Beca

Digital technologies for decarbonisation

Guidance document

Prepared for
NZ Transport Agency Waka Kotahi

11 October 2024
#makeeverydaybetter

Contents

Appendices

1 Introduction

1.1 Overview

This guidance document is a resource designed to assist the New Zealand Transport Agency Waka Kotahi (NZTA) contractors, suppliers, and partners in their efforts to decarbonise transport infrastructure. It addresses the urgent global need to limit greenhouse gas (GHG) emissions and explores the role of various digital technologies in the decarbonisation of infrastructure. The document also provides case studies to support stakeholders in selecting the most appropriate tool for their needs.

Aligned with NZTA's Sustainability Action Plan (Toitū te Taiao) and Resource Efficiency Strategy (Te Hiringa o te Taiao), this guidance document supports emission reduction and resource optimisation using digital technologies. The guidance compares digital technologies implementation readiness with emissions reduction impact so that organisations can maximise their effectiveness within NZTA's overall decarbonisation strategy.

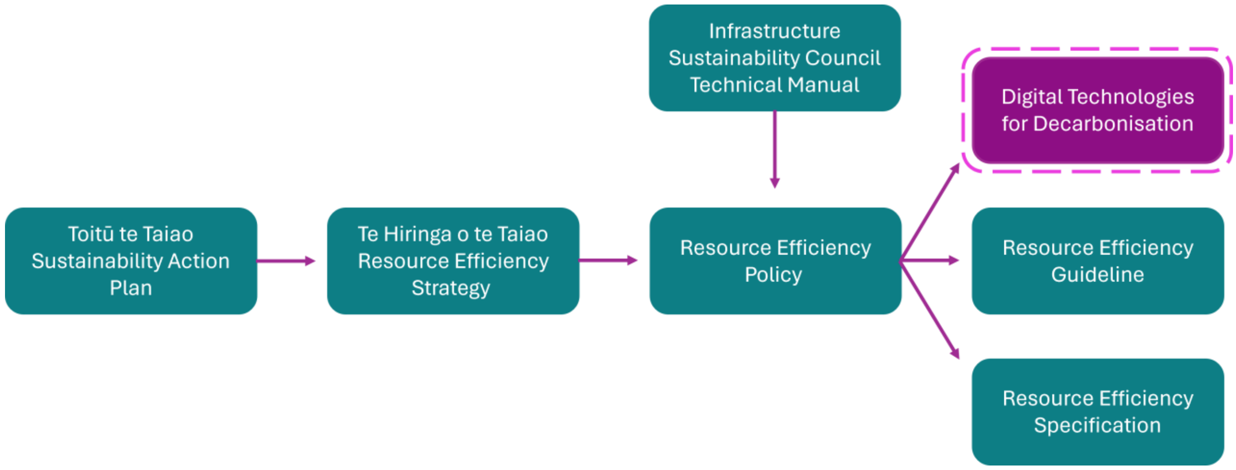


Fig. 1 - Key policy and strategy drivers for the Resource efficiency guideline

The guidance shows how digital technologies impact decarbonisation across project phases. It introduces a decarbonisation-focused evaluation matrix that streamlines project decision-making processes using the People Process Data and Technology (PPDT) change management framework. However, the real value lies in the real-world case studies, which illustrate how these digital technologies operate in practice and showcase their successful implementation.

This guidance supplements the 'Technical guidance for evaluating resource efficiency and circular design opportunities' by offering a roadmap for effectively using various technologies. The roadmap includes cost assumptions, data conformity assurance intervals, and standards compliance requirements.

Additionally, the guidance highlights emerging trends like AI, blockchain applications, autonomous vehicles, and data analytics, which can enhance operational efficiency in the context of decarbonisation efforts.

1.2 Purpose and audience

The purpose of this document is to be a practical resource for NZTA staff and stakeholders, providing insights into digital and innovative solutions that can accelerate efforts to reduce carbon emissions.

It has been developed to support the real-world application of digital technologies in various project phases. It also guides good practice in utilising digital tools and associated data to support emission reduction efforts.

Stakeholders can use this document to make informed decisions and leverage digital solutions to achieve decarbonisation outcomes throughout the project's lifecycle.

This document is intended for use by:

- Stakeholders who participate in the planning, design, construction, operation, and maintenance of the land transport systems. These include consultants, contractors, and project managers.
- NZTA staff whose work and actions affect resource efficiency.

2 Identifying technology opportunities for decarbonisation

2.1 Overview

Decarbonising the transport sector involves finding solutions to challenges such as high consumption of virgin materials, low recycling levels, construction and demolition waste, and knowledge gaps. Strategic use of digital technologies across the project lifecycle—planning, design, construction, and operation and maintenance—can help address these challenges effectively.

A rubric and evaluation matrix has been developed to guide NZTA staff and stakeholders, such as contractors, suppliers, and partners, in supporting informed decision-making when selecting digital technologies for each phase. For example:

- During the planning and design phase, digital technologies can help reduce emissions by optimising transportation routes and integrating electric vehicles.
- In the construction phase, the technologies can aid in refining the design and effective planning to support reducing carbon emissions.
- Digital technologies can enhance operations and maintenance practices through predictive maintenance and smart traffic management systems, reducing emissions.

Stakeholders engaged in different project phases can refer to the guidance to evaluate the readiness and suitability of different digital technologies for their specific projects.

The evaluation matrix and rubric used in this guidance build upon a solid foundation grounded in active engagement with partners and stakeholders through workshops, application of the PPDT, Circular Economy principles, consideration of PAS2080, and ISO 19650.

2.2 Digital technology selection

The guidance focuses on specific technologies identified as significantly enabling the decarbonisation of transport infrastructure. These technologies include:

- Traffic simulation software
- Travel demand modelling tools
- Carbon footprint assessment tools
- Digital twin platforms
- Design optimisation software
- Electric vehicle (EV) charging infrastructure planning tools
- Connected vehicle technologies
- Traffic management systems
- Predictive maintenance software
- Construction management platforms
- Drone-based monitoring systems
- Building materials selection tools

Additional information about these tools and their capabilities can be found in *Appendix A* of this document.

These digital technologies were selected based on several factors that contribute to decarbonisation efforts. These factors include:

- **Impact:** The chosen technologies can potentially reduce GHG emissions directly or indirectly.
- **Availability:** The selected technologies include well-established technologies and emerging innovations. They were evaluated for effectiveness and practical implementation.
- **Compatibility:** The selection aimed to include a variety of technologies that can work together and complement each other's functionality.

Additionally, cost-effectiveness, user adoption, and existing integration were also considered in the selection process.

It is important to note that other technologies may be relevant depending on specific contexts and priorities. By evaluating these factors, stakeholders can choose the most appropriate combination of digital technologies to support specific decarbonisation objectives.

2.2.1 Future trends in digital technology

Combining identified decarbonisation technologies with emerging digital technologies can support the design of more sustainable transportation systems. Examples are provided below.

AI and Traffic Management: AI analyses traffic data from Traffic Simulation Software to optimise traffic flow. Machine Learning (ML) predicts future patterns for smoother operation of Traffic Management Systems. This collaborative approach significantly reduces emissions in transportation networks.

Data Analytics and Personalised Mobility: Data analytics powers personalised mobility apps that provide low-carbon transportation options. Optimising the use of Electric Vehicle Charging Infrastructure and promoting a shift away from personal vehicles contributes to GHG reduction efforts.

2.3 Digital technologies and GHG impact

The guidance document simplifies the challenge in transportation projects by categorising digital tools that help reduce various types of GHG emissions.

Enabled Emissions:

Emissions resulting from the public use of infrastructure (i.e., tailpipe emissions due to vehicle kilometres travelled (VKT)). The recommended technologies support electric vehicles and efficient infrastructure operating practices to reduce enabled emissions.

Embodied Emissions:

Embodied emissions result from manufactured products and materials used in the construction of the built environment. The tools support the minimisation of embodied emissions by enabling the consideration of low-carbon materials, efficient manufacturing, and transportation to the site.

Operational Emissions:

Emissions from energy use during infrastructure operation. Tools optimise efficiencies, employ smart systems for resource management, and apply circular economy principles to minimise waste.

Lifecycle Emissions:

Emissions resulting from the entire project lifespan, from planning to end-of-life replacement, decommissioning and deconstructing. The tools allow for holistic approaches that optimise resource use outcomes and reduce GHG emissions throughout the project's lifecycle.

The table categorises technologies to clarify their target emissions, aiding stakeholders in informed decision-making for emissions reductions.

	Enabled Emissions	Embodied Emissions	Operational Emissions	Lifecycle Emissions
Traffic simulation software	●		●	
Travel demand modelling tools	●		●	
Carbon footprint assessment tools				●
Digital twins platforms				●
Design optimisation software		●		
EV charging infrastructure planning tools			●	
Connected vehicle software	●			
Traffic management systems			●	
Building materials selection tools		●	●	
Construction management platforms		●		
Drone-based monitoring systems		●		
Traffic management systems			●	

Figure 2 – The table provides an overview of which emissions type each technology primarily addresses.

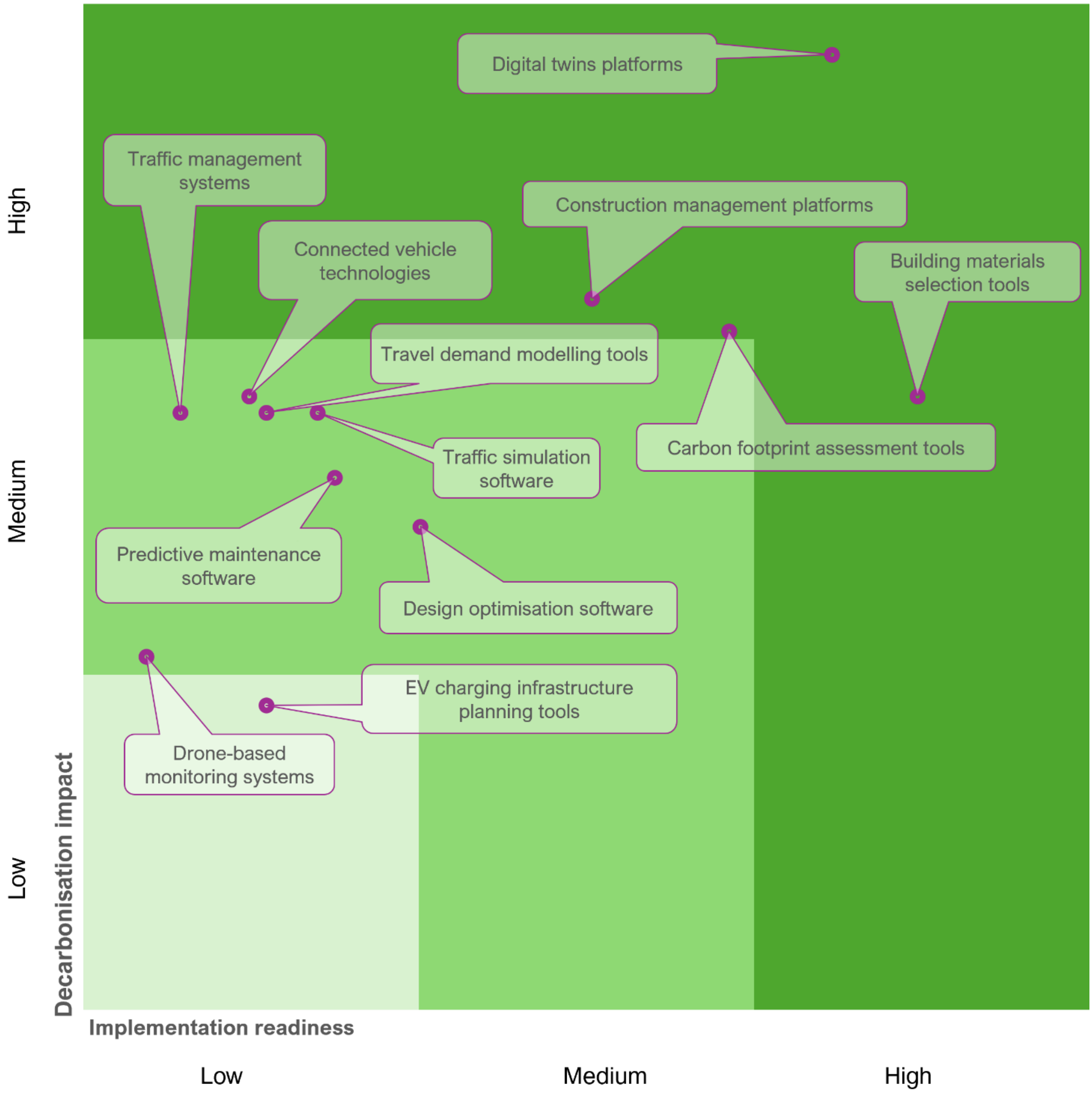
2.4 Rubric: Choosing the right technologies

This guidance presents a rubric that classifies available technologies based on their ability to support decarbonisation efforts and readiness for implementation. The assessment considered:

- implementation readiness and
- decarbonisation potential.

Implementation readiness of the digital technologies assessed potential cost savings, ease of use, stakeholder capacity and skills, and technology requirements. Potential cost savings include the tool's ability to reduce project costs using fewer resources and better planning. The decarbonisation impact assessment evaluates the extent to which each technology contributes to reducing emissions.

Based on the above considerations, certain technologies emerged as offering high potential for emissions reduction but required high implementation efforts (higher stakeholder capacity and skills to navigate the complexity of the tools). The technologies requiring higher implementation readiness showed potential for higher cost savings through reduced use of materials, better planning, and maintenance of assets. Additionally, more accessible options were identified that still provide moderate potential for emissions reduction.



LEGEND	High	Medium	Low
Implementation readiness	High potential saving costs, ease of use, stakeholder capacity and skills, and technology requirements.	Medium potential saving costs, ease of use, stakeholder capacity and skills, and technology requirements.	Low potential saving costs, ease of use, stakeholder capacity and skills, and technology requirements.
Decarbonisation potential	High potential to reduce emissions	Medium potential to reduce emissions	Low potential to reduce emissions

Figure 3. Rubric showcasing the digital tools in relation to decarbonisation impact and implementation readiness.

The digital technologies rubric provides valuable insights into selecting appropriate technologies for driving decarbonisation efforts while managing implementation readiness. The earlier the right technologies are introduced, the bigger the potential impact. For example:

- Digital twins had the highest impact, demonstrating significant potential for reducing emissions. Using virtual models, real-time monitoring and analysis can be done, including testing of various scenarios. For example, by creating a digital twin of a building or a transportation network, stakeholders can analyse its energy consumption patterns and identify energy savings and emission reduction opportunities.
- Other noteworthy technologies included Connected Vehicle Technologies, Building Materials Selection Tools and Construction Management Platforms, which balanced implementation readiness and decarbonisation impact.
- On the other hand, technologies such as Traffic Simulation Software, Travel Demand Modelling Tools, and Electric Vehicle Charging Infrastructure Planning Tools are more accessible options for organisations aiming to make sustainable improvements without significant effort.

2.5 Evaluation matrix: Technology evaluation

The evaluation matrix is designed for use by various stakeholders involved in transportation infrastructure projects' planning, design, construction, operation and maintenance phases. It aims to provide them with information to help them understand the technology and where the highest impact of decarbonisation lies.

The evaluation matrix uses the People, Process, Data, and Technology (PPDT) change management framework to facilitate decarbonisation through digital technology. Appendix B provides more information on the PPDT framework and other factors that contributed to its development.

The evaluation framework refers to the relative assessment of different factors associated with each digital technology for decarbonising transportation infrastructure. Below is a breakdown of the grading categories:

High	**Moderate**	**Low**	**Limited**
High impact or capability	Medium impact or capability	Low impact or capability	restricted impact or capability

The legend guides the optimal deployment of each technology to maximise benefits. It also illustrates how different technologies serve various functions in different project phases.

(purple)	Planning
(yellow)	Design
(teal)	Construction
(black)	Operation and maintenance

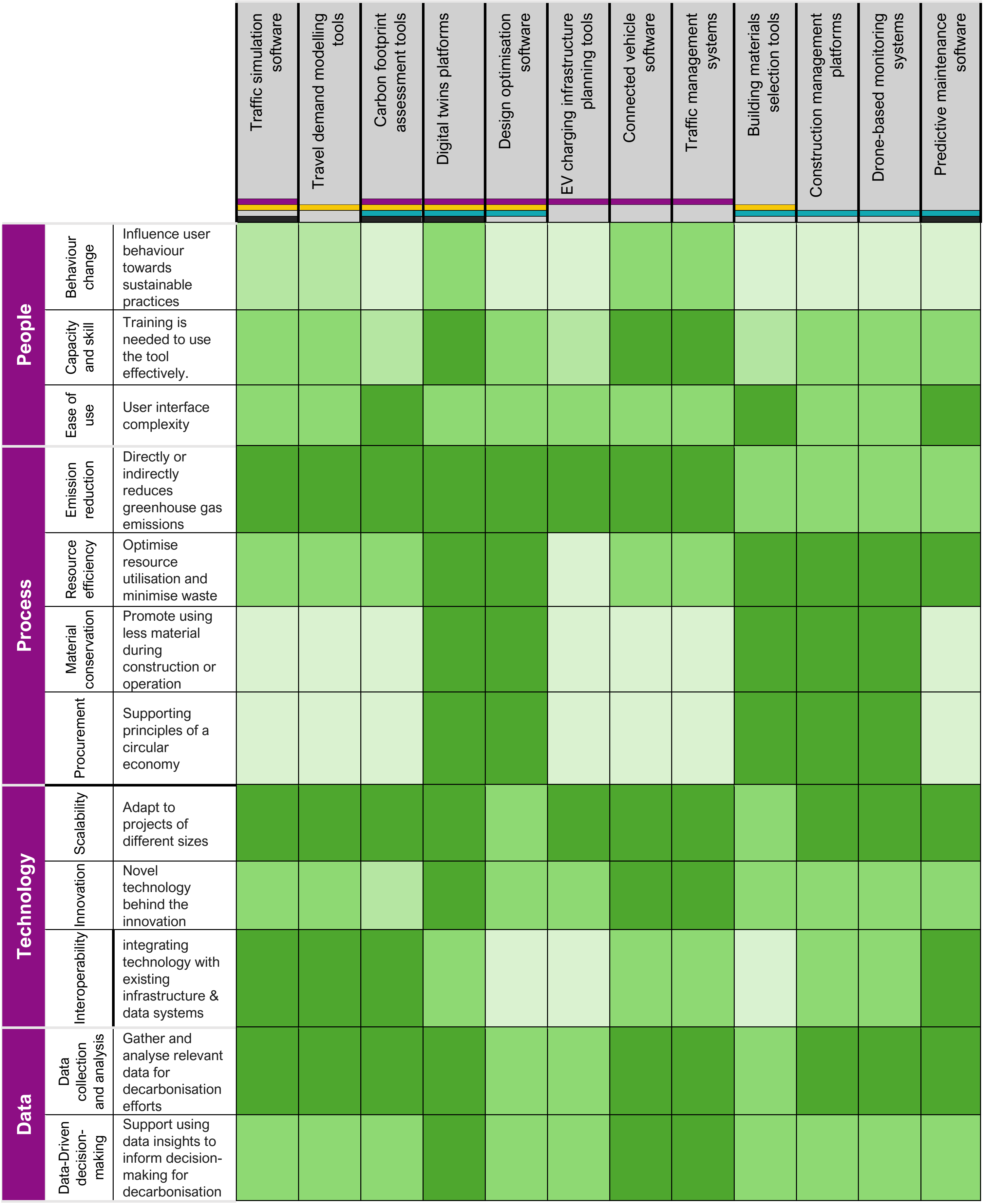
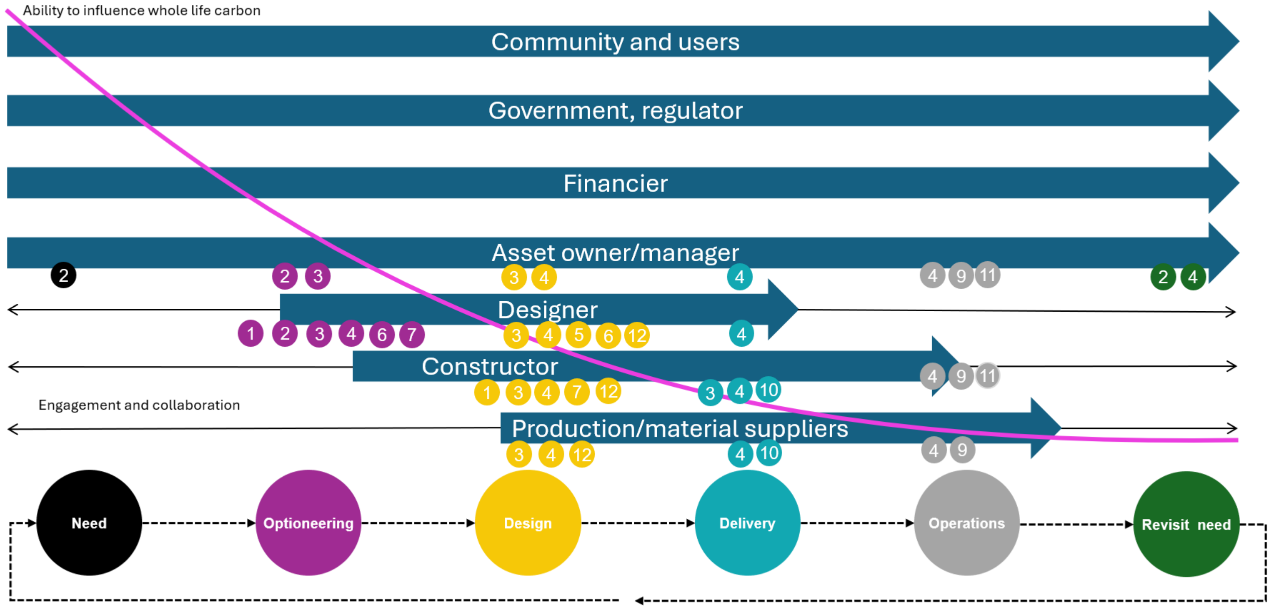


Figure 4. Digital technologies framework for decarbonisation

3 Good practice for optimal application of technologies

This section explores the optimal practices and application of tools at different phases of the project to support decarbonisation. To start, the strategic use of digital technologies in project phases is important for reducing carbon emissions. However, different stakeholders have different abilities at different phases to accelerate decarbonisation.

To illustrate this, a figure has been developed, showcasing various digital technologies that can be used by different stakeholders across the project life cycle. This section serves as a good practice roadmap, demonstrating how shortlisted technologies can be deployed in different project phases. This figure is derived from the PAS 2080 guidance document.



Key					
1	Traffic simulation software	5	Design optimisation software	9	Predictive maintenance software
2	Travel demand modelling tools	6	EV charging infrastructure planning tools	10	Construction management platforms
3	Carbon footprint assessment tools	7	Connected vehicle software	11	Drone-based monitoring systems
4	Digital Twins platforms	8	Traffic management systems	12	Building materials selection tools

Figure 5. How different stakeholders can influence emissions reduction through the project lifecycle.

In addition, there are key considerations that can enhance collaboration, support transparency of assumptions, verify data integrity, optimise technology usage, and ultimately reduce costs while increasing decarbonisation efforts. These are as follows:

- **Data standards:** Establishing common data standards and formats for consistency across teams and project phases.
- **Data management plan:** Developing a comprehensive plan for collecting, managing, and securing data throughout the project.
- **Documentation:** Recording key variables, models used, and underlying assumptions at each project phase.
- **Independent reviews:** Incorporating external reviews to assess assumptions, calculations, and verification processes.

The following figure shows the different tools and their functionality within the different phases. This supports an understanding of how to best use the tools with consistency across phases, to help generate a higher decarbonisation impact and improved systems and processes.

- Use **carbon lifecycle assessment tools** to assess carbon emissions associated with different design and operational choices.
- Incorporate **design optimisation software** to optimise sustainable and low-carbon solutions.
- Implement a **digital twin platform** for real-time data-driven analysis of transportation networks.
- Leverage automated **traffic management systems** to improve traffic flow efficiency and reduce overall emissions.
- Utilise **traffic simulation software** to model different scenarios and evaluate environmental impacts.
- Incorporate **travel demand models** to understand future transportation needs and promote sustainable modes of transportation.
- Consider planning for **connected vehicle technologies** and **EV charging Infrastructure** to support electric mobility.

- Continue utilising **carbon lifecycle assessment tools** and **design optimisation software** to maintain decarbonisation goals throughout the project.
- Apply **digital twin technology** and **traffic simulation software** to simulate alternative design scenarios.
- Incorporate **travel demand models** to inform decisions and encourage environmentally friendly transportation options.
- Include the use of **building materials selection tools** to minimise emissions during the design phase.

- Continuously monitor construction activities' carbon emissions using **carbon lifecycle assessment tools** for compliance with emission reduction goals.
- Apply **design optimisation software** throughout construction implementation.
- Utilise **digital twin** for ongoing monitoring, issue identification, and process optimisation.
- Employ **predictive maintenance software** effectively for optimal resource utilisation and reduced energy consumption.
- Utilise **construction management platforms** for efficient communication and coordination among stakeholders.
- Deploy **drone-based monitoring** solutions for improved site surveillance with reduced manual inspections.

- Continue utilising **predictive maintenance software** and **digital twin** for proactive asset maintenance management.
- Adopt advanced **traffic simulation software** for efficient operations and emission reduction efforts.

Figure 6. Good practice for implementing digital technology across various phases.

4 Case Studies

Digital technologies can advance decarbonisation at any infrastructure project stage by supporting resource efficiency and enabling circular design. These technologies facilitate automated identification of decarbonisation opportunities across the lifecycle, from sourcing sustainable materials to maintenance.

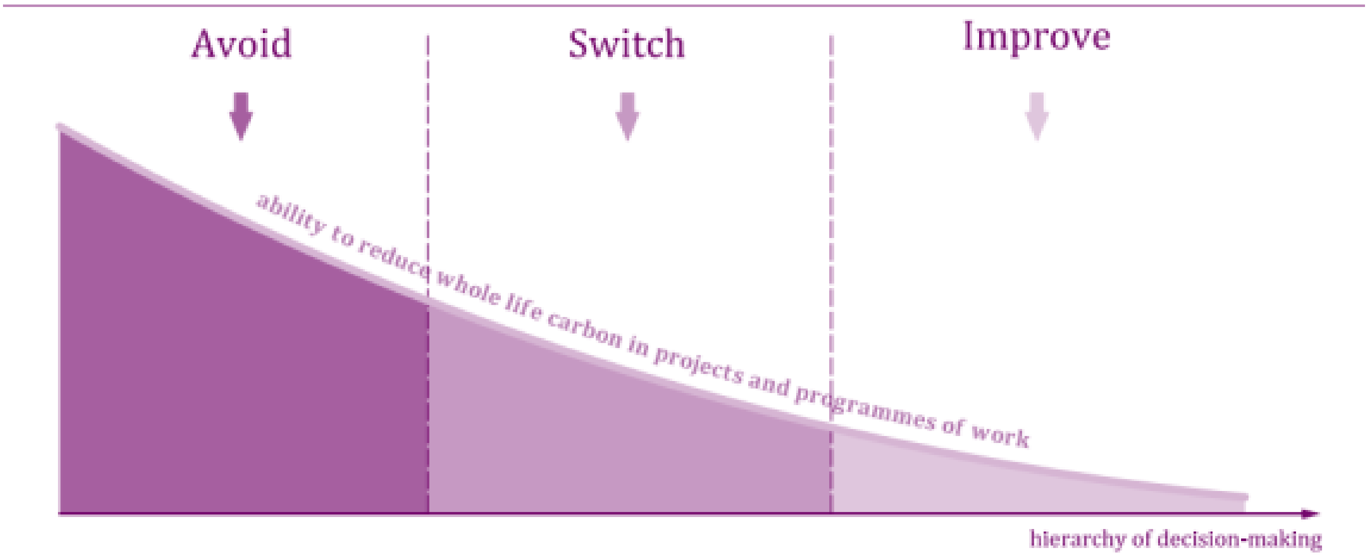


Figure 7. PAS 2080 (2023) hierarchy of decision-making.

Optimal decarbonisation outcomes are often achieved by using digital technologies in preliminary planning stages to evaluate the whole-of-life impact and make design changes. Technology supports decision-makers in assessing 'avoid, switch, and improve' applicability. In addition, the case studies below identify how technologies have been introduced at each project stage to accelerate decarbonisation.

The case studies provide practical illustrations of digital technologies in action, showcasing their impact on emissions reduction, improved design and operation. In addition to the case studies, Appendix C aligns the various project types with digital technologies.

Adopting technologies during planning and optioneering provides the best opportunities to decarbonise.

By optimising existing resources, evaluating the impact of alternative solutions, and establishing targets that support carbon reduction beyond initial phases, there is a higher potential to impact whole-of-life outcomes.

During this phase, it may be decided that the build-nothing (avoid) solution will likely be the best outcome, driven by the ability to adapt existing infrastructure.

Auckland City Rail Link (CRL) – Auckland, New Zealand

Source: https://www.cityraillink.co.nz/

The Auckland City Rail Link (CRL) is a significant project for New Zealand, designed to expand the size and capacity of Auckland's rail network. The project involves building and renovating stations and supporting infrastructure to meet a growing population's future public transport needs. Emission targets have been set for the project and its operation to establish a benchmark for sustainable infrastructure delivery in New Zealand.

Introducing ambitious carbon reduction targets during the planning and design phases has led to innovation in adopting digital technology. While many technologies were used during the project lifecycle, CRL is an example of how digital twins, travel demand models, traffic simulation software, and carbon lifecycle assessment tools played a significant role in the decisions.

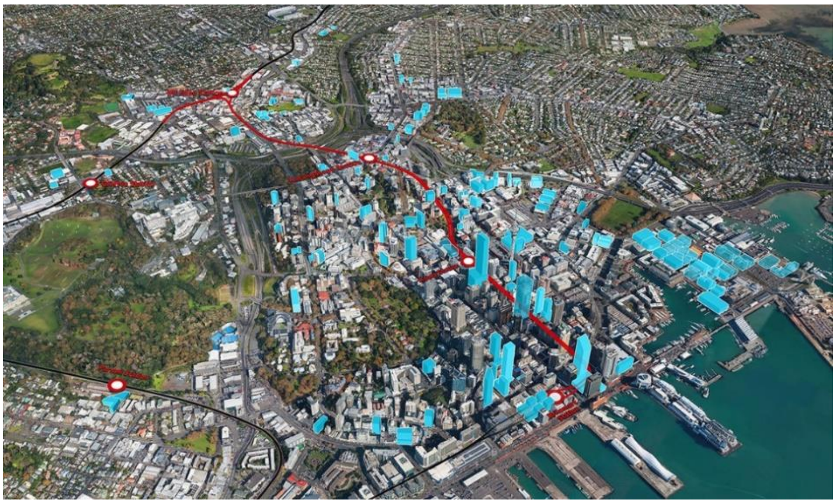


Figure 8. The City Rail Link designation from the Waitematā Station (Britomart) to Eden Terrace and the new Maungawhau Station (https://www.cityraillink.co.nz/crl-route-maps)

Examples of how technologies were used:

- **Traffic Simulation Software and Travel Demand Models:** Utilised to analyse current and projected travel patterns, assess demand for public transit, and optimise station locations and service frequencies.
- **Carbon Lifecycle Assessment Tools:** These technologies are embedded in the digital twin to evaluate the environmental impact of construction materials, transportation activities, and operational emissions associated with the project.
- **Project Digital Twin:** Providing a common platform for the Link Alliance to collaborate on project deliverables and interrogate both quantities of materials used and associated carbon emissions[1].
- **Design Optimisation Software:** Employed to optimise the design of station buildings and other infrastructure elements for energy efficiency, emission reduction, and minimal environmental impact.

[1] https://www.wsp.com/en-au/insights/implementing-sustainable-design-for-city-rail-link

Associated benefits:

- **Data-informed design:** Forecasted demand and travel simulation provide data that influence planning and design parameters, ensuring the project would effectively meet the community's future needs.
- **Emissions reduction by design:** Design optimisation software has empowered teams, helping to phase out and effectively track the reduction in emissions through different phases of design. For example, reducing mined tunnelling and associated concrete and steel by 11 per cent in the redesigned Karanga-a-Hape Station and 45 per cent at Maungawhau Station[2]
- **Waste reduction in construction:** Carbon lifecycle assessment tools have assisted in identifying the carbon footprint of materials, supporting an 18 per cent reduction in the footprint of concrete used, equivalent to eliminating more than 7000 truckloads of concrete[3]

Melbourne Metro Tunnel – Melbourne, Australia

Source: https://bigbuild.vic.gov.au/projects/metro-tunnel

Rapid growth in demand for public transport across Melbourne has accelerated demand for the expansion of Melbourne's rail and tram networks. Leveraging smart technologies, Public Transport Victoria (PTV) is focused on achieving optimum network efficiency by creating an integrated transport system that automates route planning, speed control, and physical train accessibility. Overall, public transport availability and access advancements are expected to promote greater use of sustainable transport modes.

Travel demand modelling was used to demonstrate future stations' station and interchange behaviour and identify the capacity required for the newly built metro network. Examining both the associated demand for public transport and the potential changes to road usage along the same route, advancements in rail capacity are being supported by the adoption of new high-capacity signalling, a connected vehicle technology, enabling turn-up-and-go services. This technology allows trains to communicate with each other and the surrounding infrastructure to automatically slow down, enabling trains to move faster and closer together safely.

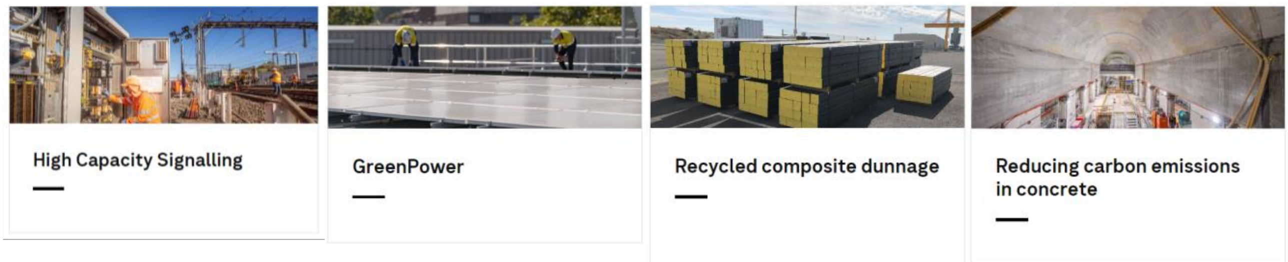


Figure 9. Different technologies and decarbonisation initiatives on the project

Examples of how technologies were used:

- **Traffic Simulation Software and Travel Demand Models:** Forecasted demand and optimised rail network design to accommodate future growth.

[2] https://issuu.com/cityraillinkltd/docs/crl_hses_report_2022-english_ff69b64b51c964
[3] https://www.railexpress.com.au/sustainability-design-award-for-city-rail-link/

- **Design Optimisation Software:** Optimised station designs for energy efficiency and decarbonisation, minimising environmental impact.
- **Connected Vehicle Technologies:** Integrated into rail operations for real-time monitoring and management of train movements.

Benefit:

- **Encouraging sustainable modes:** Ensuring connected vehicle technologies are embedded has been baked into the planning process, enabling trains to communicate with each other, the infrastructure, and travellers to share real-time information and accelerate operational efficiencies.
- **Energy-efficient designs:** The use of design optimisation software resulted in energy-efficient station designs, achieving a 20% reduction in energy consumption compared to traditional designs, aligning with emission reduction objectives[4].

[4] https://bigbuild.vic.gov.au/projects/metro-tunnel

Optimising digital during the design phase has proven invaluable in driving data-driven decision-making for the selection of materials and sustainable design configurations. While a do-nothing approach is most favourable, there are always ample opportunities to reduce the impact of design-build less (avoid).

Introducing these technologies early provides the added benefit of testing, realising, and remediating in a virtual environment before designs are finalised. This may include identifying ways to optimise existing infrastructure or materials, reduce embodied carbon by design, and embed digital tools into construction to service the asset across the lifecycle.

Digital Twin of Grafton Bridge – Auckland, New Zealand

Source: https://www.beca.com/what-we-do/projects/transport-and-infrastructure/grafton-bridge-digital-twin

Grafton Bridge is a historical city connection that has facilitated the transit of pedestrians, cyclists, commuters, and public transport since 1910. Serving as a vital transport infrastructure link to city districts, the Grafton Bridge Digital Twin was developed proactively to help monitor and maintain this vital asset for Auckland's transport network.

Today, the Grafton Bridge Digital Twin empowers design teams by providing an accessible gateway to reliable, connected, readily available information. The initial configuration of the digital twin integrated various technologies, infrastructure data management and engineering information into an interactive model. Enhancements of live sensor data and carbon monitoring tools were consolidated into live dashboards and embedded into the platform. Together, these technologies provide an accurate virtual representation of Grafton Bridge, enabling stakeholders to explore various design options and simulate real-world scenarios while balancing aesthetics, cost-effectiveness, and decarbonisation considerations.

Figure 10. Digitised view of Grafton Bridge from the motorway.

Examples of how technologies were used:

- **Carbon Lifecycle Assessment Tools:** Carbon density models can evaluate design alternatives to reduce carbon emissions throughout the project lifecycle.
- **Digital Twin for Transport Infrastructure:** Integrates datasets, technologies and real-time dashboards for data-informed decision-making.
- **Automated Traffic Management Systems:** Sensor data monitors changes or discrepancies on the road, detects crash contingencies, and monitors road usage.
- **Predictive Maintenance Software:** Forecast condition monitoring and maintenance using live sensor data and consolidated asset information embedded in the digital twin.

Benefits:

- **Performance monitoring and usage:** Live data feeds provide insights into the bridge's usage requirements, helping to inform future considerations for updated signal timing and monitor infrastructure degradation over time.
- **Optimised design planning:** When reviewing design options, digital twins have been an effective tool for modelling and demonstrating the impact of different design options and effectively engaging stakeholders.

The Takitimu North Link – Bay of Plenty District Council, New Zealand

Source: https://www.nzta.govt.nz/media-releases/itwin-we-win-takitimu-north-link-wins-international-award/

The Takitimu North Link project in New Zealand is a significant infrastructure development aimed at improving transport options and safety in the western Bay of Plenty. As part of the New Zealand Upgrade Programme, the project has been recognized for its innovative use of technology to enhance sustainability and efficiency.

A key factor in the project's success has been the implementation of a digital twin, or iTwin. This 3D visualization tool has allowed designers, builders, and stakeholders to collaborate effectively and make data-driven decisions throughout the project's lifecycle.

The Takitimu North Link project demonstrates the potential of digital twins to transform infrastructure development. By leveraging this technology, the project has achieved significant environmental and efficiency gains while delivering a high-quality outcome for the community. As construction continues, the full benefits of the digital twin approach are expected to become even more evident.

Figure 11. Digitised view of Takitimu North Link project

Examples of how technologies were used:

- **Digital twin platform**: Provided a powerful tool for data analysis, visualization, and decision-making.
- **Construction management platform:** Managed field operations, tracked materials, and monitored safety, ensuring efficient project execution.
- **Building material selection tool:** Provided information on the environmental impacts of various construction materials, facilitating the selection of sustainable options.

Benefits:

- **Reduced carbon emissions:** The project's carbon footprint has been reduced by at least 10% due to more efficient earthworks planning and reduced transportation needs.
- **Minimized environmental impact:** The optimised design, enabled by the digital twin, has avoided the need for imported fill and reduced the overall environmental impact.
- **Increased productivity:** The use of the digital twin for design tasks has led to a 25% increase in productivity.

Trailblazing: Building a new culture for carbon assessments in schools

Source: https://www.education.govt.nz/school/property-and-transport/projects-and-design/design/design-standards/whole-of-life-carbon-assessment-for-new-build-projects-at-schools/

The Ministry of Education (MoE) has implemented the need for whole-of-life carbon assessments on all new build project property designs in schools. Providing an example of where compliance at the forefront intends to upskill the supply chain both in digital and decarbonisation, this programme intends to progressively incorporate carbon assessment and carbon reduction targets into business-as-usual processes (and MoE design standards) at a pace that the industry is capable of accommodating[5]. This expectation will begin with high-value projects and trickle down to low-value projects, including operational carbon reporting. Design teams can use their technologies for carbon assessments or leverage those provided by MoE to identify and influence a more sustainable material selection for construction.

[5] https://www.education.govt.nz/school/property-and-transport/projects-and-design/design/design-standards/whole-of-life-carbon-assessment-for-new-build-projects-at-schools/#intro

Decisions made during construction have direct bearing on sustainable material selection, promotion of longevity, and reduction of emissions during operation. During this stage, the preferred options are to build clever (switch) and build efficiently (improve). Preliminary project stages may provide a data foundation to accelerate emission reduction during construction. However, the nature of the project, resource capability, or interoperability may sometimes mean that Carbon Lifecycle Assessment Tools, Design Optimisation Software, or Digital Twins are introduced during this phase.

Construction Management platforms have been powerful technologies for driving collaboration, transparency, and ownership on significant infrastructure projects or programmes. Infrastructure development may also leverage Carbon Lifecycle Assessment Tools, Design Optimisation Software, and Predictive Maintenance Software to consider a product's whole-of-life emissions.

O Mahurangi - Penlink – Auckland, New Zealand

Source: https://www.nzta.govt.nz/assets/projects/penlink/docs/o-mahurangi-penlink-sustainability-annual-report-2024.pdf

The O Mahurangi - Penlink project is a new seven-kilometer highway in Auckland, New Zealand, connecting Whangaparāoa Road to State Highway 1. Its primary goal is to improve accessibility, reduce travel times, and bolster community resilience in the region.

Construction began in October 2023 with a strong focus on sustainability. To minimize its carbon footprint, the project is reducing energy consumption by 10% compared to standard practices through optimised construction methods and material sourcing. Additionally, over 60% of office waste, 90% of construction waste, and 100% of spoil will be kept out of landfills. To identify and mitigate high-emission activities, the project is using CCS Candy software to track its carbon emissions.

Figure 12. O Mahurangi – Penlink map

O Mahurangi - Penlink is a significant step towards decarbonising Auckland's transportation sector. By reducing vehicle emissions, encouraging active travel, and adopting sustainable construction practices, the project is contributing to a more environmentally friendly and sustainable future.

Figure 13. 4 key elements of the projects

Examples of how technologies were used:

- **Carbon footprint assessment tools:** CCS Candy is used to estimate and track the project's carbon footprint, enabling informed decision-making and the identification of opportunities for carbon reduction.
- **Traffic simulation software**: This software is crucial for modelling traffic flows, assessing the impact of the new highway on congestion, travel times, and road safety.
- **Building materials selection tools:** These tools can help select sustainable and low carbon building materials, reducing the project's overall environmental impact.

Benefits:

- **Reduced vehicle emissions:** By providing a more efficient transportation route, the project will reduce the number of vehicles on congested roads, leading to a decrease in greenhouse gas emissions from tailpipe emissions.
- **Carbon-efficient construction:** The project's implementation of sustainable construction practices, such as the reuse of materials and the reduction of waste, contributes to a lower carbon footprint during the construction phase.
- **Carbon tracking and mitigation:** The use of CCS Candy software enables the project team to identify and address high-emission activities, ensuring that the project's carbon footprint is minimised.

Thames Tideway Tunnel – London, United Kingdom

Source: https://www.tideway.london/

London's super sewer construction was guided by a strong commitment to reducing carbon emissions. Digital technology empowered twelve disciplines from European firms to make intelligent design decisions that influenced the use of low-carbon materials, route selection, and efficient processes.

Carbon reduction efficiencies were achieved throughout the project lifecycle, particularly through redesign efforts. Digital technologies enabled the teams to make impactful decisions that had positive effects on offsetting construction emissions. Changes to the network routing, such as choosing a shorter route, significantly reduced the use of materials, especially concrete and steel.

Additional environmental initiatives, like "More by River," prioritised transporting more materials via the river. Furthermore, a dedicated program, funded by Tideway, was implemented to monitor and measure fuel reduction behaviour changes and the effectiveness of training in reducing idling and fuel consumption from plants and equipment.[6].

Examples of how technologies were used:

- **Carbon Lifecycle Assessment Tools:** Assessed tunnel construction and operation's environmental impact and carbon emissions.
- **Design Optimisation Software**: Enable optimised tunnel design to achieve carbon-positive redesigns to reduce the associated expenditure of resources.
- **Sustainable Building Materials Selection Tools:** Identified where a reduction in the use of proposed materials was feasible and wouldn't impact the durability of a structure.
- **Construction Management Platforms:** Automation alleviated the manual labour costs associated with data processing on large projects, while digital tools provided an intelligent link between programmes and models.

Benefits:

- **Emissions reduction in material transportation:** Under the 'More by River' initiative, introduced the use of biodiesel into the central marine fleet, saving over 4000 tCO_2e expended over 140,000 litres[7]. Plus, there is an associated reduction in emissions from keeping lorries off London's roads.
- **Reduce the amount of construction material:** Driven by emissions targets, designers identified many opportunities to maintain structural integrity while reducing the demand on resources

[6] https://www.costain.com/solutions/case-studies/tideway-east-decarbonising-infrastructure/
[7] https://tideway.london/media/5689/tideway-sustainability-report-2022.pdf

effectively. On the wider project, the selection of a shorter route contributed to a 19% reduction in material use[8].

- **Effectively coordinate complex designs**: Teams were able to start the construction process with a clear understanding of what needed to be done and how it would be achieved, as well as an awareness of any potential hazard[9].

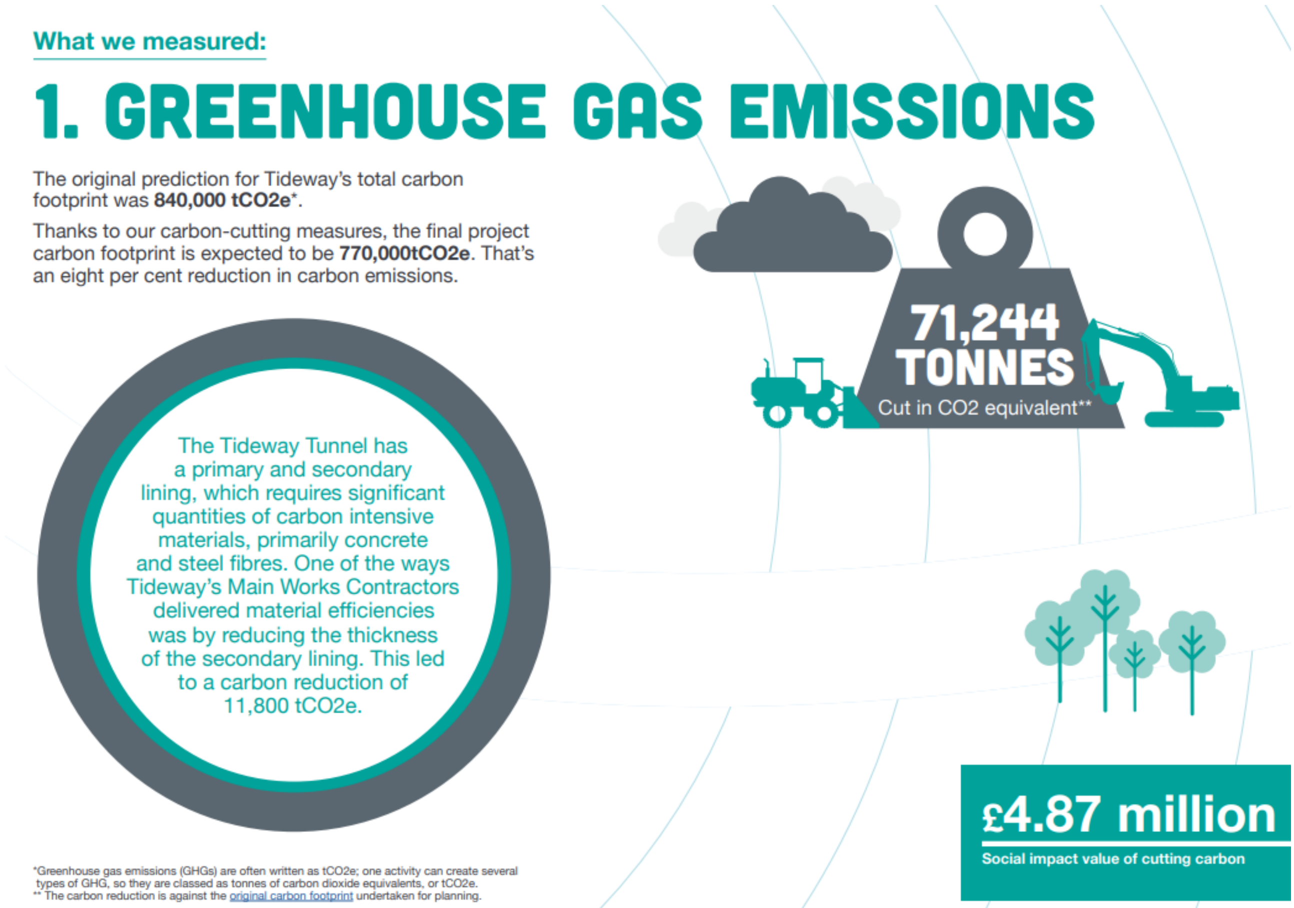


Figure 14. The Tideway social impact story looks at GHG. Source: https://www.tideway.london/media/6093/tideway_impact-report-summary_final_links.pdf

[8] tideway.london/media/5689/tideway-sustainability-report-2022.pdf
[9] https://www.costain.com/news/insights/digital-approach-to-construction-of-london-s-super-sewer/

State Highway 25A Taparahi Bridge – Coromandel, New Zealand

Source: https://www.beca.com/what-we-do/projects/transport-and-infrastructure/state-highway-25a-taparahi-bridge

Repairing the vital connection for the Coromandel Peninsula required a consorted effort to accelerate construction and delivery 12 months ahead of schedule. At the heart of this project was the diligent approach and unified delivery, made possible by digital technologies, to build a 124m-long, 3-span steel composite girder bridge over 15m above the slipped area[10].

While ample data was available to coordinate decision-making for rerouting and automated traffic management signalling that would minimise bottlenecks during the road closure, drones and construction management platforms helped monitor project progress, identify opportunities for machinery efficiencies, and steer the construction programme toward efficient delivery.

Figure 15. Repair of the SH25A

Working together, technology was a significant enabler for bringing together contractors, programmes, and communications during a tight construction timeline.

Examples of how technologies were used:

- **Traffic Management Systems:** Proactive traffic monitoring and counting was used to forecast the demand for traffic services on alternative routes during construction.
- **Construction Management Platforms:** Supported an innovative, collaborative approach for project management, scheduling, and communication to meet a fast-tracked timeframe.
- **Drone-based Monitoring:** Employed for aerial inspections after significant weather events, surveying, and progress monitoring to enhance construction site safety and efficiency.
- **Predictive Maintenance Software**: Data collected from proactive monitoring of the route identified the potential for instability and cracking during significant weather events and informed the options analysis for construction.

Benefits:

- **Accelerated project delivery:** Optimised equipment performance, scheduling, and traffic management systems improved construction efficiency and reduced downtime, helping fast-track delivery.
- **Sustainable tool selection:** Overcoming constraints from a remote location, opting for sustainable sources of power generation delivered greater reliability and efficiency over the project lifecycle.
- **Local sourcing:** Sourcing the initial components of the bridge from a local contractor that was in surplus, rather than China, reduced the procurement timeline and associated emissions significantly[11].

[10] https://www.beca.com/about-us/news-and-awards/december-2023/beca-helps-nzta-waka-kotahi-get-kiwis-safely-back-on-sh25a
[11] https://www.mcconnelldowell.com/case-studies/serious-about-sustainability

Most of the transport infrastructure we will use across our lifetime is already in operation. While the ability to influence carbon reduction by design and construction has passed, there is still massive opportunities to optimise and continuously improve the operational efficiency.

During operation, connected vehicle technologies and traffic monitoring systems can enable flow of transportation activities, reduce congestion and associated emissions. Predictive maintenance solutions and drone technology have been beneficial to monitor and detect potential issues, reduce downtime and enhance operational efficiency while minimising emissions.

Wellington City Council Digital Twin, NZ

Source: https://environment.govt.nz/what-you-can-do/stories/wellingtons-digital-twin/

Wellington City Council has created a virtual representation of their live environment by integrating real-time data into an interactive city model. As Wellington seeks to accelerate its transit options and navigate climate adaption, connecting various datasets from the traffic environment enhances its understanding of network usage and contributes to a data-driven vision for future infrastructure.

Using augmented reality and predictive analytics has made it easy for everyone to understand and discuss how future climate risks could affect the city's infrastructure. It has improved public awareness and is helping to make better decisions for the community.

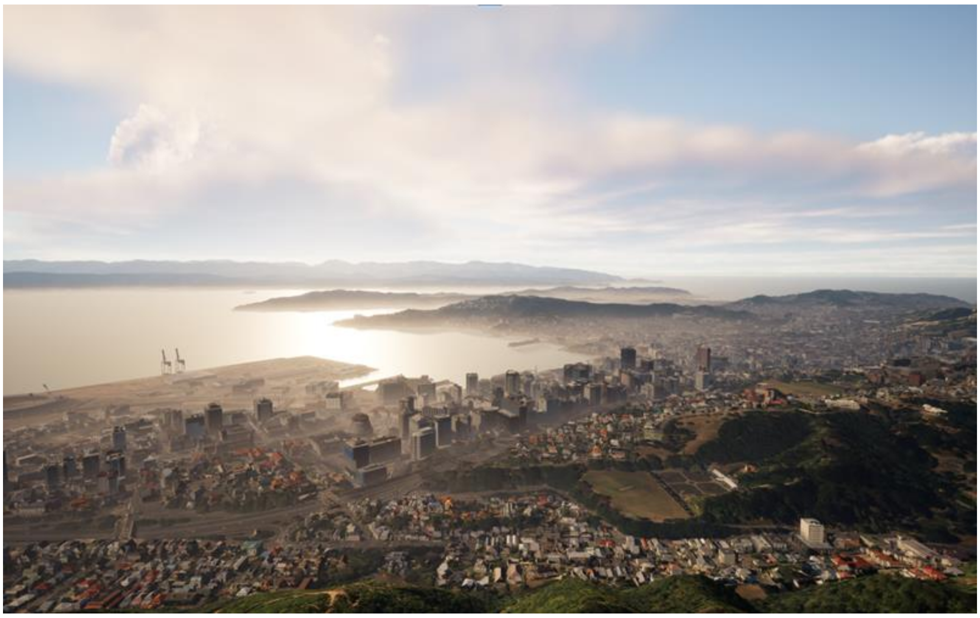


Figure 16. Digital Twin still of Wellington City. Source: https://wellington.govt.nz/news-and-events/news-and-information/our-wellington/2022/01/bloomberg-challenge

Examples of how technologies were used:

- **Digital Twin for Infrastructure:** Augmented the live environment embedded with real-time information and predictive analytics to showcase the climate impact of different scenarios.
- **Traffic Management Systems:** Embedded monitoring systems collect real-time data on various modal options that capture trip metrics such as usage, routes and peak-hour demands.
- **Travel Demand Models:** Identifies future demands on the transport network for network planning and monitoring, with consideration of climate risk.

Benefits:

- **Building a common understanding for adaption:** Communicating and simplifying the complexities to help people understand how a location works, how it will fare as the climate changes and what the outcomes of policy decisions will be[12]. While providing a free mechanism that empowers Māori, businesses and organisations to adapt together.
- **Enabling community co-design:** The scalable platform being utilised to co-design climate adaption plans with Wellingtonians[13].

Australian Integrated Multimodal EcoSystem (AIMES) – Melbourne, Australia

Read More: https://eng.unimelb.edu.au/industry/aimes

Melbourne University has partnered with government and industry to transform Melbourne's inner-city into a world-first living laboratory, supporting the development of a sustainable, safe and intelligent transport system in Victoria.

AIMES is a six-kilometre square testing ground for emergent connected technologies[14], providing a real-world ecosystem to validate, integrate, and explore the outcomes in a live environment. Emerging from the need to make smarter use of existing infrastructure, AIMES is improving operational understanding through a distributed mesh of smart sensors (ATMS) and connected vehicle technologies. Together, these technologies collect data on multimodal traffic across road users and types in real time to inform predictive analytics, traffic simulation software, and traffic demand models.

Taking this approach, the University of Melbourne has effectively demonstrated the return on investment by adopting new technologies and understanding their ease of implementation in both rural and urban areas. Ultimately, AIMES will support the city as it moves towards its goals of adopting new autonomous transport modes and improving the safety and decarbonisation outcomes of the existing network.

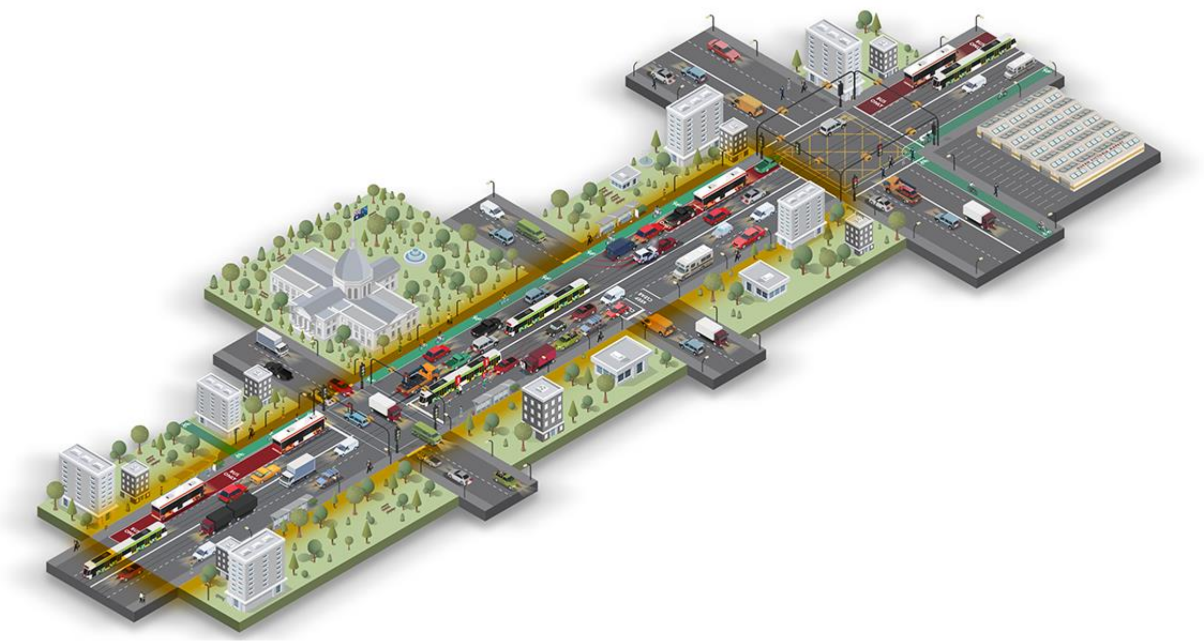


Figure 17. The Intelligent Corridor in Carlton improves the flow of traffic and safety for all modes of transport, not just cars – Source: https://research.unimelb.edu.au/partnerships/case-studies/smart-corridor-improves-traffic-flow-for-fairer-roads

12 https://environment.govt.nz/what-you-can-do/stories/wellingtons-digital-twin/
13 https://environment.govt.nz/what-you-can-do/stories/wellingtons-digital-twin/
14 https://eng.unimelb.edu.au/__data/assets/pdf_file/0007/2767255/aimes-brochure.pdf

Digital technologies used:

- **Traffic Management Systems:** Deployed on existing infrastructure to capture live data that can provide a model of the existing environment.
- **Connected vehicle technologies:** Trails using these technologies have connected vehicles with infrastructure to analyse the response times to events such as changes in road conditions, speed limit reductions, and detected collision warnings.
- **Traffic Simulation Software:** Various scenarios have been tested. One example has analysed how connected freight vehicles could be prioritised at intersections to optimise traffic flow and reduce emissions associated with heavy vehicle idling.

Benefits:

- **Innovation without interruption:** Demonstrating the potential for technologies in a testing environment, met with predictive analytics modelling future trends, has enabled the identification of 'low-hanging fruit' that will meet the community's growing needs without the need for substantial investment in infrastructure. For example, switching to autonomous buses for suburban mobility would reduce the emissions associated with minimal use of the existing high-frequency fleet[15].
- **Triaging traffic based on emissions and disruption:** Exploring the prioritisation of trucks to improve traffic flow is showcasing the significant impact that can be realised when 10-20 per cent of vehicles are connected for solutions such as dynamic traffic signal control or lane reconfiguration[16].

Defect Detection for Kerb and Channel - Study

A study with Auckland Transport has been completed that digitises and expedites pavement, kerb and channel inspections. Combining predictive and monitoring technologies for automated inspections simplifies crack detection and prescribes condition ratings for the prioritisation of maintenance. Delivering faster access to consistent and impartial defect inspections, the solution has minimised inefficiencies and eliminated network shutdowns associated with traditional pen-and-paper methodologies. While also providing the opportunity to reuse the data for integration into digital technologies for decarbonisation.

Figure 18. A pilot study by Beca used AI to detect cracks on roads.

[15] https://research.unimelb.edu.au/strengths/updates/news/connected-transport-systems-more-than-cars
[16] https://research.unimelb.edu.au/strengths/updates/news/smart-traffic-sensors-that-reduce-gridlock-and-unlock-the-economy

A

Appendix A -

Key technologies explained

Appendix A: Key technologies explained

The table below lists the technologies mentioned in this guidance document and their benefits.

Digital Technologies	Description
Traffic simulation software	Traffic simulation software models behaviour in defined areas to assess the impact of scenarios on the traffic environment. Traffic management agencies, planners, researchers, and engineers can use this tool to identify opportunities to minimise disruption and optimise the live network. **Key points and benefits:** • To inform planning, model driving behaviour for events such as congestion, road closures, crashes, and weather conditions. • Coordinate intelligent traffic sequencing, lane configurations and routing alternatives to reduce idling time and optimise traffic flow. • Investigate and test emission reduction strategies, such as congestion pricing or electrification incentives, on the network. • Design sustainable, usable, and effective urban layouts by augmenting alternative modal transportation options.
Travel demand models	Travel demand models predict travel behaviour and forecast future transportation demands in a geographical area. Planners, policymakers, and designers use these models to estimate the demand for transport, infrastructure, and policy effectively. **Key points and benefits:** • Forecast future travel patterns and trends to identify the need for infrastructure improvements or better public transport planning. • Analyse the potential uptake for mode-shift from private cars to low-emission alternatives to inform investment decisions. • Evaluate the impact on mobility by implementing a different policy that incentivises using cleaner transportation options. • Identify areas suitable for compact, mixed-use land development that reduce the reliance on private cars and long-distance travel.
Carbon lifecycle assessment tools	Carbon lifecycle assessment tools estimate the emissions associated with an asset, project, or system. By providing comprehensive insights into carbon emissions from raw materials to end-of-life disposal, these technologies are influential for policy development, decision-making, and fleet optimisation. **Key points and benefits:** • Acquire a holistic, quantified view of the whole-of-life cost of carbon emissions associated with transport activities. • Identify carbon hotspots in the lifecycle, test interventions, and compare options for reducing emissions in high-impact areas. • Conduct research initiates that explore how to reduce the environmental burden during early phases, rather than shift the environmental burden at end of life.

	• Develop targeted strategies that effectively promote emission reduction and influence modal shifts with the largest carbon impact.
Digital twins	Digital twins create virtual replicas of real-world assets, networks, and environments. They can simulate transportation networks in a virtual model that integrates asset information and connects to real-time monitoring technologies to inform decision-making. Digital twins are highly configurable tools that can provide value during planning, construction, optimisation, and maintenance. **Key points and benefits:** • Digital twins facilitate detailed planning and design of land transport infrastructure projects. • Digital twins assist in streamlining the construction process by simulating construction sequences and reviewing potential issues. • Asset performance monitoring optimises resource allocation, helps identify areas for improvement, and enhances overall system responsiveness.
Design optimisation software	Design optimisation software incorporates decarbonisation factors to help planners and designers evaluate the environmental impact of designs and systems across their lifecycle. This can be used to design and develop various transport assets, from individual vehicles to regional infrastructure. **Key points and benefits:** • Identify environmental considerations such as carbon emissions, energy consumption, and resource exploitation during design. • Incorporate design optimisation principles in the design and development process to prioritise investment in sustainable transport solutions. • Inform the selection of materials that deliver optimum energy efficiencies and support emissions reduction across the lifecycle. • Measure compliance with environmental regulations and standards.
Electric vehicle (EV) charging infrastructure planning and analysis	EV charging infrastructure tools determine the optimal design, locations, and capacities for the strategic deployment of electric vehicle charging stations. Utility companies, planners, designers, and policymakers use these tools to accelerate the adoption of electric mobility. **Key points and benefits:** • Forecast demand on grid capacity to optimise energy distribution, support grid reliability and stability, and leverage renewable sources. • Assess alternative charging station designs and layouts that promote equitable access and simplify the transition to EV. • Identify suitable locations for charging infrastructure that mitigates the impact on the surrounding environment and grid. • Develop investment strategies for deploying and operating EV infrastructure that support integration during master planning.
Connected Vehicle technologies	Connected vehicle technologies enable vehicles to communicate with each other, as well as infrastructure and systems, to enhance the transport ecosystem's performance, mobility, safety, and efficiency. Embedded systems facilitate real-time data exchange,

	assisting drivers, city planners and transportation agencies while supporting the transition towards autonomous vehicles. **Key points and benefits:** • Real-time monitoring through vehicles and infrastructure can automate optimised traffic management to reduce congestion, idling time, and fuel usage. • Leverage data from connected technologies to detect incidents and congestion and ensure the overall efficiency and safety of transportation networks. • Driver assistance for optimised route planning, reducing travel time and fuel consumption. • Track and integrate multimodal transport options in real time to improve connectivity and access.
Traffic Management Systems	Transportation authorities and urban planners use advanced traffic management systems to enhance traffic flow and safety on live networks. These systems leverage real-time data from sensors, cameras, connected vehicles, and other sources to identify traffic flow efficiencies. **Key points and benefits:** • Dynamically optimise traffic management signalling and timing based on real-time traffic conditions to reduce idling time. • Rapidly detect incidents and quickly respond to accidents to minimise traffic disruptions and congestion-associated emissions. • Integrate multiple transport modes to provide real-time traffic information to commuters and improve access to mobility choices. • Enhance system-wide transport network performance through managed lane assignments and coordinated public transport.
Predictive Maintenance Software (PMS)	Transport companies, fleet operators, and manufacturers use predictive maintenance software to detect potential issues and schedule maintenance before they escalate into failure. This software can monitor and maintain the operational efficiency of vehicles, infrastructure, and supporting systems such as signalling and communication networks. **Key points and benefits:** • Forecast equipment failure and proactively schedule maintenance tasks that minimise breakdowns and network disruptions. • Effectively identify and triage maintenance tasks that maintain operational efficiencies and lead to cleaner transportation assets. • Collect real-time data on performance and usage to continuously improve and refine an asset's reliability and durability. • Adequately allocate resources and investment with a focus on maximising the lifecycle of the assets and reducing emergency repair costs.
Construction Management Platforms	Clients, contractors, and engineers use construction management platforms to integrate project scheduling, budgeting, resource allocation, and real-time communication technologies that deliver planning and construction efficiencies across a project's lifecycle. **Key points and benefits:**

	• Effectively allocate and schedule resources in a manner that optimises materials, minimises waste and reduces emissions. • Promote transparency, accountability, and engagement to embed sustainable practices into all aspects of construction activities. • Identify inefficiencies, minimise risks and optimise project execution to reduce delays and the associated carbon footprint. • Monitor and report on project performance and environmental compliance for data-driven decision-making.
Drone-based Monitoring	Engineers, transport authorities, and construction teams use drone-based monitoring to access hard-to-reach or hazardous areas of transportation infrastructure such as bridges and tunnels. This method utilises uncrewed aerial vehicles (UAVs) as a cost-effective solution to expedite inspections, conduct aerial surveys, and monitor traffic patterns. **Key points and benefits:** • Rapidly and effectively identify defects early to reduce associated maintenance costs and minimise the disruption associated with failure. • Reduce disruption to traffic flow, enhance safety and reduce emissions associated with manual, site-based monitoring activities. • Conduct consistent environmental monitoring and assessments. • Readily available for rapid deployment for emergency response.
Building Materials Selection Tools	Building materials selection tools evaluate the environmental impact of different building materials across the infrastructure lifecycle. Planners, engineers, and construction contractors can analyse factors such as resource efficiency, circularity, energy consumption, and carbon footprint to select products that enhance durability and resilience while meeting decarbonisation benchmarks. **Key points and benefits:** • Identify materials that enhance energy efficiencies and contribute to a reduction in greenhouse gas emissions in infrastructure. • Promote circular economy principles by embedding these technologies into procurement processes to source renewable or recycled materials. • Support project decarbonisation objectives by enabling the selection of materials with lower lifecycle impacts.

B

Appendix B -
Rubric and evaluation matrix methodology

Appendix B: Rubrics and evaluation matrix methodology

The development of the rubric and evaluation matrix for decarbonisation impact across different technologies involved a comprehensive methodology that integrated various key factors. These factors encompassed the People Process Data Technology (PPDT) framework, engagement with partners and stakeholders, circular economy principles, PAS 2080 alignment, and ISO19650 compliance.

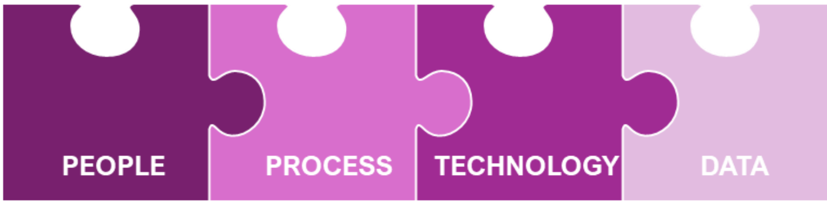
By carefully considering these elements within the methodology, organisations can make informed decisions when selecting digital technologies that maximise their impact on decarbonisation efforts and align with sound business practices.

This holistic approach ensures that the chosen technologies are effectively integrated into project workflows and embraced by users, ultimately contributing to successful decarbonisation initiatives.

People Process Data Technology framework

PPDT framework supports decarbonisation efforts by leveraging change management practices to maximise the impact of digital tools. Incorporating the PPDT framework emphasises user adoption and effective integration into project workflows. It recognises that successful decarbonisation requires considerations beyond just the technical aspects.

The PPDT framework encompasses four core pillars: people, process, data, and technology. By incorporating these pillars, the evaluation matrix provides a robust framework for selecting the most effective digital technologies for decarbonisation.



By integrating the PPDT framework, organisations can ensure that digital tools are implemented, embraced by users, and integrated seamlessly into their workflows. This approach improves the overall effectiveness of decarbonisation efforts by supporting user adoption and maximising the benefits that technology can bring.

Engagement with partners and stakeholders

Recognising that successful decarbonisation initiatives rely on collaborative efforts; the evaluation matrix builds upon active engagement with partners and stakeholders, including project managers, design and PEET partners, and construction organisations.

PAS 2080

This guidance document has been developed to align with the global standard PAS 2080 for managing infrastructure carbon. Created to meet World Trade Organisation requirements, PAS 2080 takes a holistic approach to reducing carbon and costs by emphasising intelligent design, construction, and utilisation throughout the entire value chain. A significant aspect of PAS 2080 is its focus on consistently and transparently quantifying carbon at crucial stages of infrastructure delivery, which encourages data sharing across the value chain. By promoting collaboration and systems thinking, PAS 2080 is an industry-wide enabler for decarbonisation, placing carbon reduction at the forefront of decision-making.

Throughout the drafting process of this guidance document, particular attention was given to assessing digital technologies' capabilities in facilitating key actions for reducing carbon emissions at each stage of the project.

Circular economy model

The circular economy model, guided by three principles—design out waste and pollution, keep products and materials in use, and regenerate natural systems—played a pivotal role in designing the evaluation matrix. The circular economy model is referenced in the NZTA publication 'Technical guidance for evaluating resource efficiency opportunities.'[17]

Opportunities arise in the mobility and transport sector from embracing car-free lifestyles, investing in public transport, and rethinking air travel. For the built environment, strategies include prioritising energy efficiency, reusing existing materials, favouring circular materials and approaches, and minimising construction waste through recycling.

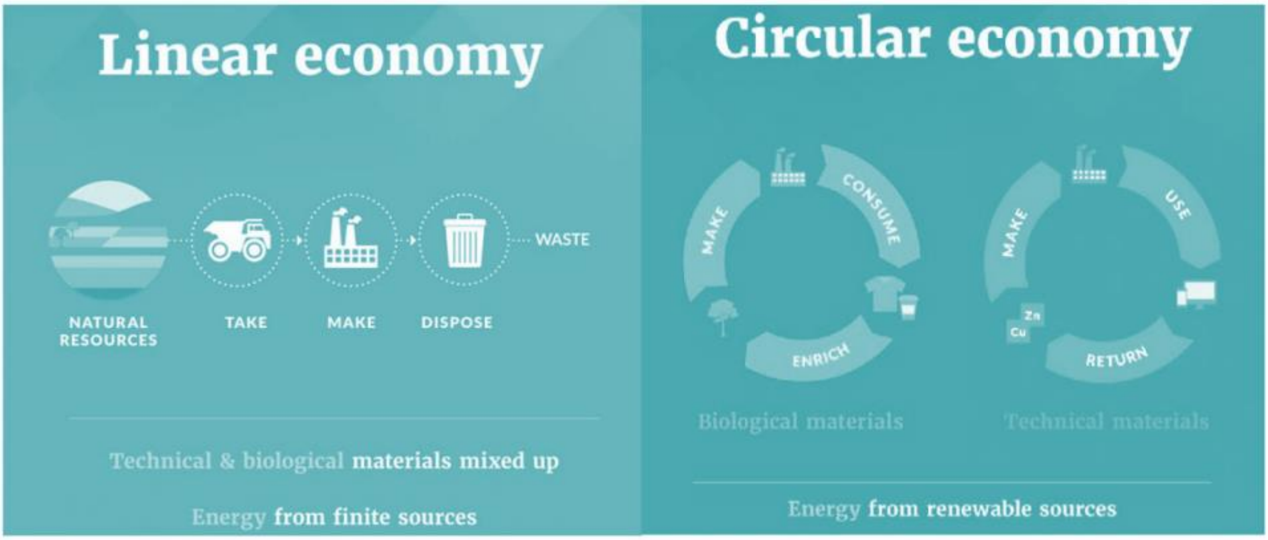


Figure 16. Linear economy versus circular economy. Adapted from Ellen MacArthur Foundation. Image source: Technical guidance for evaluating resource efficiency opportunities.[18]

ISO19650

ISO19650 is an international standard that guides efficient information management during the project lifecycle. Compliance with this standard is central to developing the evaluation matrix and rubric for decarbonisation efforts.

By adhering to ISO19650, organisations can effectively collaborate and manage information related to decarbonisation initiatives in a structured and systematic manner. This compliance ensures that relevant data and documentation are properly collected, stored, and shared throughout the project lifecycle.

By incorporating ISO19650 compliance into the evaluation matrix and rubric, organisations can gain better insights into the implementation of digital tools in decarbonisation efforts, enabling them to make informed decisions and track progress more effectively.

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[17] https://www.nzta.govt.nz/assets/resources/resource-efficiency-guideline-for-infrastructure-delivery-and-maintenance/Technical-guidance-for-evaluating-resource-efficiency-opportunities.pdf
[18] https://www.nzta.govt.nz/assets/resources/resource-efficiency-guideline-for-infrastructure-delivery-and-maintenance/Technical-guidance-for-evaluating-resource-efficiency-opportunities.pdf

C

Appendix C -

Mapping NZTA project types and digital technologies

Appendix C: Mapping NZTA project types and digital technologies

The table below aligns different types of NZTA projects with digital technologies.

Digital Technologies	NZTA project types						
	New road construction	Road upgrades and maintenance	New bridge construction	Bridge upgrades and maintenance	Public transport infrastructure	Cycling and walking infrastructure	Safety improvements
Traffic Simulation Software	✓	✓			✓	✓	✓
Travel Demand Modelling Tools	✓				✓	✓	✓
Carbon Footprint Assessment Tools	✓	✓	✓	✓	✓	✓	✓
Digital Twins	✓	✓	✓	✓	✓	✓	✓
Design Optimisation Software	✓		✓		✓	✓	
Electric Vehicle Charging Infrastructure Planning Tools	✓				✓	✓	
Connected Vehicle Technologies	✓	✓		✓	✓		✓
Traffic Management Systems	✓	✓	✓	✓	✓		✓
Predictive Maintenance Software		✓		✓	✓		✓
Construction Management Platforms	✓	✓	✓	✓	✓	✓	✓
Drone-based Monitoring		✓		✓	✓	✓	
Building Materials Selection Tools	✓		✓		✓	✓	

Apart from supporting the above project types, the technologies also help other NZTA functions including:

- transport planning and strategy making
- integrating technology systems
- engaging communities
- responding to emergencies and disaster recovery
- research and innovation.

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