less talked-about – decarbonisation of existing assets.

Terms such as 'green finance' and 'green infrastructure' are open to interpretation, constantly evolving and can be misused. We believe it is best to focus on outputs, on what can be measured and proven.

In the context of achieving net zero by 2050, this means delivering infrastructure with significantly lower carbon emissions. This applies both to new infrastructure – with each new addition viewed as part of a wider system of decarbonisation – and existing infrastructure. From now, all infrastructure must be designed as decarbonised infrastructure. Achieving systemic lower-carbon outputs must become a core design principle of any endeavour, whatever the project.

This is not simple to do. Civil engineering is a carbon-intensive sector and margins are already incredibly tight. It is a multi-faceted challenge that will redefine how we work in the coming decades. The industry needs to start now, or risk being accused of failing to recognise the scale of climate change and our contribution to carbon emissions.

Engineers are not financiers. Their role in the decarbonisation challenge is not to find and deploy the money required to achieve net zero. It is to deliver the technical improvements, innovative solutions, adaptations and best practices that can deliver low-carbon infrastructure. At the same time, civil engineers should have an understanding of the needs and expectations of financiers when they decide whether to invest in a project.

This is a huge and exciting opportunity – to help vast amounts of as-yet undeployed capital to be invested into decarbonised initiatives, supporting innovative financing models and making low-carbon infrastructure as reliable and profitable as possible.

What could this mean in practical terms? Engineers can provide accurate technical information that de-risks investments, by ensuring that proposed infrastructure assets are easy to understand and meet carbon reporting requirements. This information – ranging from technical specifications and embodied carbon to the projected lifespan of a project – should be shared more widely.

Civil engineers can help to facilitate money flowing into projects. We can be aware of what financiers want and need in a net-zero economy, and how we can help to make projects commercially attractive. We can design and build infrastructure with an awareness of what should be factored in from a carbon perspective. We can collaborate with financiers to deliver projects that generate clear revenues and pay-back as a result of investing in decarbonisation.

Decarbonisation requires us to stretch our abilities and to challenge norms. The decarbonisation we deliver now will create major social, environmental and economic benefits for centuries to come.

Creating efficiencies, making the best use of materials, and deploying technology and innovation to build safe, long-lasting assets: these are foundational civil engineering principles that have always mattered. They now need to be applied to the decarbonisation challenge.

Our task as engineers is to challenge, educate and inspire ourselves and those we work with, utilising our skills to become highly engaged, effective, collaborative leaders in global decarbonisation and how it is financed and delivered.

35 HM Government (2021) Greening finance: a roadmap to sustainable investing: www.bit.ly/GovGreenFinance

09 Recommendations

The ICE should establish a Knowledge Network that is focused on the financing of infrastructure projects and being able to respond to changes in this arena. This network would have a remit that could include:

- Reaching out to financial forums and bodies for their participation in the network to increase knowledge exchange between the finance and engineering communities
- Promoting the role of civil engineers in de-risking investments and boosting investor confidence in the potential for schemes to deliver an appropriate return on capital
- Suggesting undergraduate, postgraduate, initial professional development and continuing professional development course content to improve engineers' knowledge of finance issues and requirements and how they relate to delivering projects
- Collaborating to influence and inform government policy on ways in which schemes can be funded and to set policies that increase consistent carbon management and disclosure
- Encouraging financial institutions to clearly express to engineering and project delivery teams the expectations and requirements required to make a project financially viable
- Promoting the work of this live community and inputting into activities by the UK Infrastructure Bank and other organisations related to convening stakeholders.

Financiers should:

- Join the ICE's Knowledge Network when set up and input to relevant activities managed by it
- Promote the network and other collaborative groups and the work that comes out of them.

ICE members should:

- Provide low-carbon designs as standard and innovate to address reduction of carbon in infrastructure
- Be aware of, and develop knowledge around, the financing mechanisms used on projects and keep in mind the need to de-risk all infrastructure projects if they are to provide a return
- Provide transparent and consistently calculated data and information to assist with assessing impact, risk transfer and carbon-related payback
- Use data and knowledge to give confidence to financiers on the credentials of projects and how they support system-wide net-zero goals.

For more information on the ICE's Knowledge Networks, and to express your interest in joining, please visit ice.org.uk/about-us/what-we-do/knowledge-networks

Resources

This paper supports the research and ideas of two other ICE reports released in the past year: A Systems Approach to Infrastructure Delivery (SAID) Part 2: Putting the Principles into Practice (www.bit.ly/ICESAID2) and the Low Carbon Concrete Routemap (www.bit.ly/ICELCCR). Together, these three publications provide a clear picture of the ICE's concerns and priorities regarding infrastructure decarbonisation.

We frequently run events and create and share resources dedicated to furthering the role of civil engineers in decarbonisation. For more details, visit The Carbon Project on the ICE website: www.bit.ly/ICECarbonProject

Further reading and resources for learning more about green financing and decarbonised infrastructure:

- The UK's Green Industrial Revolution 10-Point Plan: www.bit.ly/GIR10PointPlan
- Green Finance Institute: www.greenfinanceinstitute.co.uk
- The UK Centre for Greening Finance and Investment: www.cgfi.ac.uk
- UK Infrastructure Bank: www.ukib.org.uk
- International Net Zero 2050 commitments and progress: www.bit.ly/NetZeroCandP
- The UK's incoming Green Taxonomy: www.bit.ly/UKGreenTaxonomy
- The EU Green Taxonomy: www.bit.ly/EUtaxonomy
- The Institutional Investors Group on Climate Change's net-zero framework for banks: www.bit.ly/IIGCCframework

Established in 1818 and with more than 95,000 members worldwide, the Institution of Civil Engineers exists to deliver insights on infrastructure for societal benefit, using the professional engineering knowledge of our global membership.

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UN Sustainable Development Goals (SDGs)

Linking our work back to the UN Sustainable Development Goals is a core part of the ICE's plan and mission. This paper ties in with the following SDGs:

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