Net Zero Corridors: The business case and an engagement process

Final Industry Report
Project 1.84

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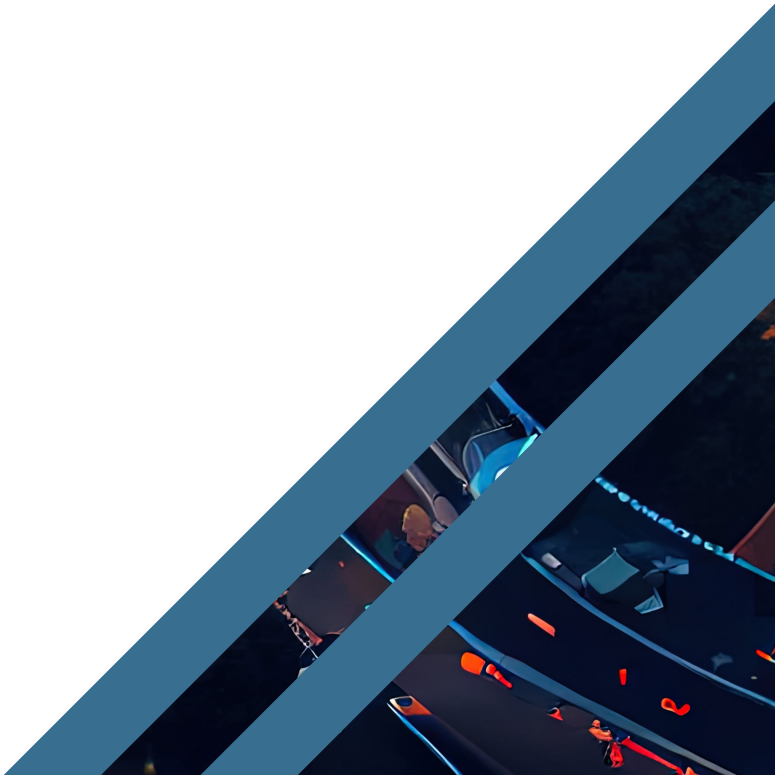
Sustainable Built Environment National Research Centre AUSTRALIA



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Preface

The Sustainable Built Environment National Research Centre, Australia, the successor to the Cooperative Research Centre for Construction Innovation, remains committed to making a leading contribution to innovation across the Australian built environment industry after more than two decades of operation. We are dedicated to working collaboratively with industry and government to develop and apply practical research outcomes that improve industry practice and enhance our nation's competitiveness.

We encourage you to continue to draw on the results of our Centre's applied research to deliver tangible outcomes for your operations. By working together, we can transform our industry and communities through enhanced and sustainable business processes, environmental performance and productivity.

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Executive Summary

The transition to net zero emissions is a global, national and local agenda. It is increasingly being seen as depending on net zero cities. This project is a continuation of research from previous years (Project 1.74 and, prior to that, Project 1.61 and Project 1.55) to show how to integrate new kinds of public transport (especially mid-tier transit) and new approaches to urban development (net zero precincts around stations that involve affordable housing) to help make Net Zero Corridors and net zero cities. The project brings the outcomes to a point where they can be delivered.

The approach to the project depends on mid-tier transit unlocking land value along main roads, enabling net zero distributed energy systems to be built into the station precincts. Such development still requires historic urbanism to guide it: urban design to create strong place-based urban activation, with a particular focus on the kind of preferred urban fabric; a well-developed business case; and community engagement. It will also require changes in the professional practice of urban and transport planning professions to enable it to be delivered.

The project has produced several practice-based academic papers on this concept. Among them is a discussion paper on how social and affordable housing can be part of Net Zero Corridors. The project also involved working closely with two project partners: Sunshine Coast Council (SCC) on holistic network modelling, considering the next decade of growth including drivers such as the 2032 Olympic Games; and the City of Stirling, in Western Australia (WA), on how to support their business case for a mid-tier transit corridor through better understanding the technology and applying it to an actual delivery process. These projects have involved considerable engagement processes. This report summarises the findings from these activities.

The Sunshine Coast study examined the potential for urban redevelopment that could be associated with a mid-tier transit system being committed to this city as has been planned over many years. A SNAMUTS (Spatial Network Analysis for Multi-modal Urban Transport Systems) Modelling exercise showed that considerable opportunities for development could follow the land value increases associated with mid-tier transit along a route linking key sites, especially when access is provided to the planned suburban rail extension from Brisbane.

The results will assist SCC in holistically planning the future connectedness of the coastal city that is more economically efficient and enables more equitable access to key local features. The research was a first for how SNAMUTS can be used for a regional city to help plan its future.

The Perth project built on previous work and a parallel exercise by a consortium of local governments that assessed the best Net Zero Corridors for their areas. The City of Stirling has been developing a federally funded business case for a mid-tier transit corridor, and previous SBEnrc reports provided part of that rationale, showing that mid-tier transit is the key enabling infrastructure for catalysing redevelopment at important nodes along the route. The partnership research in this project began testing two different trackless trams to provide technical due diligence for the business case, an understanding and a way forward for integrated and partnered delivery. It has identified the process and requirements for the new classes of vehicle to be approved for operation on Australian roads. The first results of a modelling exercise have been very encouraging. The physical trials will be completed in 2023, on site in Perth.

The local government process that led to the choice of routes for potential Net Zero Corridors was analysed at a high level and shows considerable benefits would flow from the costs of delivering mid-tier transit associated with urban regeneration. After five years of research, partner development, a consistently high media profile and a presentation by Professor Peter Newman at COP27 (the United Nations climate change ‘Conference of the Parties’) in Egypt, in November 2022, manufacturers of the trackless tram (CRRC) announced they would bring trams to be tested as part of the SBEnrc project by mid-2023. This coincides with policy support emerging at the state level across Australia, with Infrastructure WA including the concept in its *State Infrastructure Strategy*, *2023*. Thus, this research project has had a major successful outcome.

1.0 The Evolution of Net Zero Corridors: Perth Case Study

The Net Zero Corridor concept evolved from the core urban design tools of Transit Oriented Developments (TODs) and Transit Activated Corridors (TACs). TODs are well established through the New Urbanism agenda, and the idea of aligning TODs along a main road corridor led to the concept of TACs (Newman et al. 2019). The TAC concept appears to work best with a new 21st-century mid-tier transit system (BRT, LRT or trackless trams), as mid-tier transit has been known for decades to facilitate urban regeneration in station precincts (Newman and Kenworthy 1989; Calthorpe 1993).

The key principle of a TAC is set out in Figure 1 where a major transport corridor has a priority mid-tier transit line, with a precinct built around each station promoting urban regeneration that prioritises feeders and distributors such as walking and micro-mobility.

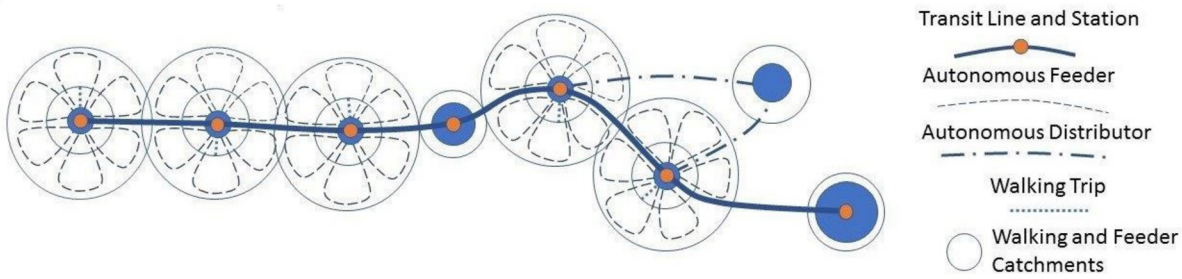

Figure 1. Transit Activated Corridor
(Source: Glazebrook and Newman 2018)

The Net Zero Corridor concept has developed from studies over the past five years with SBEnrc projects in Brisbane (Sunshine Coast corridor), Townsville (City to Health Campus corridor), Sydney (Parramatta Road, Liverpool corridor to new airport), Melbourne (City of Wyndham corridors to key rail stations) and the Perth network – focusing throughout on transit-led sustainable urban regeneration along main roads.

These projects explored funding mechanisms through integrated land development and value capture (Project 1.55), provided case studies and SNAMUTS (Spatial Network Analysis for Multi-modal Urban Transport Systems) evaluations to demonstrate the benefits and possibilities of integrated land use and mid-tier transport (1.62), investigated new forms of mid-tier transit, and developed the concept of net zero precincts (1.74). This project (1.84) has considered how TACs with net zero precincts could become Net Zero Corridors and spread across the whole city, resulting in net zero urban regeneration (see Figure 2).

TACs would need to be integrated net zero systems that provide both net zero buildings, cooling the corridor through urban forests and urban greening, along with mid-tier and micro or active transport spreading into each form of urban fabric.

The result would be a multi-nodal city and urban ecosystem joined together by corridors of electrified transport feeding off the solar generation built into the urban fabric, as set out in Figure 2.

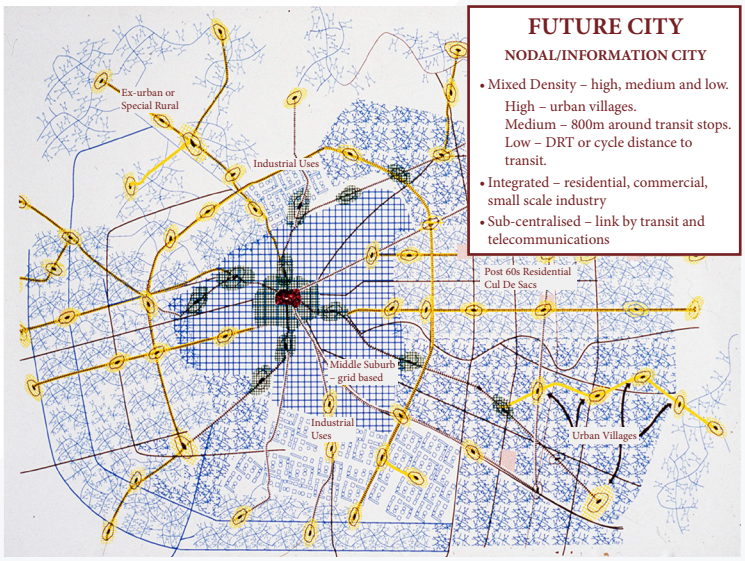

Figure 2. Future City Based on Net Zero Corridors and Precincts Across the City
(Source: Newman and Kenworthy 1999)

A core part of designing Net Zero Corridors is how to integrate a fast corridor transit system (using battery–electric vehicles) with a slow set of net zero precincts (solar–electric based) which are compact and walking-oriented and vibrant. This fast and slow double requirement is resolved by enabling fast and slow areas of the Net Zero Corridors.

A set of detailed design options in each of our projects shows how a transit service travels at speed down a clearway, where possible, or in traffic where it generally flows well, and then slows down when it enters a station precinct. Such precincts are where the design and place focus facilitate walkability and pedestrian activity. It sends the signal that dense urban development is favoured, as there is a high-quality transit system linking it to the rest of the city. This place-based precinct, with its highly attractive urban design, invites social activity in and around the stations. It would be called a '70:20 strategy', as the aim would be to bring the road-based transit down the corridor at speed (70 kph max.) and then slow down to prioritise walking (20 kph max.).

This is a very different approach to railways and traditional main roads which mostly separate urban development from the mobility goals along the different modal routes. Thus, roads chosen for this category would shift from prioritising just through-traffic to including station precincts. The approach delivers value to both developers and the community, requiring both mobility along the corridor and walkability and density inside the station precinct.

The mixture of fast transit corridors and slow walkable station precincts is fundamental to a Net Zero Corridor, with more of a focus on accessibility, sustainability and equity combined. Compared with car-only lanes, such routes could carry the equivalent of six lanes of traffic, easing congestion issues while increasing activity along the corridor through transit and urbanism. The value of this for improving transit and walkability in Perth was evaluated using the SNAMUTS Model (Curtis and Scheurer 2010) in Project 1.74.

What Are the Changes Needed in Professional Practice to Make a Net Zero Corridor?

A Net Zero Corridor will need to be a combination of transport and planning/urban design that procures mid-tier transit while procuring urban regeneration around station precincts. This will inevitably mean public and private funding and expertise are made a requirement of the process. The transition can begin by finding the best urban regeneration areas and directing a process that builds on 'Movement and Place' strategies.

Movement and Place originated from Transport for London as a way of rethinking main roads. Guidelines have been developed – for example, Guidelines for Sustainable Urban Mobility Plans, in Eltis (2019). These guidelines seek to shift the focus to people, accessibility and place over simple mobility based on increasing the speed and capacity of main roads for cars and trucks. The need to improve the balance between mobility and place has therefore become the next significant agenda in transport and urban policy. Net Zero Corridors could become the net zero design tool associated with Movement and Place. It may then enable a transition to net zero cities.

The net zero urban development around stations will need to be supported locally and be able to regenerate the neighbourhoods associated with each station. It will have the new net zero technologies built into the required designs. The Net Zero Corridor, with its net zero precincts, can spread into surrounding suburbs through expanding their local micro-grids and their local governance, embracing more and more of the city. Thus, the Net Zero Corridor concept can be used to transition to net zero cities using bottom-up approaches that link the transformation of power systems and the transformation of transport systems, building on historic urbanism.

Costs and Benefits of Net Zero Corridors Based on TACs

The evaluation of TACs undertaken in 2018 used as a case study the Stage 1 Scarborough to Cannington corridor. The benefit of a mid-tier (trackless tram or other) system along the corridor confirmed the potential for an increase in urban land value of 20 per cent for residential and 50 per cent for commercial properties, consistent with that demonstrated by an earlier study along Perth suburban rail lines (McIntosh et al. 2014) (see Figure 3).

The Scarborough to Cannington TAC case study was estimated to increase land values along the corridor from around A$19.8 billion to around $33.4 billion. This increase of $13.6 billion enables each city to gain development where it is critically needed and, with the inclusion of affordable and social housing, to see the city progress equitably and with a balanced workforce enabled to live within the area. The costs of development were estimated based on the value of land in the station precincts before the value increase. Table 1 sets out the costs and benefits in terms of jobs created to enable this urban development.

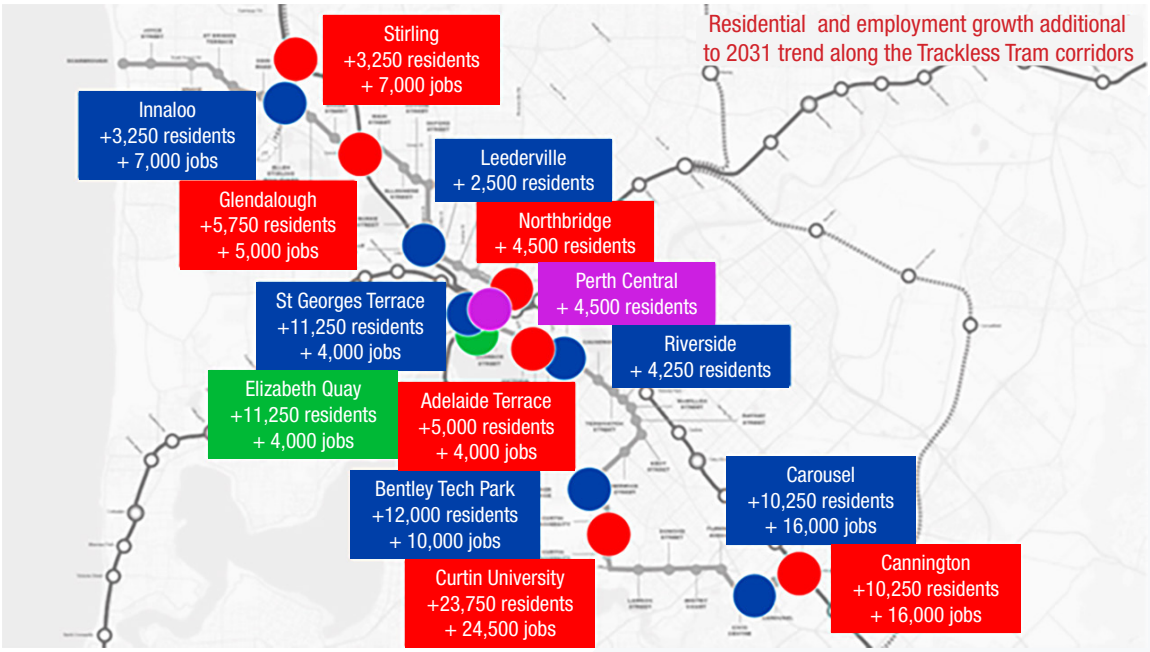

Figure 3: Residential and Employment Growth Estimates Along the Planned Transit Activated Corridor in Perth
(Source: McIntosh et al. 2014)

Table 1. Costs and Benefits (for land only) of Mid-tier Transit-led Urban Development

Project Stage	Public Investment	Private Investment	Land Investment and Jobs Created
	Vehicles, recharge and depot facilities (*$4.33m/km)[1] Roadworks ($19.2m/km)[2]	Station precincts with 200m of road around it ($6m each precinct)[3]	Land development (estimated value of land, with 9/37 jobs per $1m)[4]
Stage 1. Cannington to Scarborough 30 km	Stage 1: Vehicles $130m Stage 1: Roadworks $576m	30 station precincts $180m	$19.8b with 178,000 jobs directly and 732,600 jobs indirectly over 10 years, 10% per year, so 17,800 direct and 73,260 indirect
Stage 2. Whole-of-Perth Metro 112 km	Stage 1: Vehicles $485m Stage 2: Roadworks $2.150b	112 station precincts $672m	Not researched in detail but likely to be three times above

*Australian dollars

[1] See core report for details of vehicle costs and extra costs of fitting out recharge elements at stations and in depots: https://sbenrc.com.au/research-programs/1-74/

[2] See core report for estimate of roadworks for TransitWay.

[3] Based on 100 metres either side of station precinct, with estimated roadwork costs of $19.2 million per kilometre (see core report for details of this).

[4] Jobs estimated at nine direct and 37 indirect per $million invested by Ball and Wood (1995) and same as those used by Property Council of Australia, Urban Development Institute of Australia and Master Builders in Perth. Land value before trackless tram improved value has been used to estimate investment.

This case study's costs were seen to be very manageable and the benefits in terms of jobs highly attractive. Hence, public discussions indicated the need for this to spread to other main roads with similar goals.

The work suggested a bigger picture for Perth's mid-tier transit and urban regeneration. In 2019 SBEnrc Project 1.62 conducted workshops with all local governments and state agencies to identify the potential for key main roads to become TACs. There were a number of options identified and SNAMUTS was used to evaluate and refine the network. The preferred TACs largely reinstated the historic radial tram routes that had once linked Perth's inner suburbs to the city and key destinations, with other routes identified for the middle and outer suburbs providing east/west links connected to rail lines.

The SNAMUTS model enabled the benefits of the whole transit system to be assessed due to both the better transit service and the more intensive, focused urban development along the corridor (see Curtis and Scheurer 2010). The model was used to show how much urban regeneration could be created in precincts along the corridors for various options. This does not include the broader benefits flowing from place and climate resilient outcomes, nor the standard Benefit Cost Ratios (BCRs) parameters of travel time and road safety. If BCRs don't include these land-related benefits, then they will be missing the main point as to why such Net Zero Corridors are needed.

From TACs to Net Zero Corridors

Metropolitan Perth, in Western Australia (WA), has been built largely as an automobile city since the 1960s, with a population approaching 2.5 million. Perth's two walking cities of the 19th century – Fremantle and Central Perth – are largely intact, and the old suburbs along train and tram lines also demonstrate their transit-oriented urban fabrics. These inner metropolitan suburbs have largely regenerated in the past few decades (Thomson, Newton and Newman 2016), yet the main streets that pass through them that were once corridors of enterprise and hubs of social activity often are degraded and undervalued traffic thoroughfares.

Net Zero Corridors provide for the next phase of urban regeneration along these corridors and within the inner and middle suburbs. Local governments are seeking to discourage single-lot infill, as this results in highly sub-optimal outcomes, with the loss of mature trees and without the density for new services. The new model being sought is called Greening the Greyfields (Newton et al. 2021), based on how Net Zero Corridors could be created along main roads using the ideas outlined above to help create precinct-based net zero developments.

Figure 4 shows the City of Liverpool, Greater Sydney, vision for one of these precincts, with trackless tram stops along a main road and dedicated space for micro-mobility.

Figure 4. An Image Created to Demonstrate a Net Zero Precinct Along a Transit Activated Corridor Using a Modern Trackless Tram
(Source: City of Liverpool, Greater Sydney, Australia)

The Implementation of Net Zero Corridors

Net Zero Corridors incorporate the suite of new technologies that is challenging the old order.

At a personal level, transit diversity including shared vehicles, ride-hailing, electric cars and affordable micro-mobility is increasing choices for how we travel, and opportunities for remote work, shopping online and e-commerce is changing our need to travel. These changes also impact city infrastructure and public transport.

Figure 5 shows the outputs from the SNAMUTS modelling of these selected TACs and demonstrates the potential for significant accessibility and land value to be derived from these routes.

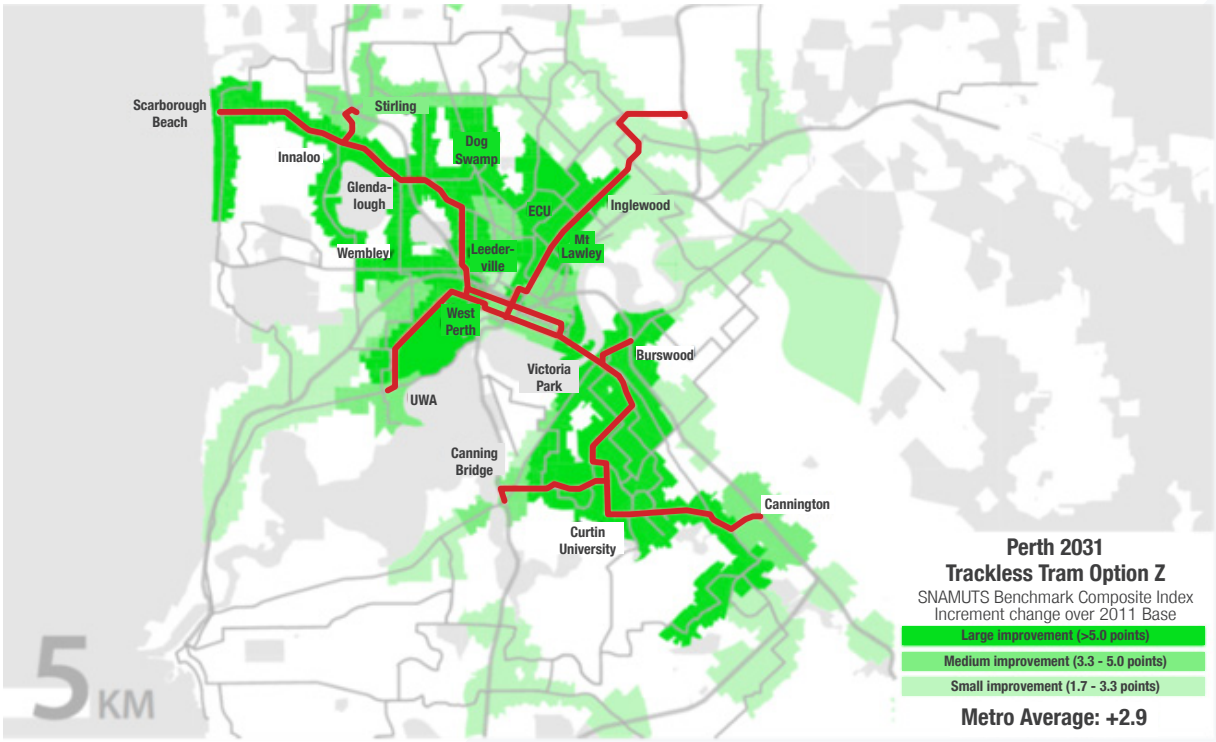

Figure 5. SNAMUTS Modelling Shows the Significant Value Derived from Inner-city Routes
(Source: SNAMUTS)

What Did Perth Local Governments Suggest for Net Zero Corridors?

In 2022, building upon the aforementioned work, a consortium of 15 local governments commenced preparation of a holistic Mid-Tier Transport Strategy for Perth (Figure 6). The routes identified were consistent with those in the SBEnrc 1.62 report and included additional routes. Further, SNAMUTS modelling was underaken and what can now be added for a more complete economic analysis are the net zero benefits due to climate change.

As these are firmly on the agenda, it becomes highly attractive for cities like Perth to establish such a net zero strategy with strong urbanism and job creation. As outlined below, this vision is now seen as the next opportunity in Perth's infrastructure and planning.

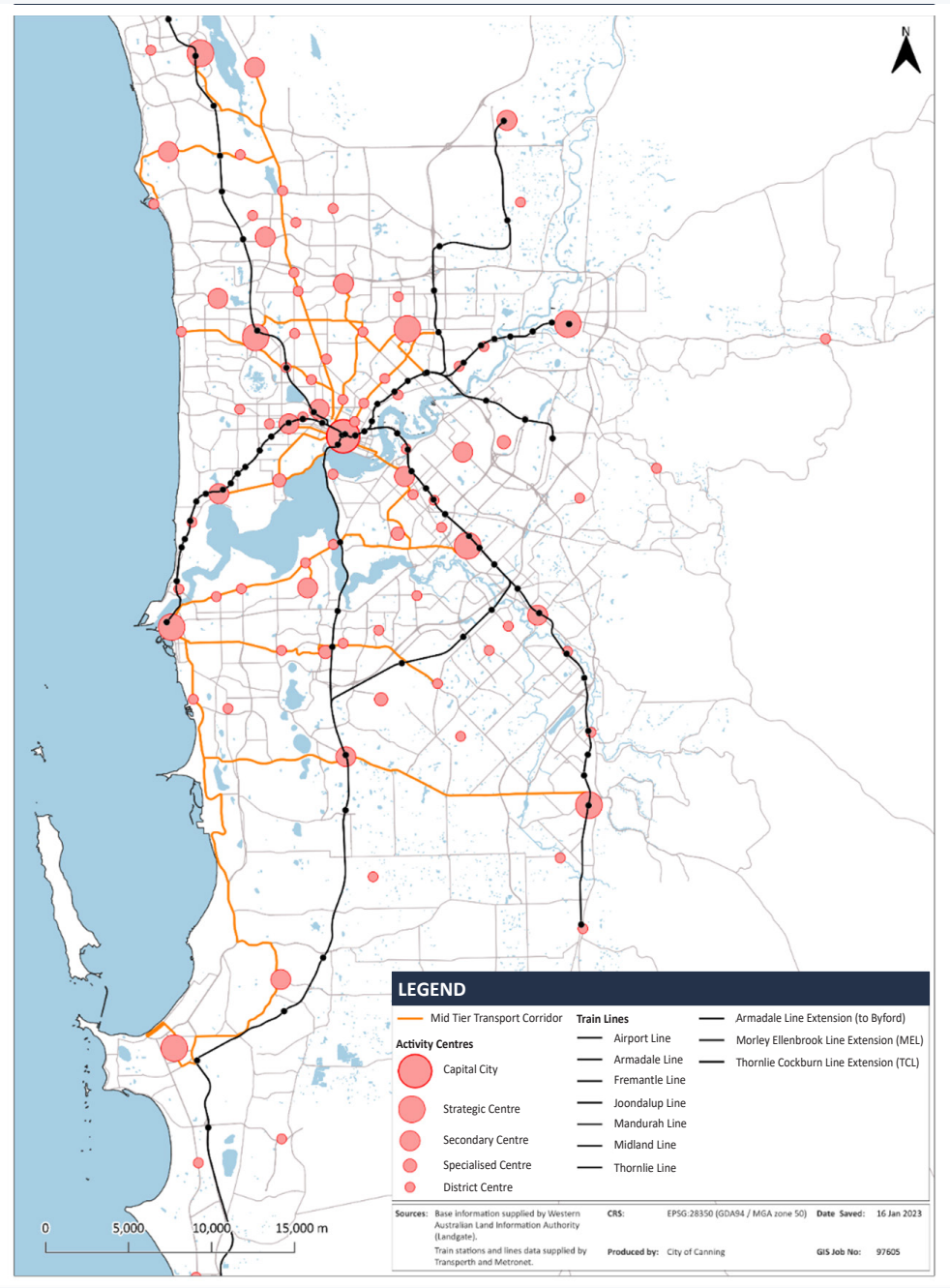

Figure 6. Potential Trackless Tram Routes and Transit Activated Corridors across Perth's Northern and Southern Suburbs
(Source: Local Government Consortium Mid-Tier Transit Strategy for Perth)

Net Zero Corridors and the WA State Infrastructure Strategy

The WA State Infrastructure Strategy (SIS) released in February 2023 reports that in 2021-22, 41 per cent of its $8.1 billion annual asset investment budget was for roads and rail transport and this is predicted to increase to 45 per cent in coming years. The SIS states we must be resilient to these technology changes and to the climate challenges, requiring all projects to move towards net zero. It suggests we learn the lessons from past infrastructure heavy solutions and look to better utilise the assets we have to adapt. The strategy goes on to say:

> *It is critical that investment on this scale has an integrated, coordinated approach to optimise long-term public benefit. WA can learn the lessons from costly, build-dominated infrastructure interventions in other jurisdictions by focusing on improving the efficiency of its existing infrastructure through demand management, smaller efficiency-enhancing projects and* ***alignment of infrastructure development with long-term land-use planning.*** *(p. 255)*

Further, the SIS suggests there is a need for:

> *[w]ell-placed developments around activity centres, urban corridors and public transport hubs to promote increased density. (p. 49)*

This research project is very much aligned to the SIS vision. The project has introduced the concept of Net Zero Corridors and looks to understand how we start that transition. It has involved academic research and engagement to test the concept applicability and community readiness. Proving the concept requires engagement and partnerships and understanding the barriers to implementation. The trial is an opportunity to share technical knowledge and collaborate on processes to build net zero urban systems.

2.0 Sunshine Coast Case Study: SNAMUTS Modelling – Towards Net Zero Corridors

Project Background

This case study was conducted within SBEnrc Project 1.84 Net Zero Corridors, which aimed to enable demonstration sites that showcase the feasibility of net zero cities, through precinct-level Net Zero Corridors that reduce reliance on car use and facilitate improved accessibility and local amenity (urban uplift).

Modelling Approach

Achieving vibrant places to live and work requires holistic planning for mobility. The SNAMUTS model enables holistic exploration of future mass transit opportunities in large capital cities around Australia. It is a supply-side tool that analyses the role of the public transport system in facilitating movement and activity across a city. Using multiple indicators, SNAMUTS helps to focus on and amalgamate key performance metrics of a transport system including serviceability, ease of movement and network coverage, as shown in Figure 7 (more information on the model website).

Building on studies in locations across Australia (Townsville, Sydney, Melbourne and Perth), the research team was interested in applying the SNAMUTS model to a medium-sized city that is experiencing and planning growth, involving different travel constraints and opportunities from large cities. The team was also interested in a linear city profile, which presents unique mobility considerations, particularly in a coastal setting where the majority of growth is on one side of a corridor.

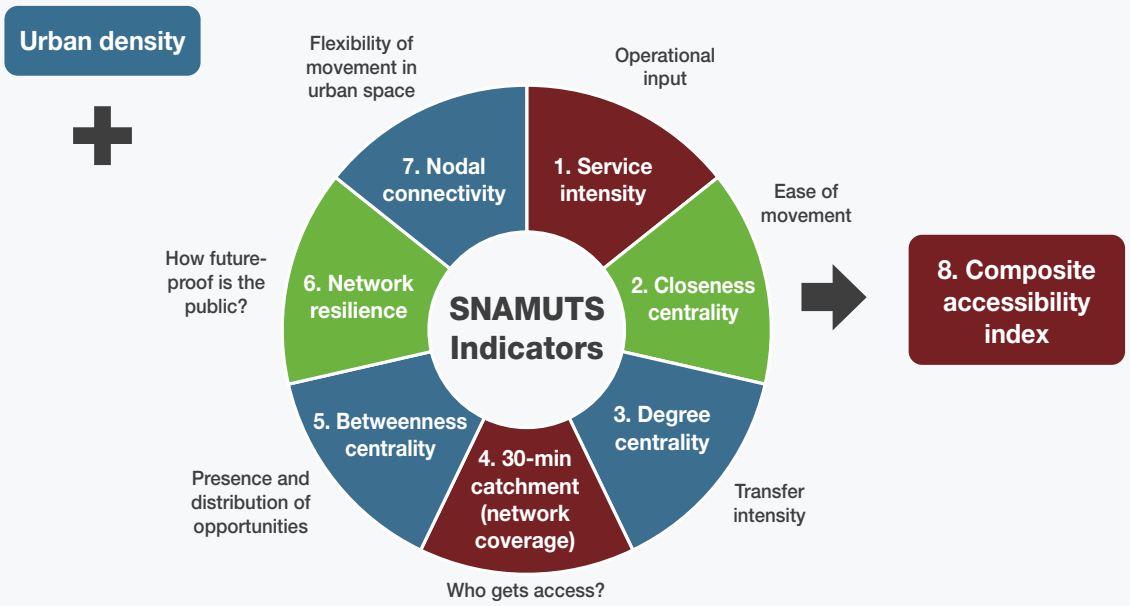

Figure 7. SNAMUTS Model Components
(Source: SNAMUTS)

Next Steps

The research team is in the process of writing the resultant SNAMUTS methodology for modelling medium-sized cities, and the potential for supporting decision-making regarding urban uplift from the SNAMUTS model. Results will be provided after Sunshine Coast Council has examined and released them.

3.0 Social and Affordable Housing in Net Zero Corridors

A paper has been produced by the SBEnrc team based on collaboration with the Department of Housing in Queensland and in WA, with the Griffith University team leading the process. The paper sets out to show how social and affordable housing can be integrated into every aspect of the Net Zero Corridors model and can also enable affordable living because of better access to urban services. The paper is still under discussion, but a summary of key ideas follows.

The Australian housing system is undergoing a structural change in response to shifting population demographics, challenges to traditional housing typologies and its ever-expanding commodification. Together, they present uncertainty for government leaders and policymakers tasked with ensuring Australians have access to safe, secure and affordable places to live.

Net Zero Corridors present one avenue for decision-makers to coordinate the increased provision of social and affordable housing around improved access and amenity and help with meeting the requirements of the net zero agenda. TACs can facilitate urban regeneration through diverse, well-located housing options serviced by an integrated network of high-quality, multi-modal transport corridors. The additional dimension is how they can also be net zero in the station precincts and transport systems. Current institutional challenges in addressing both housing unaffordability and the rising cost of living could be simultaneously dealt with through the Net Zero Corridor urban regeneration approach.

For government agencies, ensuring the conceptual notion of a TAC and how it supports Net Zero Corridors is clearly defined. The next challenge is how to facilitate their implementation in Australian cities while significantly improving social and affordable housing opportunities.

Photography by Adam Borkowski (Source: Pexels)

Project Background

For more than 10 years, Curtin University, as a research partner of the SBEnrc, has been working on decarbonising cities (Rauland, Newman 2015). This exciting research includes initiating a trial of new mid-tier transit technologies in Perth, forming an international collaboration of government, private sector and industry parties to demonstrate how urban development can be married with new transit technologies and renewable energy systems to create net zero cities. The enabling technology is what we term a trackless tram: a self-guided, battery-powered, rubber-tyred tram with three or more carriages which significantly reduces the cost of deploying mid-tier transit (see Figure 8).

The City of Stirling obtained $2 million through the federal government's Urban Congestion Fund for a business case to support a long-held aspiration for a 7 km mid-tier transit route along Scarborough Beach Road from Glendalough Station to Scarborough Beach, using trackless tram technology to implement a Net Zero Corridor. Mid-tier transit is considered the key enabling infrastructure for catalysing redevelopment at key nodes along the route, including the Stirling City Centre, planned to become Perth's second CBD, with increased employment and housing.

The Scarborough Beach Road Corridor Study, and Herdsman Glendalough, Stirling City Centre and Scarborough Beach master plans, as well as previous SBEnrc reports (see Figures 3 and 5, Table 1) have formed the basis for the mid-tier transit business case that was funded.

The SBEnrc was engaged by the City of Stirling to support this business case. The Centre provided technical due diligence via a trial of the vehicles in Perth, investigating and understanding the path to road deployment and operation in Australia, and engaging and managing a consortium of stakeholders to support these tasks. Information required about the use and value of this new mid-tier, net zero approach was transferred to the stakeholders. The project also provided the opportunity to understand how to support a business case with urban land development opportunities (as outlined above) to enable investment in new mid-tier transit. Thus, the overall research is critical to the next steps in procuring mid-tier transit on the City of Stirling road corridor and unlocking the urban development that is in their planning strategies. Central to this is the detailed trackless tram trial information.

Figure 8. Autonomous Rail Rapid Transport Trackless Tram
(Source: CRRC)

Why a Trial of the Vehicles is Needed

In 2019 it became apparent that there was a need to trial trackless trams to assist with planning and transport business cases across Australia. There were a number of questions about operational performance, pavement impact and capital and operational costs, as well as issues of how to certify such an innovative transport vehicle for road use in Australia. There were four obvious steps in resolving these issues:

1. Technical due diligence (for confidence in the operational safety, performance and maintenance).
2. Familiarising stakeholders with the new technology (operators, planners, transport agencies, regulators, consultants).
3. Building confidence for the vehicle manufacturers and distributors to justify resourcing the necessary trials (this includes developing the business case for market entry and market size).
4. Understanding the path to certification for road use and wider deployment.

These steps occurred in parallel. With the Covid-19 pandemic curtailing travel and opportunities for international collaboration, physical on-the-ground testing was necessarily delayed until 2023, as shown below. However, progress was made on all other steps.

Facilitating the Trial

The trial has been planned in stages, documented in a research agreement with the City of Stirling. The stages are:

- Planning and partnership
- Delivery and commissioning
- Testing on a private site
- A public symposium with an international profile to showcase the trackless tram and other mid-tier technology.

The first stage of the trial is now complete, with the vehicle manufacturer, CRRC, committing to delivery in the second half of 2023. This has involved:

- Developing a project plan and budget and supporting legal documents
- Accessing funding for the research through a joint submission with the City of Stirling to the federal government
- Identifying the testing requirements and procedures at state and federal levels for deployment of a new type of autonomous, electric, multi-carriage vehicle in Australia, in collaboration with industry partners and the WA Department of Transport, Main Roads WA, the Australian Roads Research Board (ARRB) and the National Heavy Vehicle Regulator (NHVR)
- Documenting regulatory need at state and federal levels for the vehicle to be certified to operate on Australian roads (which may require detailed validation of technical features)
- Working with the vehicle manufacturers and suppliers to support justification of their investment and time to test a vehicle in Australia. An evaluation of market potential for trackless trams in Australia and New Zealand was undertaken by Curtin University based on a scan of SBEnrc projects, case studies and publicly available data, and a supporting Memorandum of Understanding signed by the University, the vendors, manufacturers and the City of Stirling
- Finding a suitable test site, which was done with DevelopmentWA. After considering several sites, the Australian Automation and Robotics Precinct (AARP) was chosen – a closed site suitable for testing vehicles in an urban setting. The site owner, DevelopmentWA, has agreed to fitting guidance technologies and providing a suitable testing environment. AARP is adjacent to Barbagallo Raceway, in Perth, where gradient, speed and braking will be tested
- Obtaining import approvals, which was done with WA Department of Transport and the federal Department of Infrastructure, navigating the importation process for a new class of vehicle that is both self-guided and manually operated
- Developing the engagement plan and initiating collaboration across operators, local suppliers, vendors, engineering firms and federal, state and local authorities to build the knowledge needed for wider deployment across Australia (see Table 2)
- Developing a governance process for the consortium of partners needed for the trial
- Navigating foreign interests legislation.

The Path to Certification and Deployment

To be deployed in Australia, vehicles need to be tested as self-guided (semi-autonomous) vehicles and approved for commercial road use as a manually driven vehicle. Curtin University already has approval for importing two trackless tram models as Autonomous Vehicles (AVs) and has been working with WA Department of Transport on obtaining approval for testing these vehicles as AVs.

The first step involves Performance Based Standards (PBS) tests (for roadworthiness), beginning with computer modelling of these novel vehicles by the ARRB and working with the NHVR to detail the necessary safety and compliance at national, state and local levels. This is complex, as the guidelines for deployment of AVs on Australian roads are still under development.

The administrative pathways for gaining approval to import, test and deploy vehicles commercially are also complex. Figure 9 shows the process for approving trackless trams to run commercial services, approval for which is needed to respond to tenders in the Australian market. This can only happen if the vehicles are tested in Australian conditions.

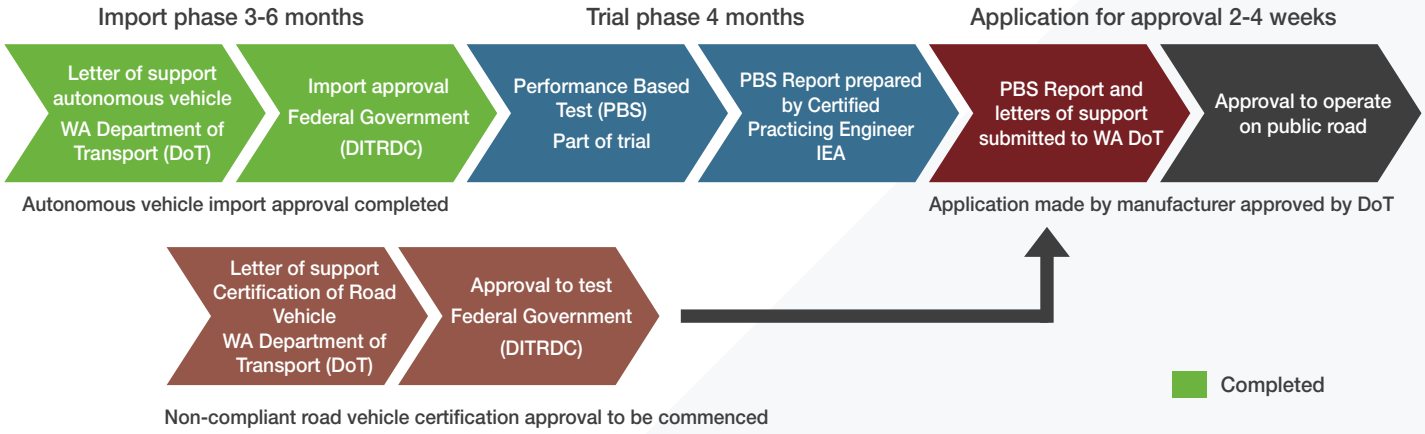

Figure 9. Administrative Pathways for Gaining Approval to Import, Test and Deploy New Road Vehicles

Engaging a Consortium of Stakeholders

Trackless trams are a synergistic new technology that, together with micro-mobility, can change travel behaviour and catalyse urban regeneration. Trackless trams introduce a new mid-tier mode between rail and bus: a disruptive technology that needs local champions and new processes to overcome system inertia that is resistant to change. During the project, the Curtin University team has established a comprehensive consortium of partners, as shown in Table 2.

Attracting and engaging these partners has been achieved through frequent meetings, professional networks and workshops and the widespread dissemination and sharing of information.

Communications channels have included mainstream TV and radio, social media outreach by Greenpeace and professionals, industry forums such as the World Economic Forum, presentations and journals. This has generated significant local and international interest in the role of mid-tier transit in urban regeneration and a snowballing of interest, opportunities and increased awareness and community support for mid-tier transit.

Table 2. Project Partnerships Developed to Form the Trackless Tram Trial Consortium

Core Partners	Role
City of Stirling	Project concept and core funding
Curtin University (includes SBEnrc)	Research lead and project facilitator
Manufacturers and Distributors	
CRRC China PZ	Manufacturer – Digital Rail Transit vehicle
CRRC TEC	Tram manufacturer – Autonomous Rapid Rail Transport vehicle
CRRC TEC Australia	Manufacturer representative in Australia
Shanghai Electric	Provider of guidance technology for the Digital Rail Transit vehicle
Infrastructure Technology Solutions Group (ITSG)	Distributor and investor for the Digital Rail Transport vehicle
Pacific Power	Distributor and investor for the Autonomous Rapid Rail Transport vehicle
Government Partners	
AARP	Test site
DevelopmentWA	Site provision, urban development advice
Main Roads WA	Advice on road certification, support for imports approvals, road engineering advice
NHVR	Peak national regulator for large road vehicles, road certification
WA Department of Transport	Advice on road certification, support for imports approvals
Engineering and Operations	
Arup	Road engineering advice, assistance with testing
ARRB	Road technology research agency, PBS modelling
Keolis Downer	Operator, provide drivers for tests
O'Briens	Assessor for Australian Design Rules
Stantec	Planning a trial in Victoria, knowledge-sharing

Next Steps

A combination of factors has led to the manufacturers of the trackless tram committing to bring trams to be tested in Perth by mid-2023. These factors have included: close working relationships with the partners, detailed trial planning, understanding the path to vehicle certification for road use, development of the business case for market development in Australia, local governments' mid-tier planning for Perth, federal support for the City of Stirling's business case, a consistently high media profile over the last five years and, finally, a presentation by Professor Peter Newman at COP27 (the United Nations climate change 'Conference of the Parties') in Egypt, in November 2022, which was conveyed to senior CRRC management.

The next steps of the trial are significant and will involve testing the vehicle, an international engagement event (symposium), and developing an understanding of how mid-tier transit can be introduced into cities and integrated with net zero development. These steps will also address the barriers for new vehicles to enter the market. In Australia and New Zealand there has been interest in the technology; however, there is system inertia and perceived risk. To mitigate these perceptions, in the subsequent stages of the trial, the project team will:

- Develop and implement a trial Risk Assessment and Management Plan
- Develop an Engagement and Event Management Plan with the City of Stirling and Curtin University, including a media strategy and involving close liaison with the project partners
- Prepare the test site for vehicle arrival including security, charging and stabling, line-marking and guidance infrastructure
- Land the vehicles in Australia, transport to the test site and commission the vehicle (by CRRC staff)
- Validate PBS tests with a certified assessor and check Australian Design Rule compliance
- Test areas not already verifiably completed by the manufacturer, or needed to validate the PBS computer model
- Refine the design, conduct and report on passenger and operator perception survey
- Prepare and release the test report to stakeholders, providing guidance on understanding real-world operating needs for Net Zero Corridor development using trackless tram mid-tier transit systems.

With these technical steps underway, the project can enable a more public and global engagement with the technology and the results obtained. The plan is to create, with the City of Stirling, an international symposium of invited international city leaders, industry and practice professionals. Guests will ride and inspect the vehicles, findings of the trial will be presented,and presentations from urban design professionals will showcase leading best practice. Curtin and the City of Stirling will oversee the event management along with industry and government stakeholders.

This seminar will provide an opportunity for input from key members of the executive teams for the other cities in Australia, New Zealand and internationally, operators, land developers and community groups who are considering the introduction of trackless trams. As outlined in preceding sections, there have been SBEnrc studies conducted in Melbourne, Sydney, Brisbane, Townsville, Perth and Bunbury. Trackless tram global studies (by Curtin) have so far been done in Philadephia (US), Bulawayo (Zimbabwe) and Chandigarh (India). These cities (and many others across Australia and the world) are looking to the trial to prove the technology and how it can be integrated into their cities to support urban growth and the net zero transition.

5.0 Conclusion

The Net Zero Corridors project has been working on a concept under four different periods of SBEnrc funding, covering six years of work. The close collaboration that has developed between the researchers and different stakeholders across Australia has been highly productive in terms of academic outputs, but mostly in terms of actual changes in how to integrate public transport (mid-tier) and urban land development (station precincts). The close engagement with local government as project partners has given the research a new dimension of practice-based approaches that are now ready to be delivered, along with the necessary government agency and industry partnerships.

The simultaneous focus on the new technology associated with net zero mid-tier transit and the focus on how to regenerate land around stations into net zero precincts has enabled a strategy to be developed as well as new professional practice. These strategies are now ready to be delivered in Perth (in 15 local government areas), Melbourne (in Wyndham and several other places developed by other groups such as at Fishermans Bend and Caulfield–Rowville), Sydney (Liverpool and Parramatta), Brisbane (Sunshine Coast), Townsville (Queensland) and Bunbury (WA). Strategies are also ready to proceed to business-case phase in Philadelphia, Bulawayo and Chandigarh.

The trial of a trackless tram in Perth has accelerated and now has commitment to proceed to on-ground testing later in 2023. A consortium of stakeholders has been formed and is committed to this trial. All the stakeholders will play a part in the trial, as well as in subsequent delivery and wider deployment into our transport networks. An international symposium later in the year will create a global focus on this project.

A fundamental aspect needed for wider deployment, which has begun, is the process of certifying these vehicles for road use and ensuring that the necessary agencies and peak bodies are aware of this new public transport option.

The next steps are to enable the governance and procurement processes in delivery of such mid-tier transit to produce the kind of outcomes now being sought by local government, state government and federal government. The full value in net zero land development and infrastructure investment needs to be achieved together.

It is intended that the next stage of the project will draw upon the findings of the trial and engagement process to draft and further engage government, industry and civil society in the development of Net Zero Corridors: Governance and Procurement – Integrating Transit with Urban Development.

5.0 Conclusion (cont'd)

'The transition to net zero is a global, national and local agenda and is increasingly seen as depending on net zero cities. This project has built on research from previous years to show how new kinds of public transport such as trackless trams can open up the potential along road-based transport corridors. This has been a passion of mine for over a decade and I have thoroughly enjoyed the progress the SBEnrc has made over the last five years. I think we are now clear on what the agenda is: we need new 'trams' that can open up urban regeneration opportunities and accommodate our expanding urban population. If we don't do this, our cities are going to continue to sprawl and become more and more divided into those who have easy access to the best urban services and those who don't – apart from the dramatically important issue of reducing climate impacts. The SBEnrc team is showing us how we can solve these issues. Now is the time to go and do it!'

Rob Adams AM
Chair, Project Steering Group
City Architect, City of Melbourne

Next Generation Autonomous Rapid Rail Transport
(Source: CRRC)

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Find out more:

Project webpages (including link to YouTube video):
Net Zero Corridors: The business case and an engagement process
https://sbenrc.com.au/research-programs/1-84/

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