Decarbonisation options for transport infrastructure

Research factsheet

February 2024

This factsheet provides an overview of the key findings from the research report *Decarbonisation Options for Transport Infrastructure* (September 2023). The report identifies opportunities that will contribute to reducing greenhouse gas emissions (carbon emissions) and delivering lower carbon infrastructure during construction, maintenance and operation of transport infrastructure. It includes a detailed review of material choices, designs and processes, and innovative solutions based on industry best practice.

Research report background

Analysis of New Zealand's carbon footprint shows that lifecycle carbon emissions from the built environment contribute approximately 13% of New Zealand's gross carbon footprint (Thinkstep Ltd, 2018), see figure 1 below.

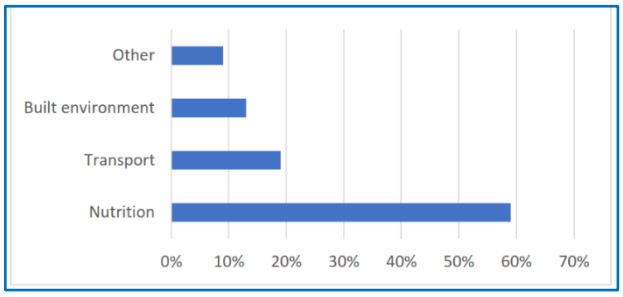


Figure 1: New Zealand sector lifecycle carbon, 2018

Transport infrastructure contributes to these built environment emissions throughout an asset's lifecycle. Greenhouse gas emissions are generated during the extraction of raw materials, manufacturing and transportation of goods and materials, construction activities and maintenance activities. (Transport emissions, from the vehicles using the land transport system, were excluded from this research).

Research approach

Following a literature and policy review, and through workshops with subject matter experts, the researchers identified recommendations and opportunities for key carbon emission reductions and solutions for the transport sector.

Carbon emissions and project lifecycle

The key approach to reducing emissions is life cycle thinking; identifying and assessing emissions across a project (or asset's) life cycle at various stages (figure 2). This approach moves away from a linear take-make-waste model where resources are lost as waste, and moves towards promoting a circular economy thinking.

Major contributors to emissions are the materials used (particularly concrete, asphalt, steel, aggregates) and transport and heavy machinery fuel use for both transport of raw materials and placement and construction at site.

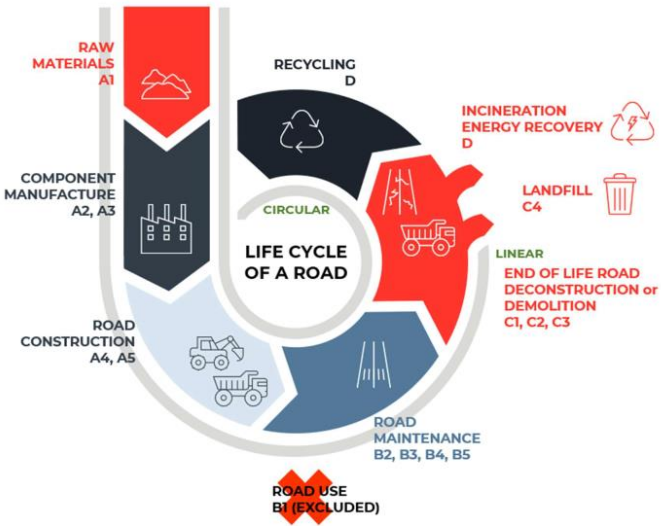


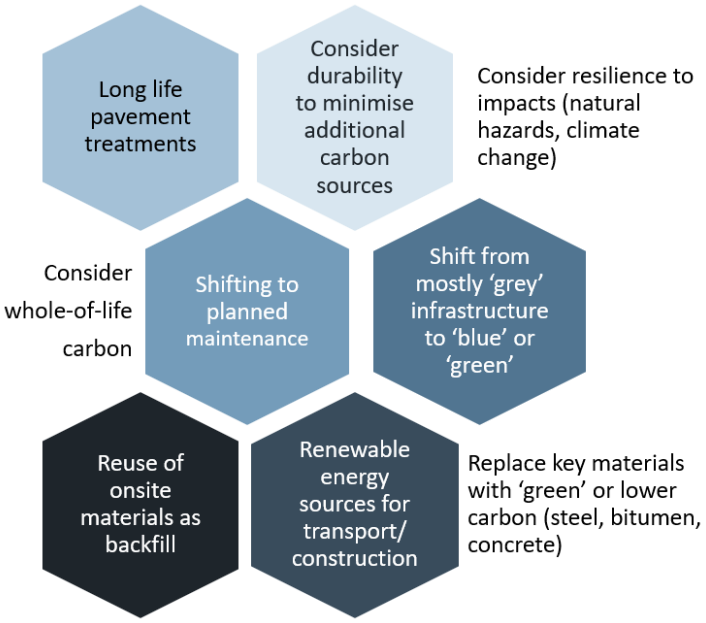
Figure 2: Circular versus linear construction project lifecycles (adapted from Moins et al., 2022)

This research therefore focused on identifying the opportunities to reduce emission associated with the following project lifecycle stages:

- construction
- operations
- maintenance.

Key report findings

Practices that are considered the most effective and efficient in terms of reducing carbon emissions in transport sector infrastructure can be grouped into the following themes:



Designing and constructing for durability and long-term resilience has the greatest potential to reduce embodied carbon emissions across the infrastructure life cycle.

Opportunities for emissions reductions

The opportunities for emissions reductions through the project lifecycle focus on four practice areas:

- processes, including design, business cases and standards
- pavement
- structures, earthworks and slopes
- water and nature-based solutions.

Processes

The biggest carbon reduction opportunities during the project lifecycle are in the initial project planning phases, when large-scale decisions are made about project feasibility, funding, scale, and location. Carbon reduction opportunities at the process and planning levels include:

- identifying options for reduction of life-cycle embodied carbon at the business case and concept design phases (investment decisions and major design decisions such as route selection, road geometry and structures requirements)
- extending the design life and defer infrastructure replacement through planned maintenance
- increasing uptake of nature-based solutions through education and incentives
- fully implementing procurement and other policies which incentivise and provide guidance for embodied carbon reduction
- promoting the use of locally produced and processed materials, where possible
- changing work practices to reduce fuel use, particularly by site machinery.

Pavement

Key opportunities for pavements are usually at the early planning stages, including aligning business cases with carbon reduction targets. Further opportunities are:

- focusing on quality and avoid future rework
- adopting warm mix asphalt and emulsion technologies
- investigating feasibility of regional depots to store and repurpose construction waste materials and resources
- allowing for site-based decisions to be made that could save materials but maintain resilience
- encouraging the transition to lower carbon fuels (such as electrification, biofuels and hydrogen) for heavy vehicles and use of light electric vehicles
- using procurement pressures and efficiencies to impact supply chain
- using pavement or basecourse materials that can be directly reused or processed for reuse.

Structures, earthworks and slopes

Structural materials play a significant role in the overall carbon footprint of the transport network.

A key focus to reduce emissions from structural components is to use alternatives to concrete and steel, which are very carbon intensive.

Key opportunities include:

- expanding the use of concrete mixtures with additives that reduce the carbon intensity of concrete
- exploring the possibility of using concrete that has permanently sequestered (stored) carbon dioxide (CO_2).

Since many alternatives are still in development, other key opportunities are:

- collating and sharing industry knowledge to improve awareness and adoption of lower carbon solutions
- facilitating wider availability of lower carbon alternatives.

Water and nature-based solutions

Water and nature-based solutions that are commonly used include swales, rain gardens, wetlands and pond systems. These systems reduce hard, impervious infrastructure, can enhance biodiversity and provide water treatment and retention benefits. These systems also reduce the use of carbon intensive materials, although some do require components of 'grey' (traditional concrete) infrastructure.

Further opportunities to adopt nature-based water management solutions include:

- revising guidelines and policies to encourage further uptake of these solutions
- replacing piped stormwater systems with nature-based alternatives during maintenance and renewals
- eco-sourcing plants (collecting seeds in close proximity to planting) to support positive biodiversity
- using less carbon intensive materials and considering whole-of-life costs for piped water management systems
- using installation practices that minimise the need to import or export materials and spoil
- undertaking additional research and development on the feasibility of establishing natural solutions for slope stability.

Reducing the carbon intensity of infrastructure projects will require life-cycle thinking involving all technical disciplines, asset owners, contractors, and consultants. There is a global focus on this work, with organisations such as Waka Kotahi NZ Transport Agency, National Highways (England) and Austroads all developing targets, processes, policy, and standards aiming for low-carbon infrastructure development, operations, and maintenance.

Further detail is available in the full report, which describes all the options that were explored in each practice area, and how they score based on their 'carbon impact', or the potential to reduce carbon emissions, their cost, and the feasibility of each opportunity.

All content in this factsheet is sourced from the report Decarbonisation options for transport infrastructure.