MI-ROG

# THE CIRCULAR ECONOMY AND NET ZERO CARBON

## Circular economy approaches to reaching net zero carbon infrastructure

White Paper No. 4 | 2020

# Preface

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Chairman

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2020 — a new decade amid a global pandemic, with an ambition to deliver a legislated target of net zero emissions by 2050. There is no doubt that infrastructure has an important role to play in an economic bounce back. The recent calls to "build back better, build back greener, build back faster" exemplifies the need to grasp this recovery period to accelerate the transition to net zero.

Circular economy thinking across infrastructure delivery has matured significantly since MI-ROG was established in 2013. The Climate Change Committee published a Net Zero Technical Report in May 2020 reinforcing the circular economy as a route to Net Zero. This MI-ROG paper draws together some of the key themes of previous thought leadership and shows how circular economy approaches are a vital ingredient in delivering any net zero carbon strategy or action plan.

Rather than re-invent the wheel, we apply circular economy approaches to the highly effective "Build efficient, Build clever, Build less and Build nothing" formula from the Green Construction Board's Carbon Reduction Curve; yielding results across the lifecycle of infrastructure projects.

Unlike recycling — circular economy thinking does not address a waste problem, it addresses a design problem. For too long we have designed infrastructure without thinking what happens at the end of its life, or indeed what the next life of vital infrastructure products and components could be once they are no longer functioning optimally. This is where the role of robust, accessible data is crucial in applying a circular economy mindset to minimising carbon — understanding what component, products and materials we have in position, where they are located, what condition they are in and how they could be redeployed in the future.

And as with all circular economy approaches, collaboration and early adoption within project delivery is crucial. Infrastructure owners and operators are showing leadership, bringing their supply chain partners with them, initiating pathfinder projects and encouraging innovation and novel approaches to meet their ambitious net zero goals.

Circular economy thinking will be integral to success and creates the opportunity for a paradigm shift across the UK infrastructure sector.

I hope there are ideas and approaches in here that you can apply within your own team and workplace as we pull together through this climate decade of transition. Planning, designing and delivering infrastructure with a circular economy mindset, will take you a very long way on your net zero carbon journey.

# Contents

# Introduction

**Circular economy principles and carbon reduction**
A core goal of circular economy principles is keeping assets, components, products and materials at their highest value for as long as possible. The underlying carbon reduction assumption is that using less material results in a lower carbon impact compared to the use of virgin materials.

**A shift to a circular economy moves us beyond efforts to minimise emissions in our extractive linear system. It offers a systematic response to the crisis by both reducing emissions and increasing resilience to its effects.**

Ellen MacArthur Foundation, Completing the Picture, How the Circular Economy tackles Climate Change (2019)

The construction and operation of the UK's infrastructure assets carries with it a large carbon footprint, and work to decarbonise the sector is expected to play an increasingly important role as the UK transitions towards its targets of net zero greenhouse gas emissions (GHG)[1]. This puts it 'centre stage' as the UK seeks to decarbonise, and without low-carbon best practice across the sector the UK's emissions targets will not be met. Urgent action is clearly required. Infrastructure accounts for 16% of the UK's total carbon emissions and has influence over a further 37%[2] attributable to the materials and energy required to build, maintain and operate it.

As our infrastructure provides vital services for society, not building, maintaining and operating it is not a viable option. Furthermore, certain changes to current infrastructure, including new builds, are necessary to transition to a low-carbon world. Therefore, how we deliver the infrastructure and the services it provides in an increasingly carbon-constrained world is a real concern. That's where the circular economy comes in; decoupling economic activity from resource consumption and therefore also reducing the emissions associated with that resource use. The World Economic Forum has estimated that adopting circular economy principles could significantly enhance productivity within the global construction industry, saving at least US$100bn a year[3].

Additionally, applying circular thinking within the built environment in London could contribute a further £3–5bn[4] to GDP by 2036, for example by reducing the costs of primary materials and by generating new jobs in the areas of re-use, remanufacturing and materials innovation[5].

Furthermore, infrastructure is a key enabler of the circular economy. A circular economy requires specific infrastructural developments such as asset-sharing infrastructure, waste collection systems, treatment facilities, material banks, and disassembly and recycling centres[6].

In a survey of investors and construction companies conducted by Arup and the Ellen MacArthur Foundation in 2017[7], respondents indicated that the lack of practical knowledge and know-how is often a barrier for implementing the circular economy. Respondents identified a need for greater dissemination of knowledge, with clear signposting of the steps necessary to make the transition, i.e. practical guidance rather than discussion of concepts. This paper has been prepared to go some way towards meeting that need and sets out to explore the different aspects of circular economy thinking presenting pathways and opportunities to delivering low-carbon or net zero emissions in the delivery of sustainable infrastructure assets.

[1] UK target: net zero GHG emissions by 2050; Scotland target: net zero GHG emissions by 2045; Wales: 95% reduction in GHG emissions relative to 1990 for Wales by 2050 (however have adopted the ambition to be net zero by 2050)

[2] HM Treasury (2013) Infrastructure Carbon Review

[3] World Economic Forum (2016) Shaping the Future of Construction

[4] ARUP (2016) The Circular Economy in the Built Environment

[5] LWARB (2017) London's Circular Economy Route Map

[6] Ellen MacArthur Foundation (2019) Completing the Picture: How the Circular Economy tackles Climate Change

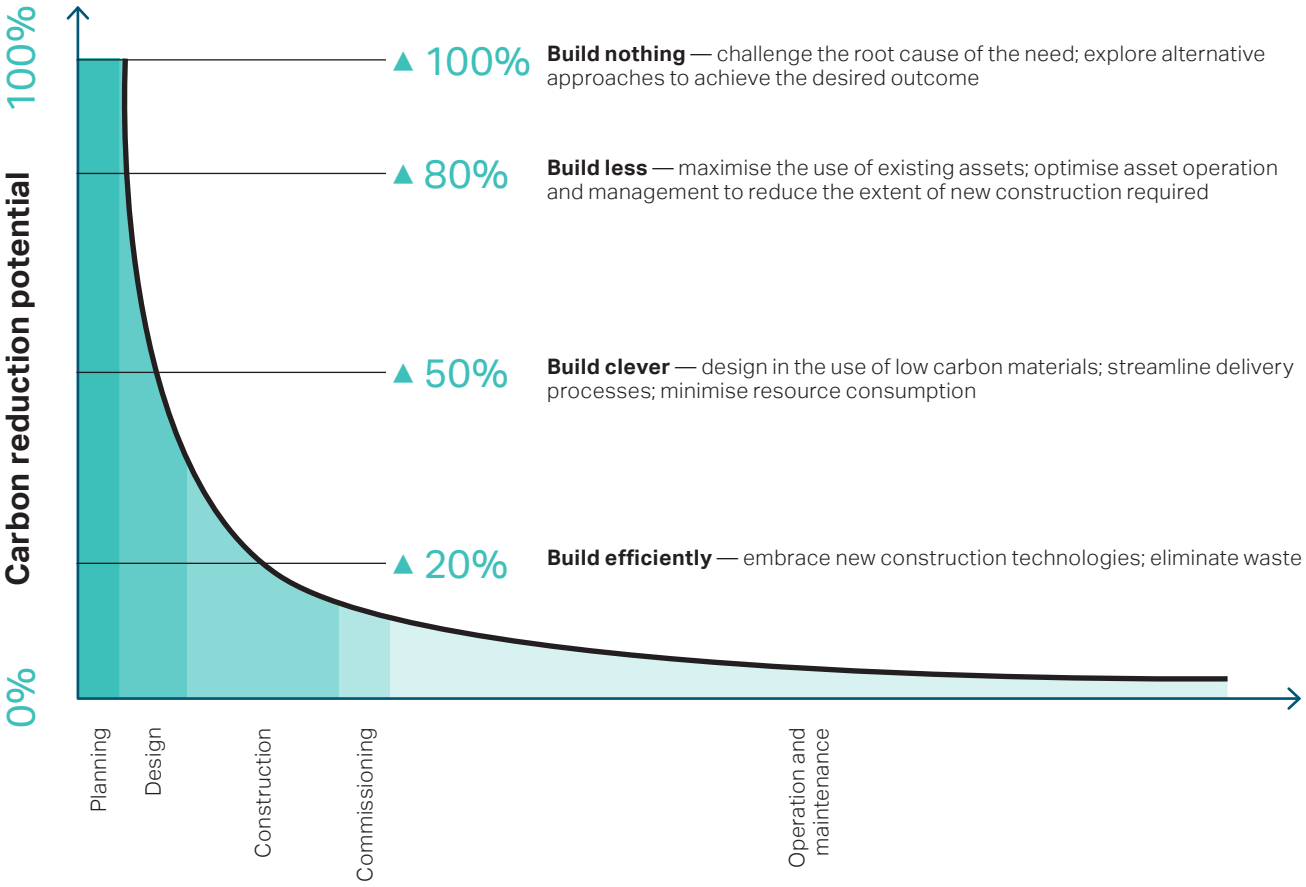
[7] Arup and the Ellen MacArthur Foundation (2018) From Principles to Practices: First Steps towards a Circular Built Environment

# The infrastructure carbon review

The Infrastructure Carbon Review (ICR)[8] published by the UK Government in 2013, aims to highlight the value of lower carbon solutions, make carbon reduction part of the DNA of infrastructure in the UK, and address the low-carbon aspirations set out in the Government's Construction Industry Strategy[9]. It emphasises that carbon can be reduced at any point in the delivery process, but reduction opportunities are greater the earlier you start.

The ICR encourages consultants, contractors and suppliers to rethink their business models, to think beyond simply creating assets, and to consider business opportunities that exist within the following themes: Build Nothing, Build Less, Build Clever and Build Efficiently. This is illustrated in Figure 1 and circular economy thinking has been mapped to each of the themes in Table 1.

**Figure 1: The Carbon Reduction Curve (Source: Green Construction Board)**




[8] HM Treasury (2013) Infrastructure Carbon Review

[9] HM Government (2017) Industrial Strategy: Building a Britain fit for the future

**Table 1: Mapping Infrastructure Carbon Review themes to the circular economy thinking**

| ICR Themes | Circular economy thinking |
|---|---|
| **Build nothing**<br>Challenge the root cause of the need; explore alternative approaches to achieve desired outcome | **Retain**<br>Maximise the use of existing assets to reduce the extent of new construction required<br>Design for durability, longevity, and adaptability<br>Apply procurement approaches that encourage service and performance |
| **Build less**<br>Maximise the use of existing assets; optimise asset operation and management to reduce the extent of new construction required | **Re-use, reclaim, re-cover**<br>Follow the hierarchy of re-use<br>Condition-based maintenance<br>Share materials information with other projects/industry sectors<br>Data and the digitisation of infrastructure as an enabler of both low carbon outcomes and circular economy action plans |
| **Build clever**<br>Design in the use of low-carbon materials; streamline delivery processes; minimise resource consumption | **Re-think**<br>Use less material<br>Extract maximum value from resources<br>Select construction materials with low carbon intensities<br>Select local materials, minimising material movements<br>Use renewable energy for materials movement |
| **Build efficiently**<br>Embrace new construction technologies; eliminate waste | **Optimise**<br>Using new technologies, e.g. for:<br>Material re-use<br>Resource efficiency<br>Flexibility and adaptability<br>End of life (disassembly and re-use)<br>Design to minimise waste, use greywater<br>Design to enhance natural capital/carbon storage |

# Build nothing: retain

## Build nothing

Challenge the root cause of the need; explore alternative approaches to achieve desired outcome

The greatest opportunity for reducing carbon is not to build anything new at all. Decision makers should always challenge the root cause of the need and explore alternative approaches to achieve the desired outcome.

However, new or upgraded infrastructure is needed to facilitate the changes required for a low-carbon world, to contribute towards the United Nation's Sustainable Development Goals (UN SDGs), including Goal 9: Industry, Innovation and Infrastructure, Goal 12: Responsible Consumption and Production and Goal 13: Climate Action, as well as for implementing some of the practical requirements of a circular economy.

Infrastructure is inherently built for longevity and durability by design, reducing the need for future construction of whole new assets.

To keep infrastructure in service as long as possible it is necessary to consider:

- Designing infrastructure such as that it can be maintained and upgraded;
- Employing condition-based maintenance to focus on only necessary work; and
- Procurement approaches that encourage service, performance and durability, and repair and refurbishment over replacement.



# Build less: re-use, reclaim, recover

## Build less

Maximise the use of existing assets; optimise asset operation and management to reduce the extent of new construction required

Where new or upgraded infrastructure is necessary, significant carbon reductions can be made by following the hierarchy of re-use (see Figure 2) and minimising the use of new/virgin materials.

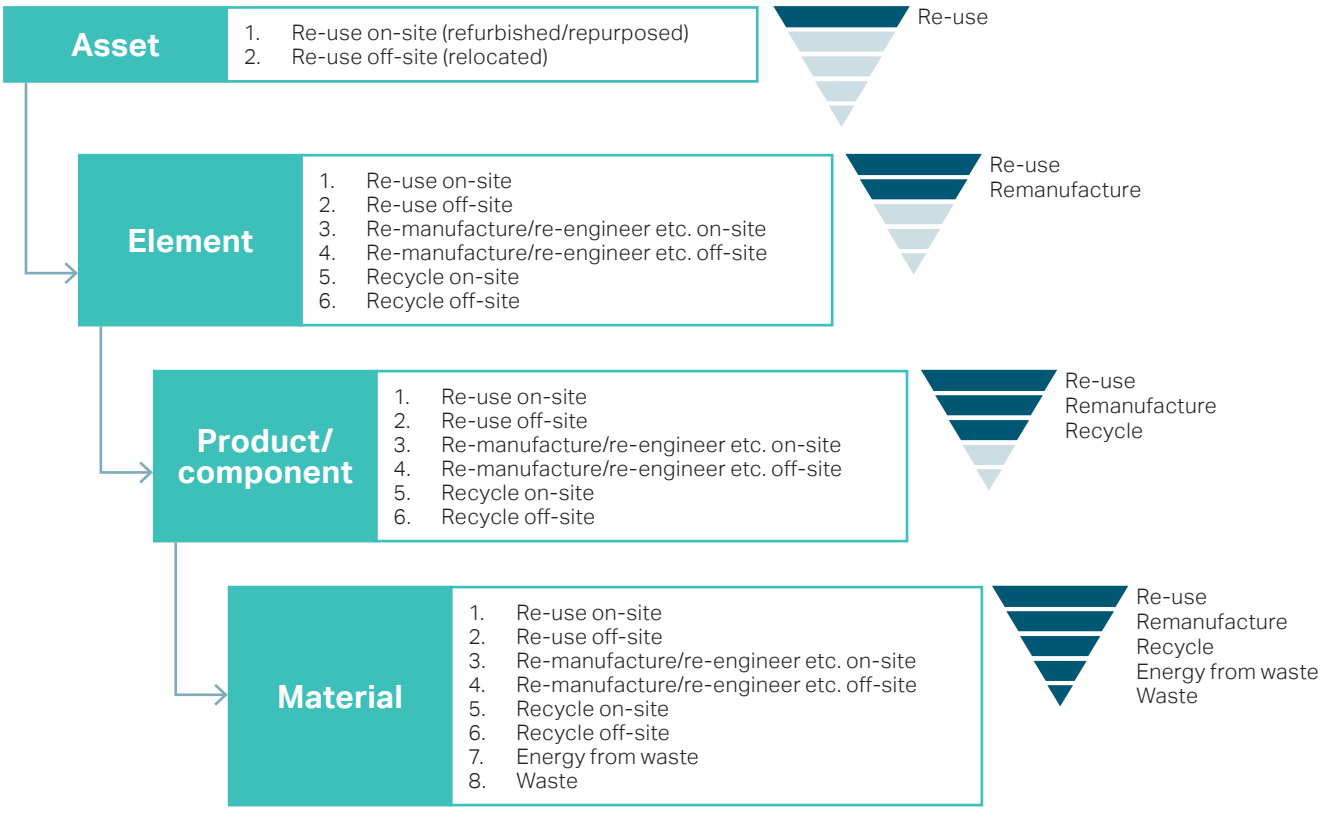
The hierarchy favours re-use, where possible, over remanufacturing, and remanufacturing over recycling.

It also favours re-use/ remanufacturing/recycling of assets (e.g. an elevator) as the most preferable option, followed by components (e.g. winches or doors from the elevator), followed by products and the specific materials, as a last resort. The third element to the hierarchy is favouring on-site sourcing where possible over offsite sourcing.

The following principles therefore apply to "Build Less":

- Designing out the need for extra components (e.g. using passive design negating the need for cooling or ventilation);
- Re-using whole assets where possible;
- Breaking assets into components, products or materials where necessary to use what can be extracted from derelict or redundant infrastructure;
- Using waste, surplus, secondary, or underutilised construction materials to get them back into the value chain;
- Using materials with recycled content;
- Testing all earthworks materials for re-use as high in the waste hierarchy as possible;
- Storing materials for long-term re-use if short-term use not feasible; and
- Where surplus is unavoidable (e.g. tunnel spoil), identifying re-use.

**Figure 2: MI-ROG asset hierarchy cascade for maximising circular economy opportunities**



### Design for recovery and regeneration

Whether it is a whole asset, such as a power station, or a component within a larger system such as signalling within a railway or a pump within a water facility, elements within the infrastructure system will need periodic replacement. When this occurs, and assuming remanufacture/re-engineering is not possible, the best outcome is that the materials and products within them are recovered and regenerated.

The circular economy principle of recovering and regenerating materials and products at end of life is vitally important when we consider the long-term reduction of carbon emissions. As energy supplies become increasingly decarbonised, it will become ever more important to minimise the residual carbon emissions from material extraction and processing that are more difficult to avoid.

Therefore, making best use of existing materials with minimal reprocessing and reducing the use of new virgin materials will become increasingly important. To maximise recovery and regeneration in the future, the potential end-of-life and next life should be considered within the design process (see "Build Efficient").

The asset, product or material must be able to be re-used, remanufactured, recycled or composted at end of (first) life, and it must be assembled into the larger product, component or asset in a way that allows this to happen. This can be enabled through digitisation using materials passports to understand the provenance of materials and products and specifying the recovery notes in the design.

### Data and the digitisation of infrastructure

Data and the digitisation of infrastructure is an enabler of both low carbon outcomes and circular economy action plans. Digitisation allows the tracking and optimisation of resource use and strengthens connections between supply chain actors through online, digital platforms and technologies.

MI-ROG's white paper on the case for a resource exchange mechanism[10] explores the criteria and potential approaches for the "architecture" of digital mechanisms for matching available surplus materials, components or products with end users.

### Digitisation and the internet of things

**Why data is the circular economy's best friend**
The creation of waste is linked to a lack of accessible data on the state, condition, and age of existing assets and components. Providing all components with a documented identity enables re-integration into the economy.

Digitisation of infrastructure assets reveals residual value and longevity as part of optimisation/ maintenance. It facilitates re-use and exchange of materials, assets or components and allows for discovery and re-integration into value chain.

Radio-frequency identification tags (RFIDs) allow product, component and material recognition (passport), which allows producers or manufacturers to have a record in the value chain of what is available to be reclaimed and reused, and which infrastructure asset it is embedded in (Producer Responsibility). This reduces demand for virgin material extraction.

**Waste is material without an identity.**

Thomas Rau, Architect

[10] MI-ROG (2019) White Paper No.3: The case for a resource exchange mechanism

# Build clever: re-think

## Build clever

Design in the use of low-carbon materials; streamline delivery processes; minimise resource consumption

**Business models**
There's lots of discussions about how different business models can increase circularity and many of these will also create benefits for embodied carbon providing a win a win solution. For example, leasing components as opposed to purchasing them.

Where use of new materials is unavoidable, carbon reductions of around 50% can be achieved by designing in the use of low-carbon materials, streamlining delivery processes, and minimising resource consumption[11].

Applying the circular economy here is about re-thinking the selection of materials used, in terms of their carbon intensity; with a key consideration being the ability to extract maximum value from resources once they are in the economic system.

It is critical that a carbon assessment is carried out before making any decisions. Each project and/or client will have a unique set of circumstances. In order to generate the "best" answer in terms of circular and low-carbon outcomes, the carbon impact must be fully assessed. Carbon considerations should take into account the whole life of an asset, not just Capital Carbon or Operational Carbon in isolation, aligning with circular economy principles.

In terms of selecting low-carbon materials, the carbon impact (whole-life GHG footprint) of the assets should be explored and then options considered appropriately for implementation. Options to explore include:

- Maximising low-carbon replacement for Ordinary Portland Cement (OPC), however, recognising that many cement alternatives themselves rely on very high-carbon industries or processes e.g. Pulverised Fuel Ash (PFA) and Ground Granulated Blast-furnace Slag (GGBS);
- Use of recycled or secondary aggregates (if available locally or using low-carbon transport);
- Examining the impact of using recycled steel and deploy where it can be demonstrated to be a lower-carbon option;
- Avoiding overspecification of concrete and steel, especially on the strength gain age of concrete;
- Substituting steel with low-carbon alternatives such as plastic fibres when applicable;
- Use of low-carbon aggregates as a replacement or in combination with primary and secondary aggregates;
- Using products that are certified to circular economy standards such as Cradle to Cradle (C2C)[12] and Natureplus Select[13] products that can be repaired, refurbished, remanufactured or re-used at end of first life;
- Select products that are designed for disassembly;
- Select materials that can be re-used at end of first life; and
- Select materials that can be recycled or composted at end of life.

In terms of sourcing of materials, considerations should include:

- Preference to on-site, over offsite where feasible;
- Material movements should be kept as local as possible; and
- Consider options for using renewable energy for materials movement.

[11] HM Treasury (2013) Infrastructure Carbon Review
[12] Cradle to Cradle (C2C): https://www.c2ccertified.org/get-certified/product-certification
[13] Natureplus: https://www.natureplus.org/

# Build efficient: optimise

## Build efficiently

Embrace new construction technologies; eliminate waste

**Design for recovery and regeneration checklist:**

- ✓ Easy to access to connections
- ✓ Mechanical and reversible (not chemical) connections
- ✓ No resins, adhesives or coatings on the elements
- ✓ Limited use of in-situ concrete
- ✓ Non-composite construction techniques
- ✓ Prefabricated elements are permanently marked with properties
- ✓ Pass on information about the asset, including full as-built
- ✓ Drawings, specification, warranties and identified end-of-use opportunities

Building efficiently means embracing new construction technologies and eliminating waste. Extending the lifetime of an asset is an efficient way of reducing its carbon footprint.

The UK Government's Construction Strategy[14] is focused on technological advances in the construction industry, aiming for all construction to utilise Building Information Modelling — 3D BIM Level 2, which offers huge potential for embodied carbon accounting.

This means rethinking the way we design infrastructure by designing with disassembly and re-use in mind. This includes:

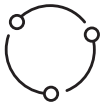
- Additive manufacturing (3D printing): creating 3D 'objects' from a digital 'model' by depositing the constituent materials layer-by-layer, using a computer-aided design model;
- Off-site manufacturing and modularisation of infrastructure design and build, which can significantly reduce waste;
- Flexible and adaptive designs that predict end of life of particular technologies or user requirements (e.g. overhead gantries, high capacity parking structures);
- Designing to minimise potable water use and increase grey water use;
- Designing to enhance natural capital/carbon sequestration;
- Implementing geothermal energy systems in underground infrastructure (piles, foundation, tunnel linings, basement) or similarly sub-pavement hydronic-heating technologies that harvest heat as a by-product of traffic movements; and
- Substituting fossil fuels with hydrogen, solar, wind, tidal energies on construction sites and during operation of infrastructure assets.

[14] HM Government (2013) Construction 2025

# Circular economy principles to support the net zero carbon transition

Table 2 presents a suite of key circular economy principles and enablers that can assist the infrastructure sector in its transition to becoming net zero.

**Table 2: Circular economy principles and enablers**

| Principle | Enabler | Descriptor |
|---|---|---|
| **Business models**  | **Financial Support** | Explore new mechanisms to implement and finance circular economy business models, incentivising environmental considerations and whole-life and natural capital approaches alongside the economic aspects of infrastructure. |
| | **Asset Baseline** | Understand carbon baseline and identify "hotspots" where circular economy interventions would have the greatest positive impacts. |
| | **Procurement** | Embed circular economy requirements into procurement contracts.<br>*Reference to: MI-ROG White Paper #1 Embedding Circular Economy Principles into Infrastructure Operator Procurement Activities* |
| | **Innovation** | Identify potential innovation in collaboration with the value chain to support the transition to a circular economy whilst achieving carbon and cost reductions. |
| **Partnership and Collaboration**  | **Digital Solutions** | Leverage the power of digital solutions to better understand the impacts of material choices and the opportunities for material, components and products exchange. For example, a national resource exchange mechanism.<br>*Reference to: MI-ROG White Paper #3 The Case for a Resource Exchange Mechanism* |
| | **Joint Commitment** | Collectively sharing the same vision and value of circularity through collaboration and sharing of best practice and resource strategies between infrastructure owners and operators (e.g. through forums such as MI-ROG and SICEF), the value chain and policy makers. |
| **Embedding the Circular Economy in Policies and Standards**  | **Policy** | Seek ways to integrate circularity into existing and emerging policies to aid the re-use of materials, components and products to prevent these becoming waste.<br>*Reference to: SICEF White Paper #1 Scotland's Circular Economy: Call to Action for the Infrastructure Sector* |
| | **Standards** | Make sure that standards and specifications facilitate the use of recycled and secondary materials and remanufactured products, so they are seen by business and consumers as comparable, or better than new products. |
| **Data and Targets**  | **Data** | Make sure that data on material use, recycled content and embedded carbon is collected and used as a tool to measure performance and identify opportunities for carbon savings. |
| | **Targets** | Develop and communicate sector specific circular economy targets and metrics with consistent measurement processes and embed these into procurement.<br>*Reference to: MI-ROG White Paper #2 Measuring Circular Economy Performance – Suggestions for Infrastructure Organisations* |
| | **Exemplars** | Identify pilot projects to demonstrate and audit circular economy approaches that will also generate carbon reductions. |

# Concluding remarks

There is tremendous opportunity for infrastructure owners and operators to contribute to the UK by applying circular economy principles.

By following the hierarchy of re-use and embracing new technologies, designing-in low-carbon materials, and making the most of digitisation and the internet of things, the infrastructure sector can minimise waste, maximise the use of existing assets, reduce development costs and contribute significantly to a net zero economy.

As with all circular economy approaches; partnerships, collaboration and early adoption within project delivery are crucial, including bringing together supply chain partners. Additionally, data and targets are essential to track material use, recycled content and embedded carbon, to enable the identification carbon saving opportunities and to measure performance.

Policies and standards will also have to be aligned with net zero ambitions and circular economy principles to facilitate the use of recycled and secondary materials and remanufactured products.

This paper has sought to provide practical steps that can be taken by infrastructure owners and operators, their design teams and the supply chain as they continue to deliver the infrastructure the country requires.

It has also highlighted some of the key enablers that need to be embraced across the supply chain from government to materials manufacturers in order to really embed the circular economy and achieve net zero carbon emissions.

# Authors

## Lead Authors

### Laura Brankin, AECOM

Laura is a Consultant and provides climate change and wider sustainability support and advice to organisations, including several of the UK's major infrastructure owners and operators. Laura co-ordinates the Scottish Infrastructure Circular Economy Forum (SICEF), MI-ROG's sister forum. She is also the Vice Chair of 2050 Climate Group's Board of Trustees.

### Andrea Charlson, London Waste and Recycling Board

Andrea is a Chartered Environmentalist and a Chartered Engineer with over 10 years' experience in leading sustainability in the built environment. She has a background in structural engineering and material consultancy and has extensive experience in embedding low carbon, circular thinking into the built environment. In her current role she is working to reduce London's consumption-based carbon emissions through accelerating the adoption of circular economy ideas in the built environment. She is the London Cluster Coordinator for the Horizon 2020 funded CIRCuIT project, which is supporting the creation of regenerative cities through implementing sustainable and circular construction practices.

### Mark Edwards, formerly Heathrow Airport

Mark is a Chartered Mechanical Engineer and Environmentalist specialising in resource efficiency and the circular economy in infrastructure. At the time of writing this paper, Mark was implementing a resource efficient low carbon approach into the expansion of Heathrow Airport.

### Reihaneh Hafizi, COWI UK Ltd.

Reihaneh is a Civil and Structural Engineer responsible for the design and delivery of a range of infrastructure projects, including tunnels, and structures, as well as managing and promoting the sustainable design and operation of tunnels. Until recently, much of her work has been for contractors on design and build schemes but recently she has been working on the preliminary design of the Lower Thames Crossing for Highways England.

### Colin Holm, Highways England

Colin is Highways England's Senior Advisor in Sustainable Development and Climate Change. Coming from a background in local government, Colin now works on a number of resource efficiency, carbon management and climate resilience projects to fulfil the ambitions of Highway England's Sustainable Development Strategy.

**Alistair Kean, COWI UK Ltd.**
Alistair is Director for Sustainability at COWI UK as well as Head of Sustainability for the Lower Thames Crossing project for Highways England. His background is in sustainable solutions for complex engineering projects including railways, land remediation projects, bridges and highways.

**Robert Spencer, AECOM**
Robert is Director, Sustainable Development at AECOM UKI and the founding chairman of MI-ROG and SICEF. He is a Fellow of the Institute of Environmental Management and Assessment and a Fellow of the Royal Geographical Society. Robert is Vice Chair of FIDIC's (Fédération Internationale Des Ingénieurs-Conseils) Sustainable Development Committee and Chairman of the Environmental Industries Commission (EIC) Natural Capital Task Force. He is also a member of the EIC Advisory Board.

**Sally Vivian, AECOM**
Sally, a Chartered Environmentalist, provides climate and wider sustainability advice and support to organisations to help them identify, manage, measure and report on their impacts and performance both within their own operations and the broader value chain. She has worked with many of the UK's major infrastructure owners and operators on a range of carbon management and reduction projects with a particular focus on developing programmes, tools and advice that integrate carbon considerations into core business processes.

## Contributors

Philip Charles is a Chartered Environmentalist at AECOM with over 17 years' project management and construction environmental management experience. Philip co-ordinates MI-ROG and was one of the lead authors for MI-ROG's third white paper.

James Richardson is a Principal Environmental Scientist at Jacobs and was seconded into HS2 Ltd to lead the carbon management technical discipline for Phase 1 (London to West Midlands). James has over 10 years' experience of sustainability and low carbon consultancy across the infrastructure sector.

Bridget Wise is a Consultant in AECOM's Climate Change and Sustainability Services team with over 13 years' experience supporting companies identify, manage, measure, and communicate the environmental aspects of their business.

## Reference

Brankin, L; Charlson, A; Edwards, M; Hafizi, R; Holm, C; Kean, A; Spencer, R and Vivian, S. MI-ROG White Paper No. 4: The Circular Economy and Net Zero Carbon. July 2020

## About MI-ROG

Born out of the National Industrial Symbiosis Programme (NISP), AECOM founded the award-winning Major Infrastructure–Resource Optimisation Group (MI-ROG) in 2013 as a forum for the UK's infrastructure operators to collaborate across the circular economy theme, meeting the challenge of delivering major infrastructure in a constrained economy.

Members include Crossrail 2, EDF Energy, the Environment Agency, Gatwick Airport, Heathrow Airport, Highways England, High Speed 2, the London Waste & Recycling Board (LWARB), Lower Thames Crossing, National Grid, Network Rail (System Operator), SP Energy Networks, Tideway, Transport for London and the University of Sheffield.

AECOM provides the secretariat and meetings rotate between member organisations, with five to six sessions per year. MI-ROG has a sister group, the Scottish Infrastructure Circular Economy Forum (SICEF) for Scotland's infrastructure organisations, which is also convened by AECOM.

The principles of the circular economy closely align with MI-ROG and SICEF's purpose, to:

- Keep resources in use for as long as possible;
- Extract the maximum value from resources while in use;
- Recover and regenerate products and materials at the end of life; and
- Keep products, components and materials at their highest utility and value at all times.

MI-ROG's and SIECF's joint mission is to be a facility for fully circular infrastructure delivery by 2030.

If you would like to learn more about MI-ROG or SICEF or contribute to the forum's work as a guest speaker then please contact: robert.spencer@aecom.com

## Disclaimer

The views expressed in this paper do not necessarily reflect those of the organisations named above.

MI-ROG was founded in 2013 and is convened by AECOM. The Chairman is Robert Spencer. MI-ROG participants represent organisations including Crossrail 2, EDF Energy, the Environment Agency, Gatwick Airport, Heathrow Airport, Highways England, High Speed 2, the London Waste & Recycling Board (LWARB), Lower Thames Crossing, National Grid, Network Rail (System Operator), SP Energy Networks, Tideway, Transport for London and the University of Sheffield. The views expressed in this thought piece are not necessarily the views of the organisations named.

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