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Charlson A and Dunwoody A (2019)
Briefing: Embedding circular thinking in a major UK infrastructure project. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **172(3)**: 115–118,
<https://doi.org/10.1680/jensu.17.00070>

Briefing

Paper 1700070

Received 08/11/2017; Accepted 04/06/2018
Published online 17/07/2018

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Keywords: natural resources/recycling & reuse of materials/sustainability

Briefing: Embedding circular thinking in a major UK infrastructure project

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High Speed Two Limited (HS2 Ltd) has identified that there is a strong alignment between the High Speed Two strategic goals and potential circular economy benefits and has therefore adopted a holistic approach to realising these benefits in the delivery of the UK's new high-speed rail network. This paper describes the work undertaken to date, including establishing, embedding and communicating circular economy principles, coordinating the realisation of opportunities and reporting outcomes, as well as providing lessons learnt for other infrastructure projects.

1. Introduction

1.1 High Speed Two

The High Speed Two (HS2) programme will run high-speed trains on dedicated lines connecting London and Birmingham from 2026 (constituting Phase One) and then along a Y-shaped route, to Crewe and Manchester, South Yorkshire and Leeds from 2033 (Phase Two) (HS2 Ltd, 2016a). As the biggest project in Europe, it will include the delivery of new rail infrastructure, stations and depots as well as rolling stock.

HS2 Ltd is the company responsible for developing and promoting the UK's new high-speed rail network. It is funded by a grant-in-aid from the government (HS2 Ltd, 2016b).

The HS2 vision is to be a catalyst for growth across the UK, a vision that reaches beyond the railway. The aim is to achieve new standards in infrastructure delivery by being an exemplar in its approach to

- engaging with communities
- sustainability
- equality, diversity and inclusion
- protecting the environment.

As part of this, robust processes are being developed so that these standards are integrated into the organisation's culture and procedures (HS2 Ltd, 2015).

In collaboration with the Department for Transport, HS2 Ltd has defined seven strategic goals that define the success of the programme (HS2 Ltd, 2017a). These are

- being a catalyst for sustained and balanced economic growth across the UK
- adding capacity and connectivity as part of a twenty-first century integrated transport system
- delivering value to the UK taxpayer and passenger

- setting new standards in passenger experience
- creating opportunities for skills and employment
- creating a railway designed, built and operated with world-class health, safety and security standards
- creating an environmentally sustainable solution and being a good neighbour to local communities.

These strategic goals are supported by a number of objectives (HS2 Ltd, 2017b).

As part of the development agreement between the Secretary of State for Transport and HS2 Ltd, HS2 Ltd needs to 'seek to identify and secure continuous improvement opportunities, which could include [...] reducing whole life, whole system costs [...]; improving efficiency and/or value' (DFT, 2017: p. 26). (Whole-life costs are assessed using *The Green Book: Appraisal and Evaluation in Central Government* methodology (HM Treasury, 2018).)

HS2 Ltd appointed its main contractors for the Phase One infrastructure works in July 2017 on a two-stage design-and-build contract. In stage one, the contractors will need to develop and cost a design that meets the performance specification set out by HS2 Ltd. In stage two, the design will be finalised and built. In addition, there will be contracts for each of the stations, which will also be design and build. All contractors will be required to self-assure their outputs meet the HS2 specification.

1.2 The circular economy opportunity

Within HS2 Ltd, there is a strong desire to deliver comprehensively on the strategic goals. Through work undertaken to explore how to 'create an environmentally sustainable solution and be a good neighbour to local communities', HS2 Ltd identified that the application of circular economy principles would be beneficial in this area. However, there is a strong alignment between many of the HS2 strategic goals and potential circular economy benefits (EMF, 2015), as summarised in Table 1.

Table 1. Relationship between HS2 strategic goals and circular economy benefits

HS2 strategic goal	Supporting circular economy benefits
Be a catalyst for sustained and balanced economic growth across the UK	Keep resources in use for as long as possible Avenue to resilient growth for the UK
Deliver value to the UK taxpayer and passenger	Lower capital and operational costs Increased whole-life value
Create opportunities for skills and employment	New job opportunities throughout the supply chain
Create a railway designed, built and operated with world-class health, safety and security standards	Improved health (of supply chain workforce and general public)
Create an environmentally sustainable solution and be a good neighbour to local communities	Reduced virgin non-renewable material use Reduced waste, carbon dioxide emissions, water use and environmental impact

2. Work undertaken to date

HS2 Ltd has adopted a holistic approach to realising the benefits of adopting circular economy principles. The approach consists of

- establishing principles
- embedding and communicating the principles
- coordinating an approach to realising opportunities
- recording and reporting outcomes.

2.1 Establishing principles

As identified by Adams *et al.* (2017), it was considered important to provide clarity of what the circular economy means to HS2, what benefits it can achieve and how it is relevant to different elements of the programme. This helps to overcome the lack of awareness of what the circular economy is and what benefits adopting circular economy principles could deliver.

HS2 Ltd reviewed a wide range of definitions relating to the circular economy, including those from Cradle to Cradle (MBDC, 2015), the Ellen MacArthur Foundation (EMF, 2017), the Great Recovery (RSA, 2015), Waste & Resources Action Programme (Wrap, 2017), the Environmental Audit Committee (UK Parliament, 2014), the UK Green Building Council (UKGBC, 2015) and the UK Contractors Group (UKCG, 2015). From these it identified that the definitions tended to be of two sorts: those which focus on materials and waste (Great Recovery, UKCG, Wrap) and those which look more broadly across a whole system (EMF, Cradle to Cradle). The key themes from across these definitions were

- recirculation of technical and biological elements
- maintenance/maximisation of quality/economic value
- most good as opposed to least bad
- elimination of chemicals toxic to human health or the environment.

Largely based on the definition provided by Wrap and the programme drivers as described in Table 1, HS2 Ltd established a set of principles, to be observed throughout the programme.

- Keep resources in use for as long as possible.
- Recover and regenerate resources at the end of each use.
- Keep resources at their highest quality and value at all times.

These are complemented by an overarching principle to use resources efficiently (HS2 Ltd, 2017b).

Resources are thought of in terms of materials, water, energy and carbon dioxide, as well as natural and social capital.

These principles were selected as they were determined to be clear outcomes that could be aimed towards and were relevant to all parts of the programme. These principles were also considered to be comprehensive in that they also encompassed the other key themes identified. For example, the recirculation of technical and biological elements and the elimination of chemicals toxic to human health or the environment would both respond to the principle to recover and regenerate resources.

Table 2 expands on those principles providing more detail and examples of how they might be achieved as part of the HS2 programme.

The HS2 programme has a design life of 120 years (HS2 Ltd, 2017c); therefore, it is likely that some of the principles are likely to be more relevant to certain parts of the programme than others. Table 3 gives an indication of the priority principles for different elements within the programme.

2.2 Embedding and communicating principles

Upon development of the HS2 circular economy principles, there followed a period of embedding and communication of these throughout the organisation and supply chain.

Embedding the principles included presenting these and the ambition for them within the organisation to the governing boards of each of the phases and aspects of the organisation. This served the purpose of raising awareness and obtaining high-level support for the work and its potential benefits. Key contacts were identified within each directorate, allowing for effective communication or progress and updates as well as insight on how to embed the principles further.

This has allowed for a top-down approach to embedding the principles, whereby key decision makers and senior members of staff are familiar with the concepts and potential benefits of this work.

Further embedding was achieved through inclusion of references to the circular economy and the HS2 principles in key policies, strategies and technical standards. This will ensure that the circular thinking will permeate as many aspects of the HS2 programme as possible and will continue to be part of the HS2 approach to

Table 2. Examples of how circular economy principles can be achieved in the HS2 programme

Principle	Approach	Details
Keep resources in use for as long as possible	Design for longer component lives Design for ease of maintenance to extend component lives	Design for durability, adaptability and flexibility. Use component or repair kits as an addition to the existing product that provides a way to fix a part that frequently fails before the rest have reached the end of their useful lives.
	Condition monitoring	Monitoring of asset condition will help to ensure that components are replaced only when their condition has actually deteriorated, as opposed to replacement on a pre-defined schedule based on performance/wear rate assumptions.
Keep resources at their highest quality and value	Design for reconditioning or remanufacturing	Design products so that they can be easily disassembled into key components to allow these to be refurbished and either put back into the same products or passed on into new products.
	Product-as-service models	Consider potential for alternative procurement models to promote circular outcomes – for example, supplier retains ownership throughout product life with full responsibility for performance, maintenance, replacement and decommissioning.
	Sharing models – to increase utilisation of resources in the economy	Sharing helps increase the utilisation of resources over their life, maximising their value.
Recover and regenerate resources at the end of each use	Design for reuse	This includes methods for facilitating reuse of components at end of life, including initiatives such as reversible building design and products with reuse models.
	Design for recovery/recycling	Design products so that they can be easily separated into raw material components; provide information to future asset owners – for example, through material passports and building information modelling.
	Use of compostable materials Product take-back	Use materials that can return nutrients to the earth. Consider potential models for returning materials to supplier at end of life, including reverse logistics and platforms for reclaiming/returning materials.

Table 3. Priority principle for different elements of the HS2 programme

Element of programme	Priority principles
Enabling works	Recover and regenerate resources at the end of each use – facilitating reuse of materials from demolition works and site clearance
Civil assets	Keep resources in use for as long as possible – design for durability and condition monitoring
Stations	Keep resources in use for as long as possible – design for adaptability and flexibility
	Keep resources at their highest quality and value – product-as-service models
Railway systems	Recover and regenerate resources at the end of each use – design for reuse, recycling and recovery of components
	Keep resources at their highest quality and value – design for reconditioning or remanufacturing
Rolling stock	Recover and regenerate resources at the end of each use – design for reuse, recycling and recovery of components

delivery as the programme grows. Additionally, inclusion in these documents means that these principles are communicated to HS2 stakeholders and the supply chain.

This is supported through continued awareness-raising and communication internally through a number of activities and initiatives, including

- innovation challenge run through the HS2 intranet
- training and knowledge-transfer activities
- board and panel update presentations
- briefings to internal teams and contractors and supply chain.

2.3 Realising opportunities

HS2 Ltd has undertaken work to identify opportunities for implementation of the circular economy into the delivery of the scheme. However, it is the intention that the majority of opportunities will be proposed and implemented by the HS2 supply chain. To ensure that the supply chain comes forward with opportunities, the circular economy principles have been incorporated into the works information provided to contractors. HS2 Ltd will work collaboratively with the supply chain to explore and develop solutions and realise benefits. A bespoke process for opportunities to be realised has been established.

HS2 Ltd is also exploring ways that it can further facilitate realisation of the principles and the benefits internally. One example that has already been pursued is in developing an approach to utilising felled timber at its highest value/quality and through doing so providing economic as well as community and environmental benefits. Other options include greater facilitation of reuse during demolition and construction activities or considering alternative procurement routes for certain packages.

It is the intention that realisation of these opportunities will start to provide precedents of the circular economy being implemented

in infrastructure projects, leaving a legacy that future projects can build on.

2.4 Recording and reporting outcomes

There is no current standard approach to how successful implementation of the circular economy principles is measured in the industry, so this presents a challenge in terms of defining success. HS2 will be recording a range of metrics reflecting sustainability performance including carbon dioxide footprint, waste generation and landfill diversion. However, specific metrics related to circular economy is an area where more industry research is required and an area that HS2 Ltd will be investigating further alongside other infrastructure organisations.

3. Lessons learnt for other infrastructure projects

HS2 Ltd is still relatively early in its journey of exploring how the circular economy can support successful delivery of the programme; however, there are a number of lessons that can be learnt from the work conducted to date that could be useful for other infrastructure providers or projects.

- Understand and communicate how the circular economy can support the delivery of the organisation's or project's objectives.
- Develop a clear definition and outcomes that respond to these objectives.
- Develop a top-down as well as a bottom-up approach; embedding the approach into key policies and strategies as well as developing general awareness and encouraging activity.

4. Summary

HS2 Ltd has identified that potential circular economy benefits could assist in achieving the organisation's strategic goals. Therefore, it has instigated a programme of work that has established circular economy principles, embedded these across the organisation and facilitated the realisation of opportunities.

It is hoped that this has created a client-led initiative to which the supply chain can respond and in turn collaborate to find innovative solutions that respond to the principles and help deliver the organisation's strategic objectives.

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