Year 2 Annual Report

Pathways to Net Zero Precincts
Embedding Research to Accelerate Adoption

pathways to net zero precincts

RACE for 2030
RELIABLE AFFORDABLE CLEAN ENERGY

YEAR 2 ANNUAL REPORT

Program: RACE for Change

Project: Pathways to Net Zero Precincts – *Embedding Research to Accelerate Adoption*

Incorporating Envision Tomorrow Australia - An Urban Footprint Model for Australian Precincts*

*A Research Activity of Pathways to Net Zero Precincts

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PROJECT TEAM

Curtin University Project Team

Professor Josh Byrne
Professor Peter Newman
Professor Peta Ashworth
Associate Professor Nasrin Aghamohammadi
Adjunct Associate Professor Dusan Mills
Dr Maureen Boyle
Dr Himanshu Agrawal
Dr Hugh Finn
Dr Rob Weymouth
Dr Stephanie Li
Dr Yongze Song
Dr Asif Sardar
Dr Giles Thomson
Aimee Smith
Faz Ikram Bin Dzulkifly
Angelina Bowden-Jones
Issana Merie Burhan
Patrick Bendall
Nikki Jia Zhang
Rasanga Meneripitiye Neththanandalage

PROJECT PARTNERS

Curtin's support includes the CISCO Curtin Centre for Future Networks

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The authors of this report would like to respectfully acknowledge the Traditional Owners of the ancestral lands throughout Australia and their connection to land, sea and community. We recognise their continuing connection to the land, waters, and culture and pay our respects to them, their cultures and to their Elders past, present, and emerging.

WHAT IS RACE FOR 2030?

Reliable, Affordable Clean Energy for 2030 (RACE for 2030) is an innovative cooperative research centre for energy and carbon transition. We were funded with $68.5 million of Commonwealth funds and commitments of $280 million of cash and in-kind contributions from our partners. Our aim is to deliver $3.8 billion of cumulative energy productivity benefits and 20 megatons of cumulative carbon emission savings by 2030. racefor2030.com.au

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Executive Summary

The RACE for 2030 Pathways to Net Zero Precincts project advances research and practical implementation strategies to accelerate the transition of Australian precincts toward net-zero emissions. In its second year, the project has consolidated progress across four integrated research pathways: Certification, Consumer Energy Resources (CER) and Grid Integration, Governance, and Urban Design (including Envision Tomorrow Australia – ETOz) to deliver new evidence, tools, and insights supporting decarbonisation and climate resilience in the built environment.

Key achievements include the development of a Net Zero Integrity Framework under the Certification pathway, expanded engagement with industry through the CER and Grid Integration Forum, and significant advances in the digital twin research at Curtin University to support asset management and future low carbon development. ETOz has achieved a functional prototype linking spatial analytics with financial modelling through industry collaboration with DevelopmentWA, Hawaiian Group, and Royal Institution of Chartered Surveyors. Collectively, these efforts have produced tangible outputs, including academic publications, a tutorial guide for ETOz QGIS open-source Geographic Information System, and industry-focused videos and factsheets that communicate project outcomes to a broader audience.

Throughout 2025, the project has strengthened synthesis across pathways, aligning outputs with national frameworks such as the Commonwealth Government's Built Environment Sector Plan (2025) and the Trajectory for Low Energy Buildings. Engagement with the Project Steering Group and Industry Reference Group members has continued to shape research direction and ensure sector relevance. With robust governance and financial oversight, the project remains on schedule to deliver its milestones, including the production of a Net Zero Precinct Guide that supports scalable adoption of research outcomes across Australia.

1. Introduction

The RACE for 2030 Pathways to Net Zero Precincts project aims to generate the knowledge, tools, and partnerships necessary to accelerate the decarbonisation of Australia's built environment at the precinct scale. A precinct represents an ideal unit for change, being large enough to enable coordinated action across energy, water, transport, and governance systems. The project integrates research from multiple disciplines and case studies to explore how urban precincts can achieve measurable carbon emissions reduction while enhancing liveability and climate resilience. This Report corresponds to Milestone 7 for the research project and provides an update on research progress, industry engagement, and management activities for the 2025 reporting period. It is structured to guide new and returning readers through the Project's scope and outcomes.

- Section 2 outlines the evolving national policy and planning context for net-zero transition in urban precincts.
- Section 3 presents progress and achievements across the four research pathways.
- Section 4 details case studies where research activities are being undertaken across Australia.
- Section 5 highlights communication, engagement, and knowledge-sharing activities.
- Sections 6 and 7 provide updates on project management, governance, and future directions.

By combining applied research, industry collaboration, and cross-sector synthesis, the Pathways to Net Zero Precincts project is contributing to Australia's transition toward a low-carbon and climate-resilient built environment. This report captures the second year of progress and sets the foundation for final-stage integration and impact delivery.

Peel Business Park, Image by J Wyld

2. Net Zero Transition in Precincts

A Net Zero Precinct (NZP) is an end stage – it is what precincts must become for the built environment to transition to net zero. Thus, while NZP research focuses on how urban precincts can decarbonise now, we are also mapping what they will look like at the end of the net zero transition. To support this envisioning of net zero precincts and enable greater consensus around what net zero means for the built environment, we are proposing to adopt the definition of 'net zero' given in *PAS2080: 2023 Carbon Management in Buildings and Infrastructure (PAS 2080)*[1] [*see BREAKOUT 'What does "net zero" mean?'*].

The work is aligned with the key national net zero planning documents released in 2025. These include the Commonwealth Government's *Built Environment Sector Plan*, which outlines a pathway for the built environment sector to transition to net zero, and the *National Adaptation Plan*. In August 2025, the Energy and Climate Change Ministerial Council issued an updated *Trajectory for Low Energy Buildings*, which provides a national strategy for building sector actions. Some key themes are emerging for how precinct-scale actions can support the overall transition of the built environment to net zero.

First, the construction and retrofitting of new-build and already-built precincts must actively align with the net zero transition in Australia and therefore contribute to limiting warming to 1.5°C, in accord with Australia's new Nationally Determined Contribution (NDC), which calls for a 62–70% reduction on 2005 levels by 2035 and covers all sectors of the economy.

Second, carbon must be managed across the precinct life cycle, including for operational, embodied and user carbon, and across the boundaries of precincts and into their linkage with broader urban systems, such as through grid integration, flows of benefits and loads (e.g. energy, water), and circular economy strategies for waste and materials.

Third, mitigation and adaptation are to be pursued together, and with equity and fairness. Achieving net zero in urban precincts is part of a broader approach to delivering low-emissions and low-energy built environments that are fit for purpose, liveable, thermally comfortable, and resilient to a changing climate.

Finally, precincts are effective units for the net zero transition because decarbonisation can be implemented at a whole precinct scale. For example, by utilising Consumer Energy Resources (CER), integrated transport, or by enabling changes in individual precinct objects (buildings or infrastructure), substantial aggregate emissions reductions can be achieved. Thinking at a precinct-scale enables a broad range of decarbonisation levers to be considered, including green and blue infrastructure, waste management, low carbon transport, electrification, energy efficiency and digitalisation, CER and grid integration, and embodied carbon reductions (including re-use of materials at the end of life).

WHAT DOES 'NET ZERO' MEAN?

The Pathways to Net Zero Precincts project has adopted the definition of 'net zero' given in *PAS2080: 2023 Carbon Management in Buildings and Infrastructure* (PAS 2080)[2].

PAS2080 is an internationally recognised best practice standard for carbon management, which has been endorsed by Infrastructure Australia, Infrastructure NSW, Infrastructure Victoria, Infrastructure Western Australia, and other Australian bodies.

PAS2080: 2023 defines 'net zero' as:

> Reduction of anthropogenic greenhouse gas emissions to zero or to a residual level that is consistent with reaching net zero emissions in eligible 1.5°C pathways (hence timebound) and neutralising the impact of residual emissions (if any) by removing an equivalent volume of carbon.

Infrastructure Net Zero and the Australian Sustainable Built Environment Council (ASBEC) endorsed this definition in a 2025 report – *A Solid Foundation: A Common Definition for Net Zero Infrastructure and How to Get There* – following extensive industry consultation.[3] *Infrastructure Australia's Embodied Carbon Projections for Australian Infrastructure and Buildings*, published in 2024, also uses the definition.[4]

This definition of net zero emphasises the work of reducing emissions to zero, or to a residual level that is consistent with reaching net zero emissions in 1.5°C-compatible pathways, with removals being used to neutralise any residual emissions.

[1] British Standards Institution, PAS 2080: 2023 *Carbon management in buildings and infrastructure*, BSI Standards Limited, 2023, page 10 (definition of net zero)
[2] Ibid.
[3] *A Solid Foundation: A Common Definition for Net Zero Infrastructure and How to Get There*
[4] https://www.infrastructureaustralia.gov.au/sites/default/files/2024-08/IA24_Embodied%20Carbon%20Report_09-08-24.pdf

3. Pathway Activities

The research undertaken across the four research pathways in the six Western Australian case studies (collectively referred to as “Tranche 1”), along with case studies conducted in South Australia and Victoria (collectively referred to as “Tranche 2”), are individually significant and informative. However, greater value will be provided when the research is synthesised and presented in a way that maximises its impact for end users. The outputs from Tranche 1 and 2 case studies will be organised into the following structure to ensure the most effective communication of findings:

- A Framework for Understanding the Decarbonisation of Urban Precincts: This component defines what constitutes a NZP, identifies key decarbonisation levers and outlines broader approaches to sustainable built environment outcomes, including adaptation and co-benefits. It also examines financial decision-making, evaluates certification options, and considers data strategies to inform evidence-based planning.
- Key Learnings: This section presents research-based insights into how urban precincts are currently decarbonising, what strategies are effective, which challenges persist, and practical guidance on decarbonisation measures, drawing on both Tranche 1 and 2 case studies.
- Decision-making Tools: This includes digital and certification mechanisms designed to support decision-making regarding the selection, implementation long-term maintenance of decarbonisation measures.

Image by J Wyld

3.1 Certification

RESEARCH ACTIVITIES

Research this year focused on evaluating the suitability of existing certification frameworks for precinct-scale new builds and retrofits, particularly the GBCA Green Star Communities Version 2[5] and the Climate Active Carbon Neutral Standard for Precincts[6], and on developing draft definitions for 'net zero precincts' using life cycle assessment frameworks for the built environment. The pathway PhD completed an integrative literature review related to integrity in climate accounting and developed a preliminary Net Zero Integrity Framework.

ACHIEVEMENTS

Pathway PhD candidate Angelina Bowden Jones successfully completed Milestone 2 in September 2025.

INDUSTRY ENGAGEMENT

Industry interviews for the pathway's PhD research have commenced and are scheduled to continue throughout 2026. Pathway researchers also engaged with members of the Project Steering Group (PSG) in October 2025 and with representatives of the GBCA in July 2025. Further engagement with the GBCA is underway regarding the alignment of the draft definitions for 'net zero precinct' and the Green Star Communities Version 2 certification.

CHALLENGES

The introduction of mandatory climate reporting in 2025 is likely to lead to broader changes in how the built environment sector measures and reports emissions and considers the alignment of projects with local and national emissions targets. The rapidly evolving space of net zero certification, planning and reporting means that pathway research must evolve to keep up to date with recent developments. The integration of mitigation and adaptation in the built environment has emerged as a key focus in net zero planning at all levels of government.

NEXT STEPS

The pathway PhD is developing a Net Zero Integrity Framework that involves practice and normative values components. The Framework will continue to integrate information from the Pathway PhD interviews, as they continue into 2026. Analysis of the data from the interviews will enable more ideas on practice and on values, along with PSG and Industry Reference Group (IRG) input. Draft definitions for NZP will be revised based on PSG and IRG feedback.

RESEARCH SNAPSHOT: NET ZERO WITH INTEGRITY

The pathway PhD research is focused on examining the ways in which integrity can be enabled in the net zero commitments, actions and plans by non-state actors. Non-state actors include corporations, financial institutions and sub-national government bodies. In the context of precincts, these are the entities that develop, manage and operate within a precinct. Given their influence on the net zero outcome for a precinct, it was deemed relevant to focus the research on them. Historically voluntary certifications have been used by organisations to communicate their net zero commitments and status. However, with the introduction of mandatory climate-related disclosures in Australia, there is now a requirement for entities captured by Australian Sustainability Reporting Standard AASB S2 *Climate-related Disclosures* to disclose prescribed information for their climate-related (e.g. net zero) targets. Coupled with the introduction of mandatory reporting is an increased focus on greenwashing activities by the Australian Securities and Investments Commission (ASIC) and the Australian Competition and Consumer Commission (ACCC), which is also influencing the level of governance required by organisations in Australia to support their net zero commitments, plans and reporting.

Although organisations in Australia are not required to have a net zero target or transition plan, financial imperatives (e.g. access to green finance) and stakeholder and community expectations often demand them. The Net Zero Integrity Framework being developed by this PhD will support organisations in ensuring integrity in their net zero commitments, actions and plans. This will include issues related to professional practice as well as normative values set to guide and deliver climate disclosure with integrity.

[5] https://new.gbca.org.au/green-star/rating-system/communities/

[6] https://www.climateactive.org.au/be-climate-active/tools-and-resources/climate-active-carbon-neutral-standard-precincts; Climate Active is an Australian Government program and is currently under review.

3.2 CER and Grid Integration

RESEARCH ACTIVITIES

The data collected from industry stakeholder interviews is currently being examined to identify key barriers and opportunities for CER and Distributed Energy Resources (DER) integration across three typologies: microgrids, embedded networks, and Virtual Power Plants (VPPs). The research engaged 21 participants representing government organisations, property developers, private industry, consultants, regulatory bodies, and Distribution Network Service Providers (DNSPs).

ACHIEVEMENTS

The team held an online CER/DER and Grid integration forum on 23 September 2025. The primer and report from this forum are included with this report in Appendix 1.

INDUSTRY ENGAGEMENT

The IRG was established to provide advice and industry insights to the CER and Grid Integration pathway of the NZP project. The previous IRG meeting was held on 16 April 2025 and was attended by six industry members and several Curtin staff members. The meeting went through some of the key findings from the interviews, and the IRG group provided feedback on this. They also provided constructive feedback on the theory of change model, suggesting further clarification on how the various linkages within the framework could be explored, given the project's scope and available resources. The IRG also recommended considering both real and perceived barriers to achieving NZP outcomes to strengthen the framework's applicability and impact.

PUBLICATIONS

One paper is currently in the drafting stage: Economou, D., Boyle, M. Ashworth, P. Byrne, J. (2025) Accelerating net zero through urban precincts. The target journal is Energy Research and Social Science. The paper is based on interviews with industry stakeholders, as noted above in the research activities. Ashworth, P and Pashajavid, E. (2025) Explainer: What does it actually mean to 'firm' renewables? Two literature reviews were conducted by two postgraduate students, Timothy Gifford and Muhammad Salman through Curtin's Industry Exchange. The literature reviews synthesised academic and grey literature on CER and Grid integration and were supervised by Dr Maureen Boyle and Dr Dean Economou.

CHALLENGES

The research team experienced some challenges related to the reliance on PhD students to undertake key components of the work, which effected continuity when circumstances changed. Earlier this year, a PhD candidate withdrew after completing approximately six months of research. To maintain momentum, additional research within the CER and Grid Integration pathway will be advanced through collaboration with industry partners.

NEXT STEPS

There is a need to have a richer dataset to quantify the impacts and lessons from relevant CER and Grid integration work across the pathways to NZP. Additional research will be conducted in collaboration with the Governance pathway to contribute to the broader research agenda.

3.2.1 Digital Twin

RESEARCH ACTIVITIES

The current research focuses on enhancing the digital twin framework for real-time energy forecasting at Curtin University's Bentley campus. The study concentrates on two buildings: the TL Robertson Library (Building 105) and the School of Design and the Built Environment (Building 418). Since the initial phase, the framework has been expanded to integrate environmental data, such as temperature, humidity, solar radiation, and wind speed, from the Bureau of Meteorology (Australia) and the Green Electric Energy Park (GEEP) at Curtin University, along with occupancy data provided by the Digital and Technology Solutions (DTS) team. These datasets have been incorporated into predictive energy models to improve the accuracy and responsiveness of real-time forecasting.

ACHIEVEMENTS

The integration of environmental and occupancy data has resulted in a significant improvement in model accuracy and reliability. This advancement supports Curtin University's sustainability objectives by enabling near real-time decision-making to enhance energy efficiency and operational performance across the campus. A PhD student has recently been recruited to contribute to the further development of this research.

INDUSTRY ENGAGEMENT

Partnerships have been established with Cisco and Western Power to advance Curtin University's Digital Twin Pilot for Building 105. Cisco's Application Programming Interface (API) provides real-time infrastructure for capturing occupancy and environmental data, forming a key dataset for operational carbon modelling and space utilisation analysis within the university precinct.

PUBLICATIONS

A manuscript entitled "Digital Twin-Enabled Real-Time Forecasting of Energy Consumption: A Case Study at Curtin Campus Precinct" authored by Sardar, A. Jayaweera, R. Byrne, J. Ashworth, P. Goerke, T and Agrawal, H. was submitted to IEEE Access. The paper has undergone peer review and is currently being revised in response to review comments prior to resubmission.

CHALLENGES

Gathering reliable, continuous data was a significant challenge. People count data were only available between 8 am and 7 pm, making it difficult to estimate actual occupancy. Integrating datasets from the Bureau of Meteorology, GEEP and the DTS systems also required careful cleaning and alignment. The work to ensure successful data integration is ongoing.

NEXT STEPS

The next phase involves collaborating with Western Power to translate outcomes of data-driven modelling on Consumer Energy Resources (CER) and Grid Integration pathways for Curtin Exchange Precinct into actionable insights that support decarbonisation and grid resilience.

3.3 Governance Practices

RESEARCH ACTIVITIES

Analysis of survey research collected in 2024 was conducted this year to inform the focus of governance related research activities for the remainder of the project. Various definitions of governance were tested for their applicability to the case studies before arriving at a version encompassing a broad understanding of the systems and relationships underlying the decision making that occurs at various parts of the Precinct lifecycle by the disparate urban development actors. Interviews with residents and stakeholders from the WGV were also conducted to understand the lessons learned from an operational precinct with net zero attributes.

ACHIEVEMENTS

Around 30 interviews were gathered from around the WGV precinct and then uploaded and coded into NVivo. Preliminary analysis shows coherent themes regarding the challenges of operationalising Net Zero Precincts.

INDUSTRY ENGAGEMENT

Governance Pathway researchers met with individual PSG members in October 2025 to discuss the end of project deliverables in addition to regular PSG meetings to update the Partners. The IRG for Governance met for its inception meeting in May, following a reevaluation of its membership. Representatives from Curtin University, Shelter WA, The Strata Community Association, the Department of Planning, Lands and Heritage, local government and local architects met to review the research and synthesis plan for the pathway.

PUBLICATIONS

Multiple publications are currently under preparation. The first – titled “Navigating the ‘Net Zero’ Divide: Unmet Expectations from Residents in a Sustainable Precinct” – is currently being drafted by Annolies Truman, Maureen Boyle and Robert Weymouth based on the analysis of the WGV residents’ sustainability attitudes and appropriate journals are being investigated. Interviews from WGV will form the basis of two other papers being drafted. One will focus on the experience of CER implementation and is provisionally titled “Lessons from the Implementation and Operation of Small Scale CER Systems: A Case Study” by Maureen Boyle, Annolies Truman and Robert Weymouth, and appropriate journals are being investigated. The other will draw out governance lessons and is provisionally titled “Understanding Governance Challenges for Aspirational Net Zero Precincts,” by Robert Weymouth, Annolies Truman and Maureen Boyle in a peer-reviewed journal. Finally, a publication titled “CASI: Incorporating Culture into the Avoid Shift Improve model as a Leverage Point for Climate Action”, collaboratively authored by Jayne Bryant, Giles Thomson and Robert Weymouth, is in production based on improving existing frameworks for climate action to incorporate governance culture factors. This paper is currently in final draft and is expected to be submitted to Australian Planner and published by the end of the year.

CHALLENGES

2025 has been a challenging year for the pathway, marked by changes in both the Technical and Professorial Leads. In September, the Governance PhD candidate withdrew from her program for personal reasons after successfully completing the required PhD milestones. She has expressed her willingness to continue contributing to the project in a limited capacity, providing valuable continuity and support during the transition period.

NEXT STEPS

The in-progress publications will be completed and contribute to the synthesis of learnings to date. Further research will also be conducted on barriers related to governance, including regulatory culture, owner incentive schemes and strata management capacity. Additional funds available due to the resignation of the Governance PhD student will be used to support these activities.

3.4 Urban Design

To date, the Urban Design pathway research has primarily centred around the ETOz project research activities, as documented in the following section. This has been bolstered by the work of RACE PhD top-up scholarship recipient Issana Burhan under the supervision of Professor Peter Newman. Issana's research into the role of Green Infrastructure in supporting the transition to net zero urbanism has leveraged several of the WA NZP case studies to highlight opportunities for improved urban water management and urban greening outcomes (see Research Insights under the Knutsford and Curtin Bentley Campus Case Study sections).

A second RACE PhD top-up scholarship recipient, Patrick Bendall has joined the project team this year. Patrick is an architect and urban designer and will be contributing to the development of 'NZP design guidance' leveraging learnings from the NZP case studies (see Sunshine Precinct case study as an example).

Funding has been requested from RACE to support the appointment of an Urban Design Technical Lead for the final year of the project to further enable the translation of case study-based research findings into industry facing resources.

3.4.1 Envision Tomorrow Australia (ETOz)

RESEARCH ACTIVITIES

Over the past 12 months, under the guidance of Professor Josh Byrne and Adjunct Associate Professor Dusan Mills, the ETOz project has advanced in integrating spatial data analytics within urban planning frameworks with Quantum Geographic Information System (QGIS). Key research activities have included developing enhanced data pipelines for financial, building typologies and Geographical Information System (GIS) datasets, refining the generative spatial methodology for scenario testing and conducting pilot simulations in selected precincts such as WGV and the Knutsford Swanbourne Street Structure Plan Area. Collaboration with Hawaiian Group and DevelopmentWA has enabled integration of development feasibility data and building typologies and environmental performance metrics.

ACHIEVEMENTS

Notable achievements include the successful prototype of the ETOZ framework, integrating GIS-based visualisation with financial modelling and illustrating land-use efficiency. The project team achieved measurable milestones in algorithm accuracy and testing the beta-version with spatial science researchers from Curtin University and Hawaiian Group. A tutorial guide to the ETOz model in QGIS for non-expert users has been developed and tested by members of the research team. PhD candidate Faz Ikram completed Milestone 2 and won a coveted spot in the National Energy Transition Accelerator (NETA) 2025 as a cohort, recognising emerging leaders in energy transition.

Nikki Zhang commenced her PhD in September, focusing on the Environmental Performance Index (EPI) and Urban Design. Nikki Zhang has completed the building typologies for WGV, incorporating the EPI framework. This work will serve as a foundational basis for future modelling within the Knutsford Swanbourne Street Structure Plan Area.

INDUSTRY ENGAGEMENT

ETOz has engaged actively with key industry partners, including DevelopmentWA, Hawaiian, and the Royal Institution of Chartered Surveyors (RICS) to align the tool's predictive capabilities with practical planning applications. Workshops and technical sessions were held to gather feedback from end-users in the property, infrastructure, and sustainability sectors. These engagements have led to expressions of interest in commercial deployments and collaborative research initiatives under Net Zero Precinct research project.

PUBLICATIONS

A book chapter titled “Designing for Complexity: Strategic and Regenerative Approaches to Resilient Urban Futures” by Aghamohammadi, N*. Ikram, F. Byrne, J . Pinto, D. and Mills, D. has been accepted for publication in an upcoming volume currently being updated under the working title Case Studies in Smart and Sustainable Built Environment. The book is being considered for inclusion in Springer’s Green Energy and Technology series and is scheduled for publication in late 2025.

CHALLENGES

The main challenges encountered include data harmonisation across planning codes, such as Western Australia and South Australia, as well as computational constraints in large-scale corridor simulation. The issue regarding harmonisation of data occurs due to the wide case study areas, such as WGV and the Knutsford Swanbourne Street Structure Plan Area, which is located in Fremantle, Western Australia, while the third case study is located in City of Onkaparinga, South Australia. Resources such as datasets, time and cloud platform application are required to be allocated well, especially balancing academic research and project operation for interdisciplinary integration and stakeholder engagement.

NEXT STEPS

Upcoming priorities include expanding the pilot studies to additional urban regions, enhancing predictive precision and developing a minimum viable product for broader deployment. Further engagement with policymakers and investors will ensure that ETOz’s research outcomes translate into scalable solutions supporting Australia’s net-zero precinct and sustainable urbanism.

East Village at Knutsford, Knutsford Urban Regeneration Precinct, Image by J Wyld

4. Case Studies

The case studies in this report consist of six sites within Western Australia (studied by Curtin University researchers), which are collectively known as “Tranche 1” case studies. “Tranche 2” case studies include a site in Melbourne, Victoria (studied by RMIT researchers), a site in Adelaide, South Australia (studied by Adelaide University researchers (formerly University of South Australia)) and a district-scale urban area in South Australia (also studied by Curtin Researchers). These case studies cover a wide range of development types, development stages, uses, developer governance and research methods. A broad overview of the breadth of this research is shown in the table below.

SITE	TYPE	STAGE	USE	DEVELOPER GOVERNANCE	RESEARCH METHOD
Knutsford	**Brownfield**, Greenfield, Retrofit	Feasibility, Design, **Operating**	**Residential**, Commercial, Industrial, Mixed-use	Private, **Government**, University	**Digital data gathering**, **Modelling**, Interviews, Surveys, **Literature**
Rivermark	**Brownfield**, Greenfield, Retrofit	Feasibility, Design, **Operating**	**Residential**, Commercial, Industrial, Mixed-use	**Private**, Government, University	Digital data gathering, Modelling, **Interviews**, **Surveys**, **Literature**
Curtin	Brownfield, Greenfield, **Retrofit**	Feasibility, Design, **Operating**	Residential, Commercial, Industrial, **Mixed-use**	Private, Government, **University**	**Digital data gathering**, **Modelling**, Interviews, Surveys, Literature
Alkimos	Brownfield, **Greenfield**, Retrofit	**Feasibility**, **Design**, Operating	Residential, Commercial, Industrial, **Mixed-use**	Private, **Government**, University	Digital data gathering, **Modelling**, **Interviews**, Surveys, **Literature**
Peel	Brownfield, **Greenfield**, Retrofit	Feasibility, Design, **Operating**	Residential, Commercial, **Industrial**, Mixed-use	**Private**, **Government**, University	Digital data gathering, Modelling, **Interviews**, Surveys, **Literature**

SITE	TYPE	STAGE	USE	DEVELOPER GOVERNANCE	RESEARCH METHOD
Roe	**Brownfield** Greenfield Retrofit	Feasibility Design **Operating**	Residential Commercial **Industrial** Mixed-use	**Private** **Government** University	Digital data gathering Modelling **Interviews** Surveys **Literature**
Noarlunga Centre and Beach Road (Net Zero Corridor)	Brownfield Greenfield **Retrofit**	**Feasibility** **Design** Operating	**Residential** **Commercial** **Industrial** **Mixed-use**	Private **Government** University	**Digital data gathering** **Modelling** Interviews Surveys Literature
Sunshine	**Brownfield** Greenfield Retrofit	**Feasibility** **Design** Operating	**Residential** **Commercial** Industrial Mixed-use	Private **Government** University	**Digital data gathering** **Modelling** **Interviews** **Surveys** Literature
Rundle Mall	Brownfield Greenfield **Retrofit**	**Feasibility** **Design** Operating	Residential **Commercial** Industrial Mixed-use	**Private** Government University	**Digital data gathering** **Modelling** **Interviews** **Surveys** Literature

4.1 Knutsford Urban Regeneration Precinct

OVERVIEW

The Knutsford Project, led by DevelopmentWA, forms part of the City of Fremantle's long-term urban regeneration initiative aimed at transforming underutilised industrial land into a sustainable, mixed-use, medium density urban neighbourhood. Research activities over the past year include the application of the ETOz scenario planning tool to the Knutsford Swanbourne Street Structure Plan Area and the use of the East Village at Knutsford (EVK) sub-precinct as a case study to develop Net Zero Urban Water principles (see EVK Research Snapshot).

PROGRESS

Progress on the Knutsford ETOz case study activities has advanced through integrated spatial and valuation modelling aimed at supporting sustainable urban redevelopment. Using QGIS as a primary analytical platform, datasets from DevelopmentWA and the City of Fremantle have been combined to assess building typologies, land efficiency, and decarbonisation potential across the Knutsford precinct. The spatial models identify optimal configurations for medium-density and mixed-use developments, environmental performance indexing to assess energy and water use, urban greenspace and carbon emissions within the local urban design context.

Structure plan data were incorporated into ETOz's valuation and scenario tools, enabling predictive simulations of density yield, transport accessibility, and infrastructure capacity. Collaborative data exchange with DevelopmentWA has enhanced the precision of 3D typology mapping, facilitating comparison between proposed design typologies and sustainability benchmarks. This integration supports decision-making for future land releases and aligns redevelopment objectives with Fremantle's net-zero and livability goals. The next phase will focus on refining the building typology dataset and validating model outputs.

FINDINGS

Analysis of the Knutsford project indicates strong alignment between spatial modelling outcomes and DevelopmentWA's sustainable redevelopment goals. This, in turn, indicates that the methodology is replicable for the analysis of feasibility for other projects with a sustainability focus. The modelling also highlighted opportunities for the application of environmental performance index for medium density building typologies. Additionally, the integration of DevelopmentWA's datasets has helped to improve typology precision and valuation accuracy. However, adjustment for building costs through the construction cost guide provided by Rawlinsons Construction Cost Guide 2024 and 2025 confirms that spatial and development feasibility metrics can effectively guide evidence-based decision-making for medium-density precincts with adequate information.

PLANNED ACTIVITIES

Under the continuing supervision of Professor Josh Byrne and Adjunct Associate Professor Dusan Mills, upcoming work will focus on expanding the spatial and valuation modelling capacity of ETOz to support the next stage of Knutsford redevelopment. Key activities include refining the building typology library with verified design and sustainability data, integrating QGIS-based carbon and land-use models, and enhancing 3D urban form simulations for scenario testing. Collaboration with DevelopmentWA will continue to improve access to real-time site, infrastructure, and valuation data sets. The project will also develop benchmarking dashboards to monitor performance across density, EPIs, and financial feasibility. Further stakeholder workshops are planned to validate modelling outcomes and contribute to DevelopmentWA's project planning processes.

RESEARCH SNAPSHOT: EVK WSUD

The concept of Net Zero Urban Water (NZUW) has emerged as a system-based approach that balances water inputs and outputs across spatial scales to achieve a net zero water footprint through conservation, demand management, and offsets, while reducing associated GHG emissions. Two key concepts underpin NZUW: Water Sensitive Urban Design (WSUD), which provides a planning and design framework for managing the entire urban water cycle, and Urban Water Metabolism (UWM), which diagnoses and quantifies water flows through urban systems. UWM allows the assessment of WSUD strategies by accounting for reuse, recycling, water/stormwater decentralisation, and green infrastructure (GI), supporting evidence-based decision making towards circular water loops and NZUW pathways.

Despite widespread recognition, WSUD and UWM are still predominantly framed as adaptation tools for flood mitigation and stormwater management. Their contribution to broader climate action, through energy-efficient water use and contribution to urban livability through improved amenity and urban heat mitigation, is less well known. Empirical evidence of their interaction in delivering NZUW at the system or precinct scale is limited.

Research into how WSUD and UWM can strengthen climate action agendas and operationalise NZUW in practice is being undertaken at WGV and East Village at Knutsford. Research activities include examination of WSUD initiatives, their impact on water self-sufficiency, potable water reduction, stormwater capture and reuse, alternative supply provision, and metabolic circularity through a water mass balance analysis. The case study-based research will be used to inform design principles and urban form characteristics to support NZUW precincts.

East Village at Knutsford, Knutsford Urban Regeneration Precinct, Image by P McGovern

4.2 Rivermark

OVERVIEW

The Rivermark residential development is located on a former brickworks site near Guildford. The private developer, Hesperia, targeted net-zero status for all the stages of its land development on this site. Stage One has been completed with planning for Stage Two in progress, making this case study an example of a precinct conceived, designed, constructed and operated with net zero aspirations.

PROGRESS

Stage 1 began with assessments of the whole of life carbon impact of activities under Hesperia's influence, followed by preparation for measuring and offsetting of residual emissions with carbon credits. This informed the design work and led to the use of recycled and low carbon materials in the civil and landscape works. In conjunction with these net zero attributes, there was a focus on ecological placemaking at the site through strong Aboriginal engagement, the creation of public green space, opening access to the Swan River and mature tree retention. As a land-only development site for Hesperia, initiatives to support and advocate for uptake of low carbon technologies and behaviours by builders and homeowners were required. These included house design guidelines supporting energy efficiency for builders and a sustainability incentives program where residents could choose a number of low carbon options, including e-bike/e-scooters; acoustic upgrades; waterwise landscaping and irrigation; energy and utilities upgrades such as heat pump hot water systems.

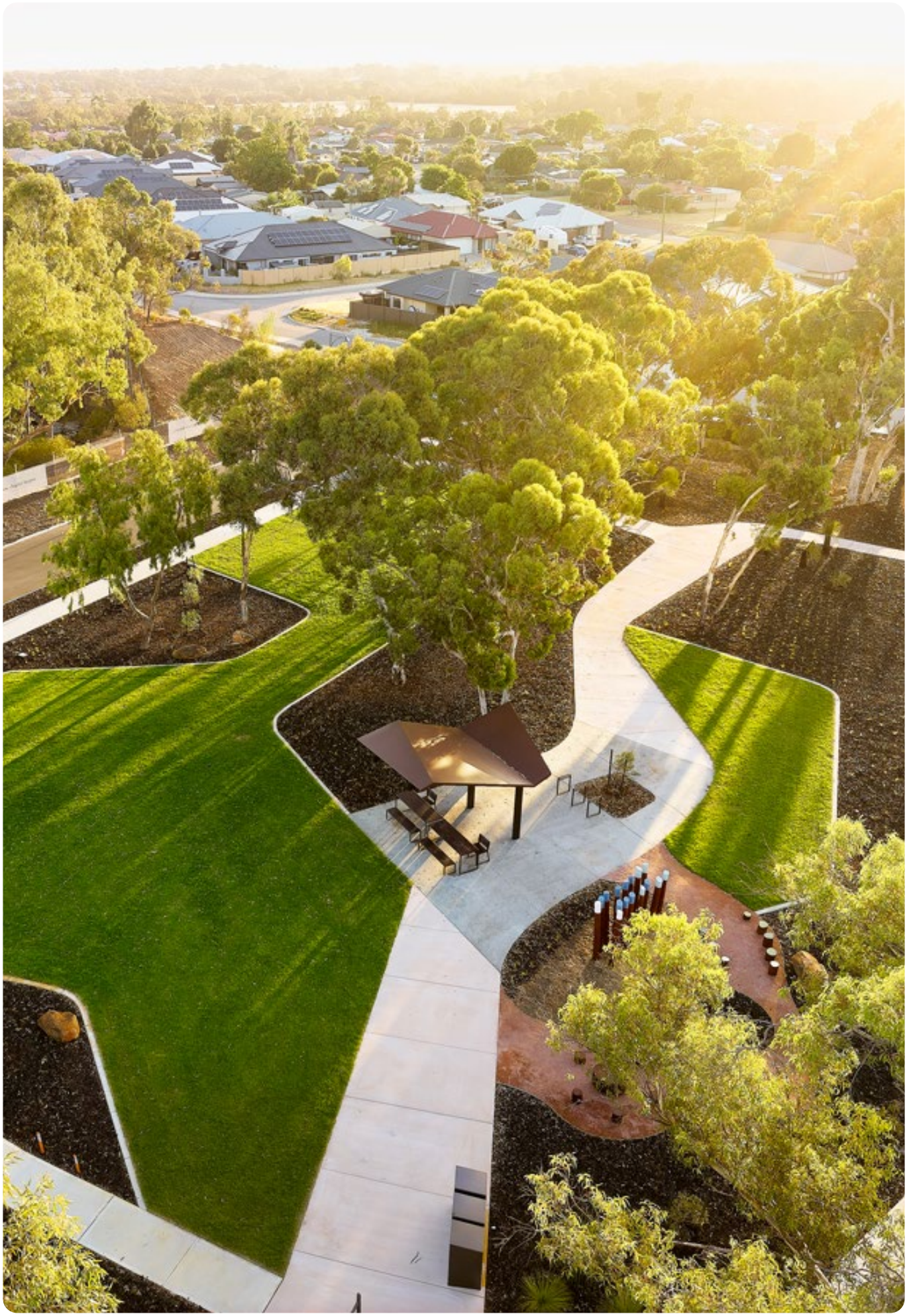
Plans to power the precinct with renewable energy through the installation of a microgrid were hindered by regulatory barriers, which led to a developer-led behind the meter battery leasing service termed Solar Maximiser. The scheme was effectively a no-interest loan for homeowners to install solar and battery systems to utilise locally generated renewable energy. However, the scheme showed very low uptake rates. Hesperia took the lessons from this and have now updated their sustainability incentives in future developments to include a home battery package (which offers additional incentivises in addition to the state and federal home battery scheme). They also offer an "all electric package" to encourage householders to install a heat pump hot water system or solar hot water system with an electric booster.

FINDINGS

For the achievement of net zero outcomes in precincts, there needs to be alignment of the net zero ambitions of the developer, mature net zero technologies, enabling legislation/ policies and net zero literacy and behaviours from precinct residents/tenants. Decisions by regulatory bodies can be a significant barrier to developers committed to net zero outcomes. This requires strong leadership and a commitment to net zero outcomes to overcome such barriers. It also helps to encourage innovation and creative thinking to find new solutions. Trust, education and behaviour change interventions with both builders and homeowners and prospective residents are important for achieving operational net zero goals.

PLANNED ACTIVITIES

In 2026, Rivermark will continue to be part of research investigating the effectiveness of incentives to encourage homeowners to enhance the net zero attributes of their precincts. It will also be used as a case study illustrating governance barriers in regulatory agencies and the strengths of internal sustainability cultures to overcome barriers or remain committed to net zero outcomes.



Rivermark, Image by DMax Photography

4.3 Curtin Bentley Campus

OVERVIEW

Located 6km southeast of the Perth CBD, Curtin University's Bentley campus spans 116ha and comprises over 100 buildings supporting academic, administrative, commercial, residential and recreational uses. Research activities for this case study align with a scheduled campus masterplan review being undertaken by Curtin Properties, Facilities and Development (PFD), as well as the preparation of the University's decarbonisation strategy.

Research activities for this case study during 2025 have focused on enhancing a campus-scale digital twin framework integrating real-time data streams for accurate energy forecasting at the campus. Work has also been undertaken on investigating the role of Green Infrastructure in net zero precincts through analysis of the Curtin Exchange Precinct (see Research Snapshot).

PROGRESS

The digital twin research has centred on two buildings: the TL Robertson Library (Building 105) and the School of Design and the Built Environment (Building 418), the latter forming part of the Curtin Exchange Precinct. These buildings differ in purpose, age, and architectural design, providing valuable diversity for evaluating predictive models under varying operational conditions.

Extending the capabilities of the initial prototype, the framework has been enhanced through the integration of detailed weather and environmental data sourced from the Bureau of Meteorology (BOM) and Green Electric Energy Park (GEEP) at Curtin University. In addition, occupancy data supplied by the Digital and Technology Solutions (DTS) team has been incorporated. Collectively, these datasets have transformed the digital twin into a dynamic, data-driven system capable of capturing both external climatic influences and internal occupancy dynamics in near real time.

The study introduced composite environmental indices by adapting combined temperature–humidity–solar–wind formulations originally developed in livestock studies. These indices effectively captured the combined thermal and environmental influences relevant to building energy dynamics. Their integration significantly improved model performance, enhancing convergence speed and stability under both static and adaptive learning modes. A robust data framework was also established, enabling retrospective validation and supporting real-time predictive capability.

FINDINGS

The analysis demonstrates that the integration of weather and occupancy data substantially enhances both the accuracy and interpretability of energy consumption predictions. Results indicate that temporal variables, particularly the previous days and the previous week's energy consumption, are the most dominant predictors, reflecting the persistence of energy-use patterns over time. Solar radiation emerged as the next most influential factor in Building 418, where daylight-driven heating and cooling demands are significant. Occupancy data were found to exert a stronger influence than temperature alone, underscoring the pronounced effect of human activity on HVAC and lighting systems. Furthermore, humidity ranked higher than temperature in predictive importance, especially during Perth's warmer months, when comfort-related systems respond more actively to moisture variations. The inclusion of hybrid environmental indices, combining temperature, humidity, solar radiation, and wind speed, enabled the model to capture both indoor comfort dynamics

and external environmental loads, yielding more stable performance across seasonal conditions. These findings provide valuable inputs for demand forecasting and operational control. By improving the precision of building-level energy modelling, this work supports the development of responsive demand management systems, enabling smoother integration with Smart Grid infrastructure and facilitating data-driven pathways toward decarbonised campus operations.

PLANNED ACTIVITIES

The next phase of the research will extend the digital twin framework to incorporate rooftop solar photovoltaic (PV) system data from Curtin University's campus. This enhancement aims to enable a more comprehensive representation of building energy dynamics and sustainability outcomes. Planned activities include integrating solar generation data to model net energy demand and quantify carbon dioxide (CO_2) emissions reductions. Emissions estimates will be derived using the national CO_2 intensity index from Australian Government datasets and subsequently linked with indoor CO_2 and volatile organic compound (VOC) data available through DTS systems. Collectively, these developments will expand the framework toward a sustainability-oriented digital twin capable of assessing both operational energy performance and indoor environmental quality.

RESEARCH SNAPSHOT: EXCHANGE PRECINCT URBAN GREENING

Net zero strategies are commonly framed around performance towards mitigation, such as reducing energy use, emissions, and resource demand, particularly within engineering and environmental management disciplines. In contrast, Green infrastructure (GI) draws from ecological and social systems to restore ecosystems, support biodiversity, and improve human wellbeing. While net zero provides a measurable target, GI offers an ecologically restorative pathway. The integration of these approaches remains limited in current urban design practice. The Curtin Bentley Campus Exchange precinct demonstrates how they might operate at the precinct scale.

At Curtin Exchange, net zero innovations include the generation of 735 MWh of solar energy annually, offsetting 422 tCO2e, and integrated stormwater and rainwater harvesting systems that support circular water flows. The transit-oriented design supports 130 daily bus movements and serves an estimated 12,500 commuters, reducing private vehicle reliance and associated emissions. Indigenous design principles are expressed through the Wadjuk Noongar Songlines and *Winin Katidjin Bilya* (Living Knowledge Stream), which guided the integration of GI and cultural interpretation elements to strengthen ecological and cultural connection.

The result is a high-performance landscape aligned with Curtin University's mission for an inclusive, resilient, and culturally grounded campus. Biodiversity increased 8.5-fold, with 68% native species supporting over 53 bird species, including the threatened Black Cockatoos. Trees are projected to sequester 160 tCO2e and store 222 tCO2e over 20 years. Peak flows reduced by 32%, conserving 5,053 kL of rainwater annually, and reducing potable water use by 45%, offsetting 4.5 tCO2e each year.

Socially and economically, the mixed-use, pedestrian-friendly design that links all the GI promotes strong community use, provides high occupancy economies, and diverse recreation. Such outcomes demonstrate how to integrate carbon, water, and social outcomes within a net-zero precinct framework.

4.4 Alkimos Central

OVERVIEW

Alkimos Central is a new city centre precinct, planned by DevelopmentWA, that will be delivered over the next 20–30 years. Located in Perth's northern coastal region, Alkimos Central will include mixed-use commercial and residential development, with a focus on lower carbon and sustainability outcomes that create a livable, connected and lower carbon built environment.

PROGRESS

DevelopmentWA has undertaken extensive work to evaluate Alkimos Central as a net zero-aligned project and to consider certification options. This work includes cost-benefit analyses of decarbonisation options for the precinct, and life cycle assessmentz of pathways to net zero for operational carbon as well as for upfront carbon in civil works. Research to date has engaged with this information to understand the range of options that can be feasibly considered for implementation at a precinct-scale and the challenges (including costs) associated with their adoption.

FINDINGS

At the planning stage, Alkimos Central demonstrates how mitigation and adaptation can be integrated, with a focus on integrated and active transport, green infrastructure (trees) to reduce urban heat island effects, and design guidelines to: ensure new buildings and infrastructure are built with lower upfront carbon, improve energy efficiency in commercial and residential buildings, and support electrification at a precinct-scale.

PLANNED ACTIVITIES

Research in 2026 will continue to engage with the planning approach being taken for Alkimos Central, particularly in the context of the Alkimos Central Precinct Plan and project design guidelines, supporting technical and sustainability information, and continued evaluation of alignment with the Green Building Council of Australia's (GBCA) Climate Positive Pathway.

Draft render subject to final details and updates, Image provided by DevelopmentWA

4.5 Peel Business Park – Nambelup Kaadadjan

OVERVIEW

The Peel Business Park – Nambelup Kaadadjan is designed as an innovative business precinct, located in the Peel region of WA, 70km south of Perth. The business park has several tenants, including the Western Australian Food Innovation Precinct, run by the Shire of Murray and a Bushfire Centre of Excellence, run by the Department of Fire and Emergency Services. On completion, the Peel Business Park will be a 1,000-hectare industrial estate.

The site was former agricultural land with limited infrastructure or the ability to service general infrastructure. DevelopmentWA are one of many landholders at the site. They were provided with state government funding to deliver trunk infrastructure to the site, including a distribution feeder connected to the Pinjarra substation. DevelopmentWA also designed and installed a distribution network for the Peel Business Park to connect a private microgrid, which is owned and operated by Peel Renewable Energy.

The microgrid comprises a 1.2MW ground mounted solar array and a 2.5MWh battery storage system. The system was designed to ensure that further renewable energy capacity can be added through rooftop solar PV as more tenants move into the business park. The aim is to ensure that there is enough generation capacity on site to provide for all future tenants.

PROGRESS

The NZP certification, governance and CER integration research teams have been working closely with DevelopmentWA over the project period to understand key learnings from the project and how these may apply to similar precincts.

FINDINGS

The Peel site had a constrained grid connection, which was a key motivation for DevelopmentWA to develop the microgrid. Western Power had indicated that costs to service the area would range from $50–80 million for phase one of the project, which included upgrading the zone substation, transmission line and the transformer. However, the total project budget from the State Government was $49 million. This was to cover all of the trunk infrastructure required, including roads, water, power, gas, drainage and communications. Therefore, it was not possible to develop the site without an alternative to a traditional grid connection.

The other motivation for the microgrid was the need to have “green” and affordable energy for an energy intensive agri-processing industry. Food producers were sensitive to the need for “clean and green” production methods from their customers. Peel Business Park has been nationally recognised by the Urban Development Institute of Australia (UDIA) as an environmentally sustainable development; this certification was achieved in 2020.

LESSONS LEARNED

DevelopmentWA have noted their preference for the same access rights for private operators of microgrids, as those that exist for public operators like Western Power. Western Power has the right to access any of its infrastructure through the Energy Operators (Powers) Act 1979, whereas private operators require easements to access their equipment on private land and road reserves. This adds to the complexity for private operators as it requires specialist knowledge from lawyers. There is a provision in the Energy Operators (Powers) Act 1979 which should be used to enable private operators carrying distribution licenses to access network assets in private and public land without easements.

4.6 Roe Highway Logistics Park

OVERVIEW

The Roe Highway Logistics Park ('ROE') is a 75ha industrial estate in Perth, located near the city's eastern industrial area. ROE abuts major arterial roads and has Restricted Access Vehicle 7 combinations (RAV7) and rail freight access, which allows tenants and occupiers efficiency and flexibility in freight movements and logistics operations. ROE is part of the Maddington Kenwick Strategic Employment Area (MKSEA) and led by developer Hesperia, involved the acquisition, amalgamation and rezoning of over 40 parcels of land. ROE includes the first two 6-Star Green Star (Design & As-Built) industrial facilities in Western Australia.

PROGRESS

Hesperia used life cycle assessment (LCA) in its project reporting for ROE, which helped in assurance of reductions in operational and embodied carbon across the precinct lifecycle. Research to date has used the LCA for ROE to understand the practical opportunities and challenges for decarbonisation in a new-build light industry precinct, and the challenges associated with seeking third-party certification at the precinct scale.

FINDINGS

ROE demonstrates how planning and collaboration with tenants, suppliers, and builders can achieve reductions in upfront and operational carbon in the construction and in-use stages of the development of an urban industrial estate.

PLANNED ACTIVITIES

Research in 2026 will describe in practical detail the carbon reduction actions at ROE in precinct design, upfront carbon, and operational carbon, and the utility of an LCA approach to assure and communicate decarbonisation outcomes.

Roe Highway Logisitcs Park, Image by J Wyld

4.7 Noarlunga Centre and Beach Road (Net Zero Corridor)

OVERVIEW

The proposed study of net zero corridor in Noarlunga city centre to Christie's Beach in South Australia forms a key demonstration of carbon-neutral precinct planning within the state's *Planning and Design Code* framework. The project applies integrated land-use, transport, and building modelling to promote compact, transit-oriented growth. Using the ETOz scenario modelling platform, various urban typologies are tested to optimise density, energy efficiency and decarbonisation strategies. The initiative aligns with the South Australian government's aim for climate-responsive planning, housing diversity and sustainable infrastructure. The net zero corridor seeks to redefine suburban redevelopment by embedding measurable carbon reduction and performance-based urban design principles.

PROGRESS

Initial progress has been achieved through data identification, model selection and spatial testing of building and development forms. The project team is gearing towards multiple scenarios exploring residential density, mixed-use potential and emissions profiles along the corridor. Engagement with Dr. Giles Thomson, Adjunct Associate Professor Dusan Mills and the proposed asset manager for Noarlunga has ensured alignment between ETOz's intended modelling aim and the *Planning and Design Code*, South Australia, particularly in relation to zoning, height controls, and transport overlays. Urban infill projects in Noarlunga are identified as the preferred urban form under current principles; further stakeholder feedback is required to refine considerations of amenity, green space, and transport infrastructure preferences.

FINDINGS

The initial stage of ETOz through QGIS, feasibility, and residual land value financial analysis demonstrates that medium density and single housing typologies achieve optimal outcomes for land efficiency. However, replicability remains to be tested in Noarlunga as it involves diverse types of land development strategies such as brownfield, greyfield and greenfield sites within the context of urban regeneration for improving density and transport activation.

PLANNED ACTIVITIES

The next phase will focus on refining building typology datasets, which are currently underway by PhD Student, Nikki Zhang, under the supervision of Dr Giles Thomson, Professor Josh Byrne and Adjunct Associate Professor Dusan Mills, providing a commercial interface with required development buildings. The objective is to form and extend ETOz modelling to test infrastructure dependencies for transport and embodied carbon impacts related to the PhD student's research.

4.8 Sunshine Precinct

OVERVIEW

The Sunshine Precinct case study is situated 12km from central Melbourne, around two railway stations in an area slated for urban renewal in anticipation of an expected doubling of the population in the next 30 years. Since this regeneration project is in the planning and feasibility phase, the research has focused on digital twin and digitalisation tools to support planning and investment. Research from RMIT led by Professor Rebecca Yang (now at University of Melbourne) has undertaken modelling on urban temperature, energy, water and embodied carbon scenarios of the subject area and represented the findings in a 3D digital twin. Extensive stakeholder engagement was carried out before and during the modelling to ensure that what is modelled is relevant to stakeholders, the results are credible and can usefully inform policy and community discussions.

The research was undertaken in three phases. The first phase involved scoping the project, engaging with stakeholders, then gathering data to support the future modelling of temperature, water, embodied carbon and energy. The second phase involved developing and running reference cases for each of the temperature, water, embodied carbon and energy models. Finally, the results of the reference cases were used to develop informative alternative scenarios (in consultation with stakeholders) that were then modelled. All results are being integrated into the Digital Twin Victoria platform, a comprehensive digital model of Victoria that accesses thousands of 2D, 3D, 4D and live data points to assist decision-making.

PROGRESS

The RMIT-led project is nearing completion, with the modelling work and analysis being finalised.

FINDINGS

The project team is currently creating a high-level document introducing evidence-based spatial considerations for 'net zero attributes in urban developments. The net zero attributes will be tailored to those identified in the Sunshine Precinct urban regeneration area but will aim to be generalisable for similar urban environments in Australia. (See Research Insights breakout for summary of findings).

PLANNED ACTIVITIES

This work will be supplemented by the distilling of 'design guidance notes' structured around thematic areas based on the key challenges and opportunities identified for decarbonising the Sunshine Precinct urban regeneration area. The document will comprise a series of concise, targeted net zero learnings drawn from the project's key focus areas, addressing topics of greatest relevance to planners and designers. These learnings will be refined in collaboration with industry partners to ensure their practical applicability and alignment with current planning and development priorities. Each thematic area will include a summary of key findings from the project, references to relevant research published by RMIT and others, interlinks to other thematic areas, and diagrams illustrating the spatial implications on the urban realm. The diagrams illustrating important design and planning considerations for net zero attributes in urban regeneration areas will be executed in a way that is accessible to designers, planners and a non-technical audience.

RESEARCH INSIGHTS: SUNSHINE PRECINCT DIGITAL TWIN KEY LEARNINGS

The following selected recommendations for urban design have emerged from the RMIT research team's work to date

Urban Heat

- **Optimise building and street orientation** – Designers should align buildings and streets along the north–south axis to enhance ventilation, increase setbacks to reduce heat retention, and adapt streets to support airflow and shading.
- **Integrate vegetation strategically** – It is important to select suitable tree types and placement based on climate, street orientation, and wind patterns. Irrigation should be provided to maximise cooling and maintain plant health.
- **Enhance open spaces** – Significant green space can provide shade, maintain unobstructed airflow, and use irrigated greenery or water features to significantly reduce local temperatures.
- **Use climate-responsive materials** – Applying materials that have high thermal mass and low-reflection surfaces in sun-exposed areas will make areas robust to a changing climate. Designers should also avoid unirrigated grass and overly reflective facades.
- **Leverage wind and microclimate** – Preserving ventilation corridors, managing wind speeds with tree placement, and adapting building designs to seasonal wind patterns will assist passive cooling.

Water and Trees

- **Open spaces are critical for urban cooling** – Large, well-planned open spaces can act as cool refuges and support large-canopy trees that provide significant shade and cooling benefits.
- **Maximise verge widths for street trees** – Providing for wider verges can increase soil volume, enhancing tree health, water storage, and drought resilience.
- **Tree species selection balances water use and cooling** – Although low-water-use trees survive in constrained soils, they offer less cooling. Designers should consider balancing them with medium-water-use trees that provide better shade and transpiration but require additional water support.
- **Strategic tree placement enhances cooling** – Planners should consider street orientation and urban heat analysis for tree planting, maximising shade on East-West oriented streets and airflow on North-South oriented streets. Ensuring private land planting makes a contribution to increasing overall canopy cover should be part of urban planning priorities.
- **Efficient water management supports cooling** – Maintaining cooling performance for vegetation without excessive demand on water resources can be achieved with targeted irrigation during extreme heat events and harvesting rainwater from rooftops and roads.

Energy

- **Rooftops have the highest solar potential** – Building tower rooftops, especially in northern and western parts of an urban development, receive the most sunlight and experience minimal shading compared to podiums and streets and provide the best value for electricity generation.
- **Shading varies seasonally and by location** – East–West oriented corridors are more affected by shading in summer, North–South oriented corridors in winter, and streets and podiums with eastern/southern facing areas generally have lower solar potential. These areas do not provide as great a value for renewable energy generation and should be of a lesser priority.
- **Renewable energy alone is insufficient** – Despite large gains in efficiency, even with 80% rooftop solar panel coverage, solar generation cannot fully offset the increasing expected energy demand of urban areas. Effective energy management should be encouraged to close this gap.
- **Façade PV and medium–high battery capacity improves efficiency** – There is capacity for façade solar installations to significantly enhance consumption efficiency, and paired with adequate battery storage, they can stabilise and optimise energy use throughout the day.
- **Smart management is essential for EV integration** – Planners will need to understand the impact of a swelling electric vehicle fleet and how this might draw on a precinct's electricity generation and consumption. Carparks with electric vehicles can have minimal impact if smart charging is enabled, but adding capacity without sufficient renewables or battery capacity will reduce consumption efficiency.

Embodied Carbon

- **Building materials dominate emissions** – Concrete and steel are the largest carbon contributors, making material selection critical to reduce the amount of carbon embodied in the development when it is planned and constructed.
- **Significant carbon savings are achievable** – It is possible for builders to use low-carbon materials to cut emissions by between 86% and 54% of 'business-as-usual', depending on the approaches deployed.
- **Maximum reduction potential** – Some of the biggest savings in embodied carbon construction can come from removing basements and carparks (alongside low-carbon construction). This can lower the carbon footprint, but is contingent on viable public transport alternatives being available as substitutes.
- **Need for integrated assessment methods** – Current construction workflows and reporting are siloed and hinder comprehensive evaluations of the embodied carbon in precincts. This could be addressed with a fully integrated, cross-disciplinary approach to increasing communication and meeting deadlines.

4.9 Rundle Mall

OVERVIEW

A team of researchers from the Adelaide University, led by Professor Jennifer McKay, is attempting to understand the governance and energy use in buildings in an inner-city commercial district (Rundle Mall) to develop models that can enable net zero transitions. Rundle Mall itself is a 520m long pedestrian street mall located in Adelaide, South Australia. It spans approximately 150,000m^2 and is reputed to be the longest mall in the southern hemisphere. The project intends to focus on two buildings (if the cooperation of the building managers is achieved), within the mall, with multiple diverse tenancies to:

- Understand current governance and ownership structures.
- Identify drivers and barriers for developing net-zero carbon precincts.
- Use digital tools to model energy performance interventions and scenario analysis for moving the building toward net zero.

The results of the project will be synthesised with other case studies in the NZP project to build an impactful body of knowledge for the relevant stakeholders.

PROGRESS

The Adelaide University research team commenced work in early 2025 and promptly secured ethics approval for the study. Soon after, participant recruitment began in collaboration with the City of Adelaide through the development of a survey targeting base building owners, facility operators, and retail stakeholders. The survey is currently being circulated to gauge stakeholder interest and determine the most effective ways to engage them in subsequent phases of the research.

In parallel, the preliminary precinct morphology analysis was conducted to understand Rundle Mall's dense commercial layout, urban heat challenges, and opportunities for energy efficiency, including a large untapped potential for solar PV deployment. Two buildings have been identified as promising candidates for detailed study, with final site selection for deeper analysis of energy use and retrofit strategies to be guided by insights gathered through the stakeholder survey and face-to-face semi-structured interviews.

The research team has been conducting a desktop review identifying barriers and opportunities related to governance, regulation, finance, technology, and social factors in the transition to net-zero outcomes. This review draws on both Australian and international case studies to understand successful strategies and obstacles others have faced. These insights will help shape the project's approach to tackling structural barriers and finding effective solutions for long-term change that will be revealed by the screening and follow-up surveys.

PLANNED ACTIVITIES

In the coming year, the research team expects to review the results of its initial screening survey to understand the following issues for property owners, business owners and tenants:

1. Understanding of the net zero Transition and Barriers to its achievement.
2. What are the motivations to act and the willingness to participate in net zero actions?
3. Governance arrangements for net zero transition
4. Challenges for businesses to grow/expand
5. Current energy usage and future intent

This survey will also be used to screen for respondents who would be willing to be part of follow up surveys and interviews through their interest in net zero and capacity to benefit from the transition. The follow up detailed surveys and interviews will be used to understand the governance drivers and barriers that enable or inhibit net zero transition. This understanding will be parleyed into opportunities to improve energy performance through retrofit and how current tenure arrangements (and any regulatory restrictions or obligations that may apply) can support goals for net zero.

To support this governance work, data on the energy performance of the identified case study sites will be gathered and used to conduct modelling of different scenarios to improve performance. This will assist the decision making amongst property owners, business owners and tenants in the governance stream of the project. Taken together, the use of digital tools and governance investigation will inform recommended interventions in legacy buildings with multiple tenants that can be generalised for the national context.

Rundle Mall, Image by Jennifer McKay

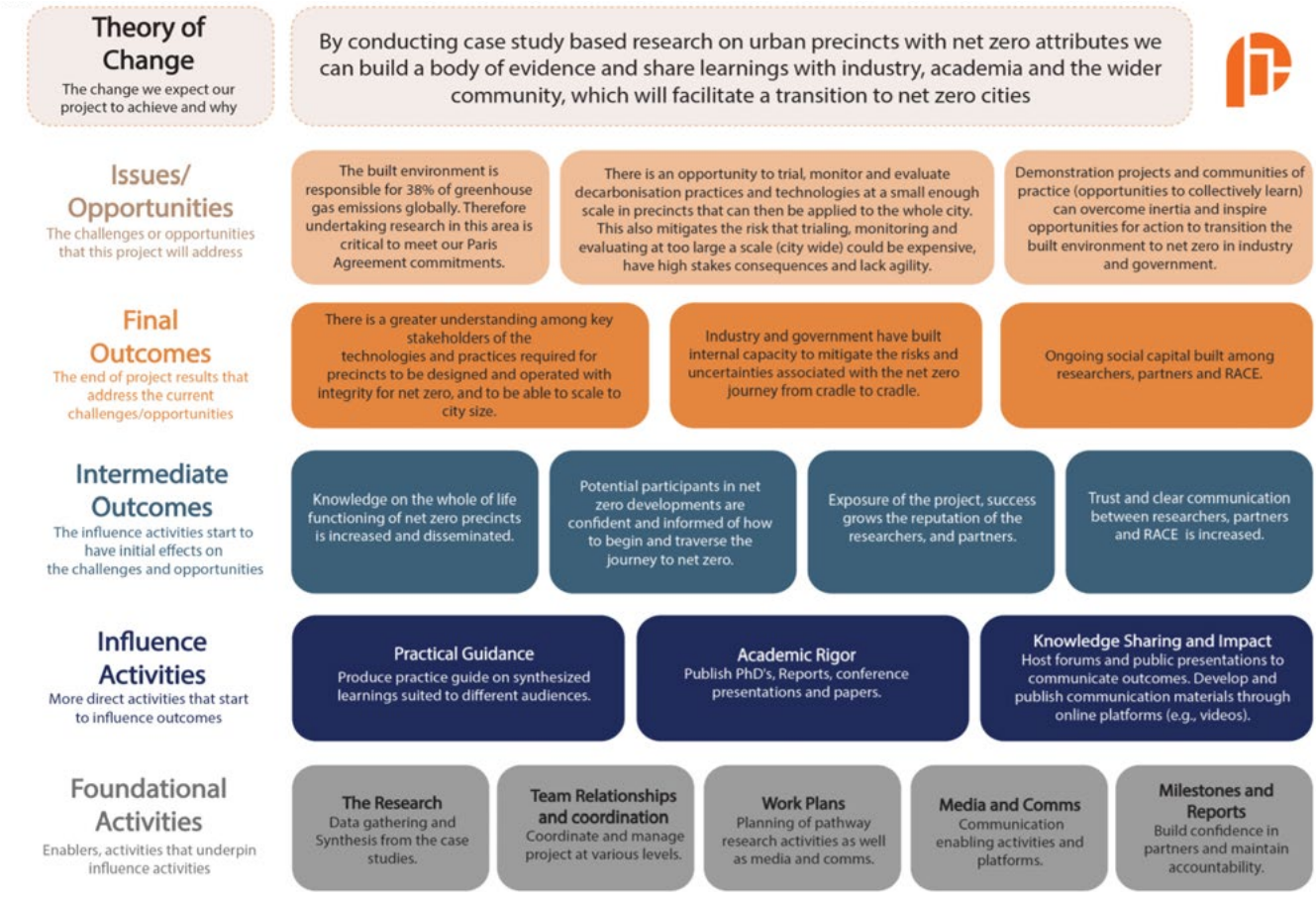
5. Communications and Engagement

Knowledge-sharing and impact activities continue to be an important part of the Pathways to Net Zero Precincts project. In this second year of the project, we have focused on capturing and communicating case study innovations and research outcomes, primarily through the production and dissemination of vignette videos and factsheets, and on integrating Tranche 2 case studies (Rundle Mall and Sunshine Precinct) into the project. The team has also actively contributed to a range of industry talks, workshops, and webinars, and successfully delivered the project's second industry forum, the Distributed Energy Resources (DER) and Grid Integration Forum to a national audience of industry, government and academic professionals. Through these initiatives, the project has continued to strengthen public engagement, enhance stakeholder awareness, and extend the overall impact of its research.

5.1 Theory of Change

Developed collaboratively through workshops involving the NZP team and RACE for 2030, the Theory of Change framework has continued to guide the project's activities and strategic focus throughout this reporting period. Our activities across research, relationship building, communications, as well as planning and reporting, continue to be guided by the goal that "by conducting case study-based research on urban precincts with net zero attributes we can build a body of evidence and share learnings with industry, academia and the wider community, which will facilitate a transition to net zero cities." As the project transitions from Year 2 to Year 3, the framework will be reviewed and refined to reflect the evolving priorities of the project and the emerging needs of industry stakeholders.

Pathways to Net Zero Precincts' Theory of Change



5.2 Website

The project website, netzeroprecincts.au, continues to serve as the central repository for project information and research resources. New content, including videos, factsheets, publications, event details, and forum materials, is regularly uploaded and maintained. Over the past year, the site has attracted more than 2,800 active users, primarily from Australia's major cities (Sydney, Perth, Melbourne, and Canberra), with growing international engagement from Singapore, the United Kingdom, and India. The website's project sign-up form continues to expand the mailing list of interested stakeholders, who receive targeted updates on key project milestones and activities via Mailchimp communications.

Pathways to Net Zero Precincts' Website

5.3 Videos

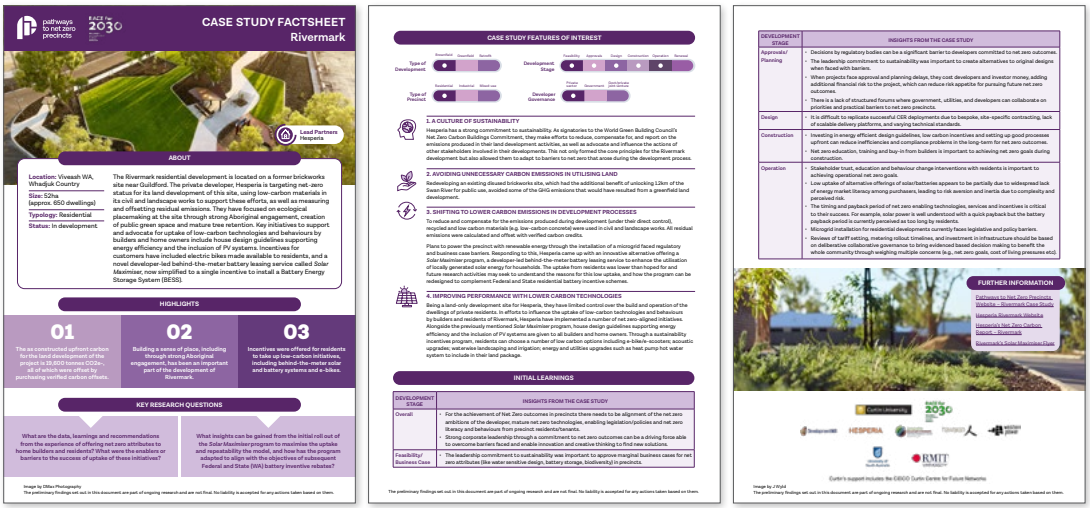
The NZP team continues to collaborate with VAM Media in the development of a video web series for the project. During the current reporting period, the focus has been on producing Case Study Vignette Videos that highlight the net-zero attributes and research activities undertaken across leading low-carbon precincts. Knutsford Urban Regeneration Precinct, Peel Business Park, Rivermark and Roe Highway Logistics Park have all been released publicly on the NZP YouTube channel, embedded on the Case Study website pages and shared on social media. Two more Case Study Vignette Videos for Curtin and Alkimos are currently in production, and conversations with Rundle Mall and Sunshine Precinct research teams to develop videos for these additional case studies are underway, with production to commence in early 2026. Industry partner feedback on the videos has been very positive; however, the project team is aware of the need to increase viewer numbers to demonstrate broader value.

Pathways to Net Zero Precincts' Video

5.4 Factsheets

A suite of fact sheets for each case study site, offering concise, accessible summaries of key initiatives, research activities and lessons learned, have been published and are accessible on the NZP website. Factsheets for Tranche 2 case studies, Rundle Mall and Sunshine Precinct, are nearing completion and will be available with the full suite imminently.

Pathways to Net Zero Precincts Rivermark Factsheet



5.5 Social Media

During the second year of the project, the Pathways to Net Zero Precincts Linked-In page affiliated with the RACE for 2030 account was established. The page has continued to grow steadily, now reaching 362 followers and generating 9,348 impressions, effectively expanding the project's visibility and engagement with industry, research, and community audiences. As research outputs continue to mature in the third year, this platform presents an exciting opportunity to showcase emerging findings and publications, further strengthening online engagement and fostering an active professional community around the NZP initiative.

A Pathways to Net Zero Precincts Linked-In Post

5.6 Events

The NZP research team have organised and participated in a number of talks, workshops and webinars this year where they have been able to share insights from the research and contribute to ongoing and emerging conversations around net zero and sustainable precincts across industry, government and academia. See table below.

Talks Workshops and Webinars Delivered by the Pathways to Net Zero Precincts Team in 2025

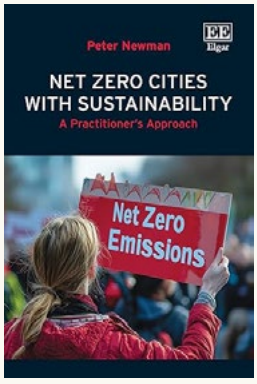
April 2025	Precinct Retrofitting for Decarbonisation – DBI Workshop at Curtin University
June 2025	Sustainable Transport in Sustainable Cities (STSC) Forum, Fremantle
June 2025	Session Six: Designing a Sustainable Future at the Curtin Energy Research Showcase
June 2025	'Why Donald Trump can't stop Net Zero' presentation at the John Curtin Institute of Public Policy Seminar
July 2025	2025 IEEE PES General Meeting and panel discussion (Chaired by Dean Sharafi, AEMO) in Austin, Texas
August 2025	Nature-Based Solutions for Urban Heat Island Mitigation in the Context of Net Zero and Envision Tomorrow Australia, in UNSW-Tsinghua University Workshop, Sydney
September 2025	NZP's Distributed Energy Resources (DER) and Integration Forum
October 2025	From Energy Research to Industry Impact: How to Partner with RACE for 2030
October 2025	Environmental Excellence Through Collaboration, Environment Institute of Australia and New Zealand Annual Conference, Perth
October 2025	Toward Resilient Net Zero Precincts: Designing for Complexity through Strategic and Regenerative Approaches, 5th International Conference on Climate Change and Environmental Sustainability

CER/DER GRID INTEGRATION FORUM

Held on 23rd September in partnership with the Curtin Institute for Energy Transition, this interactive online forum brought together industry, government and academia to discuss what we have learnt from existing precincts, and how we can work together to create the conditions to accelerate the integration of CER/DER into urban precincts, both at the residential and commercial scale. With over 100 RSVPs, attendees heard from guest speakers Dave Morgan from DevelopmentWA, Professor Mark Howden (ANU), Professor Penelope Crossley (University of Sydney) and RACE for 2030's CEO Bill Lilley. The forum primer and recordings are available on the website and the outcomes report is presented as Appendix 1.

NET ZERO CITIES WITH SUSTAINABILITY: A PRACTITIONER'S APPROACH

Launched in late 2025, Professor Peter Newman's book "Net Zero Cities with Sustainability: A Practitioner's Approach" strongly reflects NZP's research focus areas and generated substantial media coverage.



Our Team at Work, Image by J Wyld

6. Project Management Update

Project management activities during Year 2 centred on consolidating staff and student recruitment across all pathways and refining pathway work plans to align with the revised organisational structure. Identified actions have been integrated into updated work plans and delivery mechanisms to ensure efficient implementation and monitoring. The primary management focus has been on prioritising key deliverables and maintaining alignment with the overall project plan. This included oversight of progress across pathways, synthesis of emerging findings, identification of issues and corresponding mitigation actions, and coordination of research, knowledge sharing, and communication activities.

While two PhD candidates for CER and Grid Integration and Governance pathways withdrew for personal reasons, all project deliverables continue to be met through the dedicated support of Technical Leads. Recruitment for a new PhD candidate with a digital twin focus within the CER and Grid Integration pathway is currently being finalised.

The PSG meetings continue to provide an essential platform for engagement with key stakeholders, ensuring ongoing alignment between research outputs and industry needs. The PSG, comprising representatives from DevelopmentWA, Hesperia, Western Power, Hawaiian Group, and SBEnrc, met three times this year: 19 February, 2 July, and 29 October 2025, marking the seventh meeting since project commencement. Each meeting included industry updates, presentations from pathway teams, and discussions on key findings, challenges, and next steps. Between PSG meetings, Technical Leads also held targeted engagement sessions to present emerging results and obtain constructive feedback, further strengthening the integration of research activities with real-world applications.

Given the project's wide scope, IRGs have been established for each pathway. These groups include experts, stakeholders, and decision-makers who help shape project priorities, address pathway-specific challenges, and ensure research relevance to industry practice. IRGs also serve as mechanisms for knowledge exchange, providing feedback on research outputs, identifying practical applications, and suggesting opportunities for broader impact. Each IRG operates under clearly defined Terms of Reference, which outline membership roles, responsibilities, and alignment with the overarching goals of the NZP project.

Research activities throughout the year have been driven by five PhD candidates, all of whom have progressed through Milestones 1 and 2, except the recently appointed ETOz Urban Design PhD candidate, Nikki Zhang, who commenced her PhD in September.

Risk Management and Overall Project Status

All identified project risks have been carefully considered and are being actively monitored. The overall risk rating remains low, reflecting strong governance, effective planning, and continuous communication across teams. The project team demonstrates a high level of completeness and cohesion, with clear coordination among pathways and consistent progress toward milestones

While two PhD candidates, one under the Governance Pathway and one under the CER and Grid Integration Pathway, withdrew for personal reasons, the impact on project delivery has been minimal. Technical Leads and research staff have absorbed relevant research tasks and continued progressing associated deliverables to ensure continuity. The balance of the Governance PhD budget has been approved by RACE to be academic staff, enabling continued collaboration with the Governance Technical Lead to complete the planned tasks. In addition, recruitment for a replacement PhD candidate with a digital twin focus under the CER and Grid Integration pathway is being finalised, helping to maintain research capacity and steady progress across the team.

Industry engagement and communication activities continue to strengthen partnerships and ensure alignment with stakeholder priorities. Knowledge sharing and research integration are actively promoted through regular meetings, workshops, and collaborative outputs, fostering cross-pathway learning and methodological consistency. The project maintains a strong national profile, reinforcing its relevance and visibility within RACE and the broader research community. Leadership across all pathways continues to provide strategic direction, ensuring that all workstreams remain well coordinated and on track to deliver impactful outcomes.

7. Looking Forward

Planning for End of Project Deliverables and Production of the NZP Guide

As work progresses on case study–based research activities, parallel efforts are underway to plan and consult on the end-of-project deliverables, particularly the development of the NZP Guide. The Guide is envisioned as an accessible and user-friendly online tool that allows practitioners, policymakers, and researchers to easily access information most relevant to their needs. It will cater to a diverse audience, some seeking detailed, practical insights from project case studies, and others looking for a broader understanding of precinct-scale decarbonisation and its contribution to the wider transition of the built environment sector.

To meet these varied needs and effectively communicate the breadth of project learnings, the NZP Guide will be structured around three key information pillars:

1. Framework: This pillar focuses on influencing and enabling behaviours that support precinct-scale decarbonisation. It provides clear guidance on what constitutes a Net Zero Precinct, outlining the range of available decarbonisation levers for urban precincts. It also addresses how climate mitigation and climate adaptation strategies can be effectively aligned, explores financial decision-making frameworks, and examines relevant certification pathways. Collectively, these elements aim to guide practitioners, policymakers, and developers in embedding decarbonisation principles within planning and design processes.
2. Key Learnings: This pillar distils key insights into how urban precincts are currently progressing along the net zero transition pathway, highlighting what is working effectively, where challenges persist, and providing practical guidance for implementation. Drawing from case studies, it identifies successful decarbonisation measures and contextual barriers, offering evidence-based recommendations for industry practice. In addition, it provides planners and designers with evaluative insights into how design choices influence placemaking, efficiency, and long-term sustainability outcomes within precinct developments.
3. Decision-Support Tools: This pillar introduces tools and frameworks that enable informed decision-making about which decarbonisation measures to adopt, and how best to implement and sustain them. It incorporates the ETOz and digital twin tools, alongside the Net Zero with Integrity Framework, to provide a comprehensive suite of analytical resources. These tools establish a synergistic framework that integrates sustainability, urban design integrity, and development feasibility, supporting stakeholders in achieving evidence-based, context-sensitive, and financially viable net zero outcomes

Communications and Impact Activities

As the project enters its third year, the focus will shift toward the completion and dissemination of key communication and engagement outputs. This includes finalising the suite of case study vignette videos, with the remaining two Western Australian case studies, Curtin and Alkimos, currently in the planning phase, and the newly initiated Tranche 2 case studies, Rundle Mall and Sunshine Precinct, scheduled for development in the coming year. These will be integrated across all project communication platforms to ensure consistent representation of project outcomes and learnings. Attention is also being directed toward the planning and delivery of the final two industry public forums, representing the Governance and Urban Design pathways. As planned publications and research outputs begin to be released, the project team aims to amplify their reach and impact through strategic media and social media engagement, while also making them accessible as curated resources via the project website. Subsequent efforts will focus on the development of a comprehensive suite of communication and impact materials to support the dissemination of synthesised research findings. Central to this will be the practitioner-focused NZP Guide, complemented by feature videos designed to showcase the project's collective insights, activities, and contributions to advancing precinct-scale decarbonisation.

Planning for Future Research

Initial discussions on a possible second phase of the Net Zero Precincts project have begun with a broad mapping of the possibilities to extend the first phase learnings and opportunities for collaboration. Early discussions with the partners and broader stakeholders have included:

1. Existing learnings – How can these be extended to assist Net Zero Precincts? What additional questions have emerged from the current research?
2. Partner priorities – Are these changing as the wider landscape progresses and industry needs and opportunities continue to evolve?
3. RACE priorities – What is of interest to RACE in relation to their wider portfolio of projects and their evolving research priorities?

The discussion will continue with project partners and RACE alongside the development and delivery of current project outputs with a view to growing the scope and impact of the Pathways to Net Zero Precincts beyond its current end date of October 2026.

STAKEHOLDER INSIGHTS

One-on-one meetings were recently held with industry partners Western Power, Hesperia and DevelopmentWA to test the end of project end-of-project framework, learnings and tools. These discussions were highly productive, providing valuable feedback and insights to inform the refinement of the project's final deliverables.

DevelopmentWA identified the importance of boundaries for scope 1, 2 and 3 emissions aligned with different stages of the delivery of urban development. DevelopmentWA also wanted to better understand the evidence that the market would currently be prepared to pay more for land or housing in a net zero precinct. There was also discussion about future considerations with end-of-life assets and retrofitting existing structures through urban renewal to reduce embodied carbon.

Western Power provided valuable feedback on the importance of standardising terminology across the framework. For instance, ensuring consistent use of terms such as greenhouse gas (GHG), carbon dioxide equivalent (CO_2e), and distinctions between efficiency and energy. They also outlined internal process improvements aimed at reducing timeframes for new network connections, an issue commonly raised during stakeholder interviews. Western Power noted a substantial increase in connection applications, driven in part by the recent state and federal battery rebate initiatives. Additionally, they highlighted opportunities to extend considerations beyond individual precinct boundaries to enable broader carbon reduction outcomes across the network, such as through energy sharing mechanisms.

Hesperia highlighted that many developers tend to view their projects as individual developments rather than as components of a broader precinct, which can limit the relevance of a precinct-based framing. They noted that the framework may have greater applicability for organisations such as the Clean Energy Finance Corporation (CEFC), which provided financing for Hesperia's Roe development and requires developers seeking funding to meet specific carbon reduction criteria. Hesperia also emphasised the significant influence builders hold in determining the adoption of sustainability standards, as their capacity to decline developer requirements can pose challenges to achieving net zero outcomes, particularly in the context of housing developments amid strong demand for new dwellings.

8. Appendices

Appendix 1 CER/DER and Grid Integration Forum Report

Distributed Energy Resources (DER) Integration Forum Report

pathways to net zero precincts

Authors:
Elena Perse, Dr Maureen Boyle, and Professor Peta Ashworth

Curtin University

RACE for 2030

We acknowledge all First Nations of this place we call Australia and pay our respects to Elders past and present as Custodians and Owners of these lands. We recognise their deep knowledge and their cultural, spiritual and educational practices, and aspire to learn and share knowledge through partnerships and collaboration.

Authors: Elena Perse, Dr Maureen Boyle & Prof. Peta Ashworth

Acknowledgements: Thank you to all of the speakers who presented at the forum – Dave Morgan (Development WA), Emeritus Professor Mark Howden (ANU), Professor Penelope Crossley (University of Sydney), and Dr Bill Lilley (RACE for 2030 CRC)

Acknowledgements: Thank you to all of the breakout group facilitators for managing and recording forum discussions.

Executive summary

The Distributed Energy Resources (DER) Integration Forum led by the Consumer Energy Resources (CER) and Grid Integration Pathway brought together design and construction professionals, government, industry and academics to reflect on some of the key opportunities and challenges emerging for this important cross-section of urban developments.

As investment grows in these decentralised energy sources, managing their integration into the grid and our communities is critical to ensure energy reliability and continuity of supply, while at the same time maximising benefits for customers.

A number of key themes emerged from participant discussions. However, consistent across all four sessions was a focus on regulation, policy and governance. Participants emphasised the importance of good governance and policy to enable the development of and efficient and reliable functioning of energy resources in the context of precincts, both new and retrofitted.

The importance of considered and thoughtful planning of infrastructure and investment, precinct design and performance were also noted. This requires both forethought and a robust business case to ensure that all precinct developments are economically viable. Additionally, that any necessary adaptations have been adequately costed for retrofits. Participants also discussed the potential of multi-objective modelling to improve both decision-making and transparency. Identifying which factors are prioritised in a precinct development (such as costs, environmental outcomes, or grid support).

Consumer trust, benefits and protection were highlighted across the sessions, particularly in relation to Virtual Power Plants (VPPs) and embedded networks. Engagement and participation were also seen as being important. At the same time, clarifying the roles and responsibilities of various energy market actors was also seen to be important.

Overall, the forum clarified that integrating CER into precincts requires careful consideration from a range of perspectives. However, it was agreed that precincts that are well planned, designed with CER assets have the potential to reduce energy consumption and costs while delivering benefits to both householders, businesses and developers.

pathways to net zero precincts

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Introduction

The Pathways to Net Zero Precincts (NZPs) is a collaborative research initiative between Curtin University, the RACE for 2030 Cooperative Research Centre (RACE CRC) and a consortium of industry and research partners from across Australia. The project aims to identify, develop and implement innovative strategies for transitioning urban precincts towards net zero emissions and draws upon a range of case studies as a testing ground for real-world interventions. With urban centres responsible for a significant portion of the world's greenhouse gas (GHG) emissions, precincts are important places for innovation to achieve net zero outcomes. The NZP project has initially focused on six Western Australian (WA) residential, mixed-use and light industrial case studies across the Perth-Peel region: the Knutsford Urban Regeneration Precinct; Rivermark; Curtin Bentley Campus; Alkimos Central; Roe Highway Logistics Park; and Peel Business Park- Nambelup-Kaadadjan.

The project uses both the terms consumer energy resources (CER) and distributed energy resources (DER). CER are described as "consumers' resources that generate or store electricity and includes flexible loads that can alter demand in response to external signals."[1] CER includes household solar, batteries, electric vehicles and controlled loads such as heat pump hot water heaters and air conditioners. DER is also used to describe household assets, but it also includes larger assets such as neighbourhood batteries installed in the distribution network. These terms are used interchangeably across this report. However, we use CER as the default term to be consistent with the NZP overarching theme.

This DER Grid Integration online forum, held in September 2025, brought together architects, developers, builders, government, industry and academics to reflect on the key opportunities and challenges emerging for this important cross-section of urban developments. As investment grows in these decentralised energy sources, managing their integration into our communities is critical.

The forum offered an opportunity to gather insights from the range of stakeholders on how to create the conditions needed to accelerate the integration of DER into both residential and commercial urban precincts. This report is based on the notes and recorded sessions of the presentations and participant discussions.

[1] DCCEEW (2024) Consumer Energy Resources Working Group. https://www.energy.gov.au/energy-and-climate-change-ministerial-council/working-groups/consumer-energy-resources-working-group

1. Lessons learnt from Peel Business Park

1.1 Expert presentation: Dave Morgan (DevelopmentWA)

The Peel Business Park–Nambelup-Kaadadjan is situated in the Peel Region, 70km south of Perth and 10km northeast of Mandurah, in WA. It is anticipated to deliver 1000ha of industrial land at completion.

DevelopmentWA designed and installed a distribution network for the site to connect a private microgrid, which is owned and operated by Peel Renewable Energy which is a key feature of the site. The installation of the distribution network avoided approximately $50M in network augmentation costs due to constraints on the network. The microgrid is comprised of a 1.2MW ground mounted solar photovoltaic array and a 2.5 MWh battery storage system connected to the distribution network.

Future generation is expected to be delivered by the microgrid operator primarily through rooftop solar. The project provides the Peel Business Park with a minimum of 50% renewable energy at approximately 30% below the regulated business tariffs.

1.2 Participant discussions

Participants were asked the following questions in their breakout groups:

- What are your key reflections from Peel that can help to inform ongoing NZP opportunities for householders, developers and policy makers?
- What needs to change to ensure these opportunities are not missed?

The key themes that emerged from participant discussions included the need for regulations, policy and governance; the importance of consumer trust and engagement; as well as adequate planning for both infrastructure and investment. Participants felt that Peel Business Park succeeded due to the developers' openness to trying new business models in collaboration with partners. The provision of clear communication to business tenants was also seen to be important. Most of the groups discussed the important role that government has to play in supporting the development of NZPs, particularly in relation to their priorities around funding. However, some participants suggested that improving the regulatory environment was also necessary to enable and support the deployment of private energy solutions.

1.2.1 Regulation, policy and governance

Participants felt that the current policy and regulatory environment in WA limits progress towards NZPs. The potential solutions suggested were a coordinated governance vision and a government led planning process to reduce complexity in the approvals process.

Participants noted that current governance and approvals were stringent and inadvertently created disadvantages for smaller private operators who may not have the capacity to achieve the same requirements as Western Power in terms of providing 24/7 customer support, as this was seen as being not always practical for smaller operators.

Private energy solutions providers such as microgrids, are also required to comply with sections of the Australian Standard (AS/NZS3000) for electrical installations.

1.2.2 Consumer trust, communication and engagement

Peel Business Park was seen as an example of the role that trust and effective communication play in the management of energy assets and ultimately precinct success. That is, consumers need to know how the system works, the benefits, and the potential for risks (e.g. cost blowouts or failures), especially at the trial stage. This information should be provided to all so that expectations can be managed and trust can be built.

Participants believed that trust and transparency around sustainability were important for the success of NZPs. It was suggested that gaining more information on consumer perceptions of the Peel Business Park and the success of its microgrid deployment would be useful to inform ongoing NZP opportunities. For example, greater engagement with business owners could provide more information on how much of an influence sustainability credentials had on their energy related decisions making, or whether they were primarily motivated by cost or the availability of renewables on site for environmental reasons.

Embedded networks, which can lock customers into single providers with little governance accountability or transparency was also raised. This is particularly relevant for individuals in apartments or other strata managed properties. It was noted that strata companies often lack the skills or knowledge to manage shared DER assets, which creates a need to ensure there is greater consumer protection in this space. Community title was also suggested as a way to improve precinct DER management thereby avoiding the use of strata managers, who often have limited knowledge or skills in managing DER.

1.2.3 Infrastructure, investment planning and design

Participants reflected that developers and network planners should ensure that co-location of assets with loads is implemented to improve overall system efficiency. Participants emphasised that forward planning for infrastructure could enable more cost-effective non-network solutions (like batteries) can be identified via the Regulatory Investment Test for Transmission (RIT-T) on the National Electricity Market (NEM).

It was noted that DER decisions are often driven by economics rather than sustainability, and that net zero framing in the case of the Peel Business Park was viable because it was cheaper than available alternatives to augment the network. It was discussed that the return on investment for developers evaluating DER options is not always clear and the business case for being an embedded network operator is marginal. Participants suggested innovative business models such as a joint venture between tenants could be a way to support and grow DER investment.

Additionally, projects are often dependent on land value and availability, as well as other physical constraints. Participants reflected that Peel Business Park's construction on lower cost former farmland assisted the business case. Consideration of the maintenance and connection costs for energy assets compared to traditional network connections was also seen to be important. That is, the cost of network upgrades and other capital expenditure may outweigh spending on DER solutions. Participants also reflected that well managed DER assets can result in distribution network benefits external to precincts. However, this is often not accounted for as it occurs outside precinct boundaries. System design was also noted as important for future precincts. For example, matching generation to load and including diverse generation assets (such as wind for loads at night) were identified as potential additional opportunities for enhancing the efficiency of NZPs.

2. Reflections on climate adaptation for NZPs

2.1 Expert presentation: Emeritus Professor Mark Howden (ANU)

Adapting to current and future changes was identified as being key to managing the escalating risks of global temperature increases and climate related disasters. It was noted that considerations of climate change in the built environment often focus on GHG emissions and lifecycle assessments. However, it was stressed that there is also a need to consider adaptation in NZPs given we are already experiencing the impacts of climate change. To do this effectively, focusing on some core goals for NZPs was seen to be important. Appropriate goals were thought to include health, wellbeing and comfort for people mitigating against climate extremes, along with developments that enhance biodiversity and increase overall visual amenity.

There is a range of possible climate adaptations for NZPs, many of which can address multiple needs. For example, good building siting, orientation along with design and construction. That is, passive design with good insulation can lead to reduced electricity consumption. Thereby reducing the impact of increasing heatwaves, exposure to smoke (from fires), reduced operating costs and mitigating against risks from storms, cyclones and intense rainfall. Similarly, judicious vegetation planting can moderate building temperatures in both summer and winter, improve the environment for active travel and enhance biodiversity. Water management is also a key climate adaptation strategy that can include improved water efficiency, storage and infiltration to reduce water consumption, reduce costs, manage drought periods and reduce the potential impacts of floods.

This can be achieved by working through a matrix of goals, using a systematic approach to understand climate impacts for the site and region, the options available for adaptation, identification of potential co-benefits and finally, understanding the trade-offs that occur with the other goals.

2.2 Participant discussions

Participants were asked to discuss the following questions in their breakout groups:

- What examples have you seen of adaptation considerations in NZPs already?
- What are your reflections on adaptation and co-benefit considerations
- What needs to be done to ensure that they are included as part of NZPs?

The key themes that emerged from discussions with participants were governance, policy and regulatory reform, precinct planning, design and performance, community participation and engagement, economic viability and investment barriers. Participants noted that there is a need for careful and thoughtful forward planning of NZPs with a need to incorporate net zero goals from the beginning of any new development or for the retrofit of existing buildings. Community engagement, participation and consideration of economic factors were also considered important, with

adaptation features being both a key costing consideration and potential drawcard for investors.

2.2.1 Governance, policy and regulatory reform

Participants emphasised a need for foresight and a comprehensive vision, with many precinct-level developments felt to be still nascent in Australia. It was also noted that Australia was not very good at considering complex land uses that can be required for new precincts. However, participants also noted a lack of impetus for state agencies to take charge in this area, despite the fact that climate change and necessary adaptations will influence a range of professional and government sectors.

Participants suggested that current development norms were not fit for purpose with precincts needing to be able to adapt to climate-induced changes. With global temperatures already exceeding 1.5° C, it was agreed that current conventional development practices would be ineffective and that there needed to be recognition that there is no business-as-usual scenario when making cost or impact comparisons. Participants acknowledged the enormous demand for new housing and suggested that trade-offs are not being properly considered. For example, with significant water demands and the loss of mature trees to infill developments, there is a need to strengthen national building standards.

Some key areas of concern around governance and regulations included water provision, data centres and artificial intelligence (AI) resource use. The growing energy needs associated with AI and data centres was also discussed with an example of the Hume City Council in Victoria considering 19 applications for data centres, but they only have enough water available to sustain around five of them. With a significant increase in data centres' investment globally, the need to develop governance frameworks around AI related energy use was flagged as a key area for reform.

Another example discussed, was the colocation of a data centre, to capture heat for use in horticulture, aquaculture, of for pool heating. Participants felt that incorporating systems thinking and exploring ways to look at adjacent land uses to have complementary uses was needed. In WA, and Australia, we are not looking at the whole system with developments and where there are synergies to enable more efficient resource use.

2.2.2 Precinct planning, design and performance

To enable decarbonisation, participants felt that design and planning needed to consider the scale of change needed. They also noted that a socially responsive model of design that would influence people's behaviour would also be useful for precinct developments. Participants emphasised that new precincts planned to meet 2030 or 2035 targets would require more comprehensive planning in relation to building materials, energy efficiency and other key factors at the outset. Both new and existing precincts would need to improve adaptation factors like airtightness and indoor air quality so that buildings would be able to withstand increased temperatures, rain events and instances of bushfire smoke.

Reduction in energy demand was also seen to be key to a net zero future. While globally we are installing more renewable energy, we are also increasing overall energy use, including fossil fuels. Thus, there is an urgent need for more energy efficient buildings. Existing infrastructure may not cope well with climate change and simply bringing on new precincts was not seen as a solution. Participants suggested that forward planning and a systematic approach to building audits could be a solution. Other proposed planning considerations to cope with higher temperatures included assessing the thermal performance of developments, improving insulation requirements, and modelling Heating, Ventilation and Air Conditioning (HVAC) loads to ensure developments can meet increased energy demand. Ensuring sufficient shading is included in building or retrofit designs is also needed to improve the thermal performance of the built environment.

Nature-based solutions were also a key topic of discussion, with participants acknowledging the potential of urban greening to increase cooling, improve drainage and boost biodiversity. While urban greening can be controlled down to the plot level, it was felt to provide the most benefits at the whole of city scale.

2.2.3 Community participation and engagement

Participants noted that engaging with the community to increase their participation is key to the success of precincts. While NZPs can offer communities energy and disaster resilience; to be effective there needs to be people willing to live and work in them. Participants suggested that clear communication of the value and benefits for people living and working in NZPs was needed, as there is an unfamiliarity with new technology and some community polarisation. There was a sense that while there was often willingness to be part of a precinct, communities often lacked the tools or opportunities to be involved. Participants noted that structural change within net zero infrastructure tended to be more effective than behaviour-oriented programs for driving net zero outcomes.

Community mindsets towards the energy transition and reaching net zero was also a focus of discussion. Participants discussed a number of positive changes in the field of renewables, for example, citing Saul Griffith's 'Electrify Everything' campaign. Participants also emphasised that there was a need to overcome public pessimism about the energy transition to avoid scapegoating and division.

2.2.4 Economic viability and investment barriers

Participants stated that precincts need to be commercially viable before seeking financing. Lessons could be learnt from the mitigation and adaptation aspects of the Curtin campus case study, pointing to the importance of including adaptation as part of the initial business case. Participants felt that by including mitigation and adaptation in financial decision making, investors would be able to see the costs and benefits of these actions, noting that these factors are often inadequately costed (for example, tree planting). There were also concerns raised that scalability is possibly in tension with the requirements for designing climate-adaptive precincts, with site specific needs of each individual precinct would make them ineffective and uneconomic for broader implementation.

3. Regulations for DER grid integration

3.1 Expert presentation: Professor Penelope Crossley (University of Sydney)

Australia's energy system is undergoing a fundamental transformation, with DERs projected to supply over 45% of electricity demand on the NEM by 2050. This has meant that the challenge of DER integration is no longer purely technical, but increasingly also a social and regulatory challenge. The question then becomes, how do we best ensure that DER evolves from being passive exporters in the electricity system to orchestrated, system wide participants that are responsive to market demand?

Professor Crossley worked on a comparative analysis of the regulatory frameworks in nine jurisdictions around the world, aiming to identify international best practice across five core dimensions. These dimensions included: the legal definition of DER and its implications for market access and planning; technical standards; transparency and visibility of DER data; regulatory frameworks for DER connection to distribution networks; and the rules governing DER exports, including tariffs, thresholds, and conditions.

This research provides insight into how Australian DER regulation should evolve, highlighting potential reforms that could better embed transparency, connection, and innovation into regulations. Thereby, enabling greater participation, system efficiency, and resilience in a decarbonising grid. To achieve this, Australia must adopt statutory definitions, real-time data infrastructure, and a forward-looking market design to deliver a decentralised, resilient, and consumer-centred energy system.

3.2 Participant discussions

Participants were asked to discuss the following questions in their breakout groups:

- What are the necessary laws and regulations that need attention? (Or: How can electricity market regulations be redesigned to reduce complexity and meet the challenges of increasing CER?)
- How best to prioritise regulations for DER grid integration in the current landscape?

Key themes that emerged in the discussions was a need for alignment of regulatory frameworks and governance across Australia, consumer rights, participation and equity and data and forecasting.

It was agreed that CER is growing rapidly on the grid in Australia, with an urgent need to create standardised regulations that integrate household solar, batteries and EVs.

In particular, data use, customer privacy, consumer protection, and market design were highlighted as areas requiring regulatory attention. However, participants also stressed that introducing too much regulatory complexity could slow down the growth of DER. It was felt that enabling and encouraging participation of consumers through regulatory reform was crucial to ensuring the successful management of DER. Participants also suggested that there were opportunities to learn from successful developments both around Australia and internationally, citing Project Jupiter, the National CER Roadmap and Germany's central data repository as examples of progress.

3.2.1 Alignment of regulatory frameworks and governance

While agreeing on the importance of aligning DER regulation around the country, participants noted several obstacles for practical implementation of a standardised approach. For example, issues in one jurisdiction may slow down progress for all states and territories with different networks and different market designs. Suggested solutions to improve coordination included proactive, clear and transparent procurement processes, approaches to management that are transferrable across markets and identifying gaps by collaborating with industry practitioners and overseas networks.

Participants highlighted that learnings from different regulatory environments can be shared for more effective CER governance nationally. Examples included the learnings from the CER Roadmap in the NEM as well as Project Jupiter in the Wholesale Electricity Market (WEM). Having national alignment was thought to make it easier to work across the NEM and the WEM with data sharing, governance processes and rulebooks as areas needing greater consistency.

Participants noted that South Australia (SA) was an early leader in allowing greater amounts of CER and increased customer autonomy, while still ensuring grid stability through import and export limits. Building on the learnings from SA, WA is now beginning to adopt similar measures, based on learnings from Project Symphony and Project Jupiter (currently underway). Participants also felt that WA was ahead in terms of regulations and data for connections, citing the extra complexity in the NEM due to the greater number of players. However, they also suggested that the NEM was ahead of WA in relation to policies for market participation for VPPs. In this regard, participants expected that the WEM would follow the lead of the NEM.

3.2.2 Consumer rights, participation and equity

Participants agreed that a clear pathway to market participation is necessary to provide value for consumers, aggregators and retailers. However, one group also noted that full participation in VPPs cannot be expected and there was a need to understand what partial participation may mean for the effectiveness of VPP schemes and for the network. There also needed to be a testing of assumptions in the VPP model (for example around consumer knowledge and pricing) as these factors may inhibit participation.

The importance of regulations for consumer protection was highlighted across discussions. In that regard, it was suggested that the roles and responsibilities of the various energy market actors needed to be clarified, as well as ensuring that there are no hidden product terms and conditions for VPPs. The opportunity for consumers to opt in or out of VPPs was also noted as important. To build the trust required for consumers to sign their energy assets up to a VPP, consultation and a participatory approach to developing the associated regulatory model was also identified as being worthwhile. Participants also suggested that regulations should be used to achieve greater equity through improving access to the benefits of CER.

It was believed that it is important to ensure that participation in the market is simplified for aggregators and kept cost effective, to enhance the opportunities for VPPs to offer tangible network solutions. This could be through offering the right price signals, either through tariffs or time-based pricing, that provided end value to the consumer without adding extra complexity Embedded generation on a precinct scale was also discussed as an equitable and sustainable solution. For example, shared roof space can be an opportunity for benefits to be shared among residents of a precinct, with all residents receiving a reduced bill. However, participants also noted that the current Strata Titles Act makes governance and management of CER in a strata context difficult, with one participant noting that community title may be the more optimal way forward.

3.2.3 Data and forecasting

The need to understand how to improve the collation of data was also identified as an important component of effectively regulating for CER. This is because more granular data (for example EVs) can improve the forecasting capability of the market operator and help them to manage variable consumption. The example of Germany's central repository of data was raised, with participants questioning whether this could be a functional template for a centralised system in Australia. However, participants stressed the importance of scenario planning, accessing only the data that is needed to manage the system, while also respecting data privacy rules. As well as consideration of how many actors really will need to have access to asset data from individual customers.

4. Multi-objective trade-offs for NZPs

4.1 Expert presentation: Dr Bill Lilley (RACE for 2030 CRC)

Designing market and grid operations that not only ensure reliable and affordable power but also maximise environmental benefits is critical for Australia's decarbonisation. To achieve this, robust frameworks and indicators are essential to navigate the interplay of co-benefits and trade-offs when integrating CER. There is a need to provide a multi-faceted approach to integrating CER into complex energy systems, to manage the competing and at times, conflicting objectives and priorities.

In his presentation, Dr Bill Lilley discussed a number of different frameworks – including Multi-Criteria Decision Analysis, Integrated Assessment Models or Energy System Modelling, Multi-Objective Multi-Verse Optimisation algorithms, Cost-Benefit Analysis with externalities, Life-Cycle Analysis and Sustainability Indicator Frameworks. Bill suggested that a multi-faceted approach that integrates various analytical methods with a comprehensive suite of indicators is best suited for effective CER grid integration.

4.2 Participant discussions

Participants were asked to discuss the following questions:

- What frameworks/priority indicators can best enable facilitation of NZPs?
- What pricing mechanisms are needed and are workable for consumers/businesses?

The key themes discussed from participants in this session included, governance and frameworks, modelling and trade-offs in decision making, and what the ultimate business case(s) for precincts might be.

Participants again emphasised the role of governance in managing expectations and shaping successful outcomes for individual precincts in line with their unique needs and priorities. Discussion also focused on how decision-making models themselves are shaped by the assumptions underpinning them and recommended robust feedback models that ensured that such frameworks provide the best guidance for governance and development. It was reinforced that decision-making needs to be based on high-quality, transparent information to ensure planning for both new build and retrofits could be future-proofed as much as possible. Finally, finance emerged as another common theme, with participants discussing the requirements for fair and functional pricing mechanisms.

4.2.1 Developing facilitation frameworks

Participants suggested that the outcomes of modelling are dependent on who is using the models, what kind of decisions are being made, where the precinct is located and who is making the final decisions. They also felt that the governing values of an organisation can impact both the selection and outcomes of a decision-making model.

Curtin's Bentley Campus was provided as a unique example in precinct development as Curtin both built and uses the precinct. Other precincts are often created by developers and then used by tenants who may have different values to what was originally proposed by the developer. Participants proposed that when values align, the outcomes of precinct developments are improved and magnified.

Participants also raised considerations around the development of frameworks to facilitate precincts, focused on managing expectations and future uncertainties. For example, they discussed the possibility of integrating operator expectations into guidelines or regulations to avoid future complications if a new operator takes over a precinct. It was proposed that a precinct facilitation framework should include net zero performance as a key overarching element, in addition to other elements such as consumer engagement and protection.

4.2.2 Modelling and trade-offs in decision-making

Participants noted that modelling has the potential to support improved decision-making. However, instead of seeking an "optimal" outcome, modelling can improve decision making to be more consistent and transparent. It can be used as a design improvement tool by revealing weaknesses in existing options and identifying improved options, through clarifying what is important in decision making processes.

Participants also indicated that transparency around the models used will be critical to ensure responsible and trustworthy modelling. Recognising that models are generally underpinned by assumptions and values, participants suggested that making this information visible, revealing the choices and trade-offs made, would improve the quality of decisions. Participants also emphasised the need for a robust feedback system to test assumptions in models, noting that models based on older theoretical assumptions may need to be updated to reflect current realities (such as climate change impacts). For example, life cycle assessments were conducted for the Roe Industrial Park because the main priority at that site was carbon reduction.

Participants also discussed how grid planning needs to incorporate several time horizons (one year, ten years and thirty years into the future), as well as consider the benefit of non-network solutions, to potentially avoid unnecessary distribution and transmission upgrades. The assumption that future precinct developments will always be new builds was also challenged.

4.2.3 Business case for precincts

Developing the business case for precincts was also emphasised as being important. Participants noted that firming up the grid is not necessarily monetised, so ways to offer financial benefits to precincts that share CER assets for broader grid support is needed. It was agreed that precincts need to first be financially viable before considering how to contribute to grid stability. For example, the Peel Business Park is driven as much by commercial success as achieving 'green' credentials.

Conclusion

Across all four sessions there was a strong focus on regulation, policy and governance. Participants emphasising the importance of good governance and policy to enable the development and functioning of energy resources in the context of precincts, for both new and retrofitted precincts. For example, the governance arrangements for CER in a strata context is felt to be challenged by a lack of knowledge from strata management companies.

Participants also discussed the lack of consistency and increasing complexity of energy regulations nationally, highlighting the need for standardised regulations across Australia. However, it was also recognised that there are limitations with a standardised approach for jurisdictions if some are lagging. National alignment work that is already occurring, for example sharing the lessons from Project Jupiter in WA nationally, was considered important to address the lack of consistency.

Planning also emerged as a common theme, with participants discussing the importance of considered and thoughtful planning of infrastructure, investment, precinct design and performance. It was emphasised that there was a need to ensure precincts are adequately prepared for the changing climate of the future – both to withstand increases in temperature and natural disasters, as well as to contribute to the decarbonisation of society through smarter and more efficient energy use. This was felt to require both foresight and a robust business case to ensure that precinct developments and retrofits are economically viable.

Consumer trust, benefits and protection was also highlighted as important. This was particularly in relation to VPPs and embedded networks. Participants also raised the importance of early and appropriate consumer engagement and participation to build trust. Clarifying the roles and responsibilities of various energy market actors for consumers was also highlighted as a way to build trust. The importance of including consumer protection provisions in legislation was seen as equally important. .

Finally, the use of multi-objective modelling in NZPs can provide perspectives on the trade-offs and decisions that need to be made in relation to CER integration. Ultimately this improves the decision-making and transparency, by making known which factors are prioritised in a precinct development (such as environmental outcomes, cost or grid support).

Overall, the forum clarified that integrating CER and DER into precincts requires careful consideration from various perspectives. Precincts that are well planned, designed and include CER assets effectively, have the potential to reduce energy consumption, costs and deliver benefits for both householders, businesses and developers.

pathways to net zero precincts

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