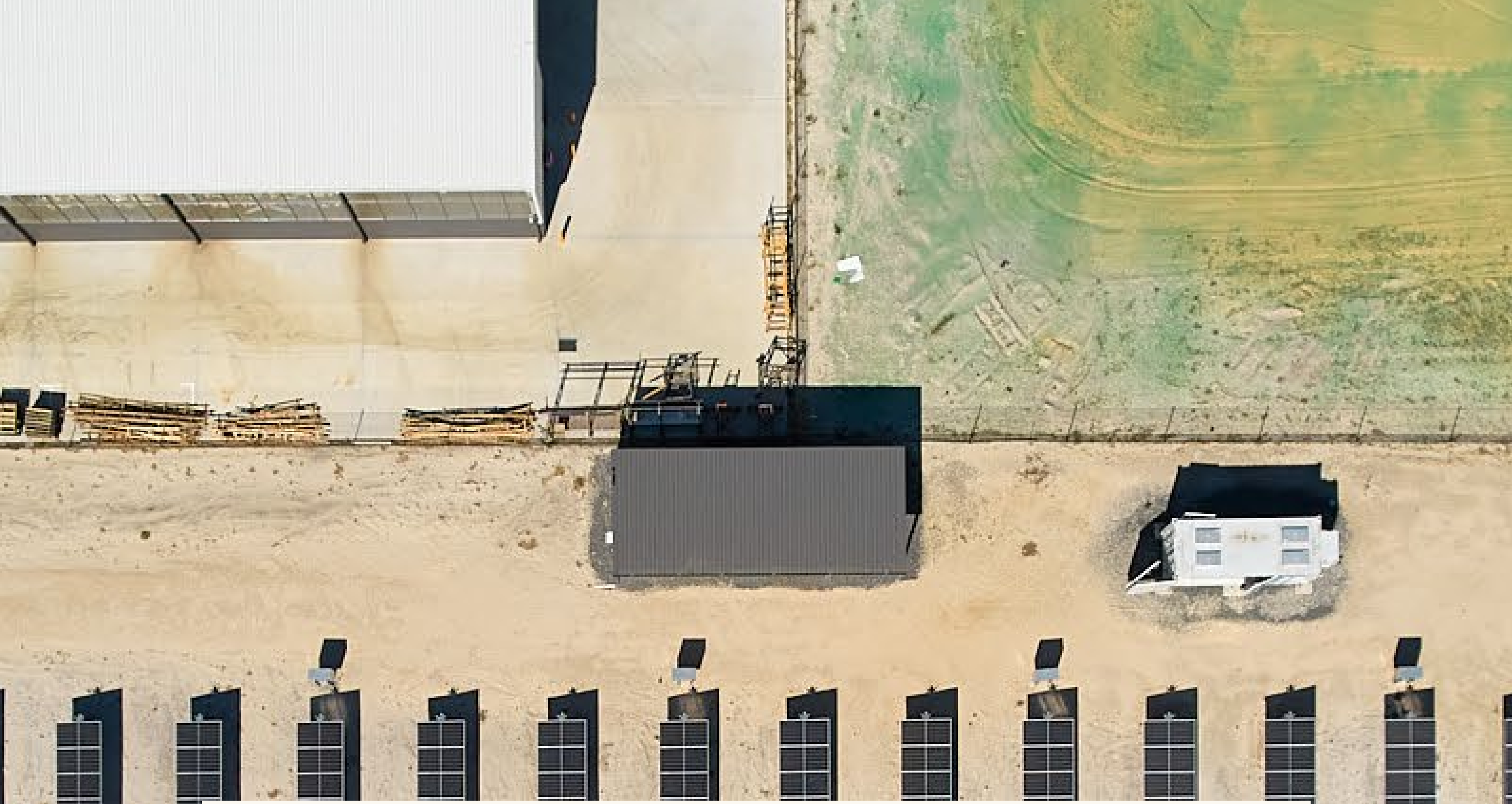

CER/DER Grid Integration for Net Zero Precincts

pathways to net zero precincts

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Background

The Pathways to Net Zero Precincts (NZPs) is a three-year research project that aims to identify, develop and implement innovative strategies for transitioning urban precincts towards net zero emissions. As 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 the country, the project 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 to innovate to achieve net zero outcomes. Their practical scale allows technologies such as solar photovoltaics (PV), batteries and electric vehicles to be readily incorporated. Precincts are a common scale for urban development or redevelopment providing opportunities to integrate net-zero measures in project delivery.

The NZP project has initially focused on six WA case studies across the Perth-Peel region. These include the Knutsford Urban Regeneration Precinct, Rivermark, Curtin Bentley Campus, Alkimos Central, Roe Highway Logistics Park and Peel Business Park. Two new case studies – Rundle Mall in Adelaide, led by the University of South Australia, and the Sunshine Precinct in Melbourne, led by RMIT, are commencing being integrated into the larger project. These case studies provide the opportunity to examine precincts at the residential, mixed-use and light industrial scale.

For the purpose of this project a precinct is defined as a "unified area of urban land within a clearly defined boundary. Synonymous with neighbourhood or district. A typical precinct will contain private and public land with shared infrastructure."[1] For Net Zero, the project adopts the definition informed by the Paris Agreement where the amount of GHG emissions released into the atmosphere is balanced by the amount removed – achieved by either reducing human-caused emissions and removing carbon from the atmosphere through natural processes or technologies.

The project uses the terms consumer energy resources (CER) and distributed energy resources (DER). CER are described as "consumer's resources that generate or store electricity and includes flexible loads that can alter demand in

[1] Thomson, G. Newton, P. Newman, P & J. Byrne. (2019) Guide to Low Carbon Precincts Cooperative Research Centre for Low Carbon Living. Sydney Australia.

response to external signals." [2] CER includes household solar, batteries, electric vehicles and controlled loads such as heat pump hot water heaters and air conditioners. Distributed energy resources (DER) is also used to describe household assets, but it also includes larger assets such as neighbourhood batteries installed in the distribution network.

Early results from interviews with a range of precinct owners and operators revealed a range of motivations for considering net zero. These include corporate net zero objectives, financial returns, environmental outcomes or responding to regulations and consumer objectives. However, many reported the business case for net zero precincts was often marginal.

Connection to the grid in WA was a common concern that was raised in interviews, with reasons ranging from long delays in connections, network issues that limit export capacity, and a need to have the support systems in place for Distribution System Operators to allow for non-network, and behind the meter solutions. Some precinct operators also found it difficult to understand the complexities of the electricity market and how they could improve the business case by operating DER assets on the electricity market.

Controlled loads such as heating, ventilation and cooling (HVAC) systems were seen as an opportunity that had not been fully realised in precinct developments. While self-consumption could enable the resolution of two problems by alleviating pressure on the grid, and in some instances could also avoid the need for network augmentation.

Developments with sufficient scale (approximately 50 to 100 lots), and with a mix of land uses had a competitive advantage, as they could support replicability, for example having processes, contracts and delivery models in place to enable efficiency for future developments. Low density residential developments often lacked governance structures and economies of scale, with the responsibility for DER and CER assets falling to individuals. Long-term governance of embedded networks and micro-grids were also seen to create internal challenges between network and non-network solutions.

This *CER/DER and Grid Integration for Net Zero Precincts* online forum brings together architects, developers, builders, 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 our communities is critical to ensure energy reliability and continuity of supply, while at the same time maximising benefits for customers.

[2] 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

Lessons learned from the Peel Business Park Microgrid

Presenter: Dave Morgan, Development Manager, DevelopmentWA

The Peel Business Park - Nambelup-Kaadadjan is situated in the Peel Region which is located 70km south of Perth and 10km Northeast of Mandurah, in Western Australia (WA). The Peel Region has a population of 168,461 with an annual economic income of $8.9 billion.[3] Of WA's nine regions, the Peel Region is the smallest in geographical size but is one of the state's fastest growing population centres.

At full build out, the Peel Business Park is anticipated to deliver 1000ha of industrial land within the Shire of Murray. It was designed with a focus on agri-food and agri-processing to develop a Food Innovation Precinct for WA and received state government funds to activate Phase 1 (290ha) with trunk infrastructure. This infrastructure was delivered by DevelopmentWA and included all the service extensions for power, water, sewerage, gas and telecommunications as well as upgrades to major roads and drainage networks.

Lots from Stage 1 of DevelopmentWA's landholding in the industrial estate were successfully delivered to the market in August 2020, and Stage 2 was released with high demand in 2023.

A key feature of the Peel Business Park is its private micro-grid, which is owned and operated by Peel Renewable Energy, a subsidiary of Zenith Energy who also specialise in operating remote off-grid renewable energy solutions for the resources industry. The initial generation footprint of the micro-grid is comprised of a 1.2MW ground mounted solar photovoltaic array and a 2.5 MWh battery storage system. Future generation is expected to be delivered by the microgrid operator primarily through rooftop solar as the Park gets built out.

[3] Regional Profile – RDA Peel

The project provides end users at the Peel Business Park with a minimum of 50 percent renewable energy, at a price discount from advertised regulated tariffs of 30 percent. In addition to the renewable energy aspect of the project, a key driver for the microgrid was the need to provide an alternative electrical servicing solution that avoided the circa $50M in network augmentation costs, which were required for a standard grid-servicing solution for the wider Park.

Early tenants to the park include a global bakery, engineering firms, a Food Agri Innovation Precinct run by the Shire of Murray and a Bushfire Centre of Excellence run by the Dept of Fire and Emergency Services.

With any new pioneering undertaking, there are always key learnings that can be leveraged by others seeking to deploy a similar solution within their net zero precincts. For the Peel Business Park, some of these learnings included:

- Engaging with energy regulators to activate some of the equipment access provisions in the Energy Operators Act for licensed private network operators. This will remove the need to use unwieldy easements to secure access for the microgrid operator to their equipment in private and public land.
- Engaging with customers before they build their premises to ensure that conduits and spare capacity is provisioned in customer installations and switchboards, to seamlessly integrate rooftop solar when it is subsequently needed down the line. This will save unnecessary installation costs and disruption to customer premises by the microgrid operator.
- Early communication to customers of the subtle differences in the license provisions of our private microgrid operator and Western Power, in regard to inspection regimes and contractor connections. This will prevent confusion around what activities and costs are paid to which parties in the construction and network connection process.

Question 1: What are the lessons learned from the Peel Business Park Micro-Grid and how might these inform other precincts?

Reflections on climate adaptation for NZPs to meet needs now and in the future

Presenter: Emeritus Prof. Mark Howden AC FAA FTSE, Australian National University

Rising levels of greenhouse gas emissions are unequivocally causing increases in global temperatures as well as influencing other key climate-related factors such as risks from floods, storms and cyclones, drought, bushfires and sea level rise amongst many others. The trajectories of change in these are consistent with future projections of climate change. The evidence of the impacts of these aggregate changes is already large (for example more than a tripling of disaster recovery costs as a percentage of GDP over the past four decades).

There are two core responses available to reduce these escalating risks: 1) reduce greenhouse gas emissions substantially, quickly and permanently including via the energy transition, and 2) adapt to the current and future changes. Other speakers will cover aspects of the first, whereas this short paper will cover the second.

A good start when considering adaptation is to focus on the core climate-related outcomes or goals we usually require from residential precincts and how they support particular values and aspirations held by the residents and owners. A non-exhaustive list could be:

- **Location**: NZP's sited so they are not prone to flooding, sea level rise and fire
- **Structural integrity**: to ensure longevity in the face of high winds and other factors
- **Health, wellbeing and comfort**: NZP's that buffer against climate extremes, encourage active travel and exercise, reducing poor health outcomes
- **Energy efficiency and integration**: addressing climate-driven changes in electricity supply, demand and reliability and reducing costs
- **Water efficiency and management**: addressing the

increasing variability in water-related factors

- **Visual amenity**: enhancing capital value as well as being linked to the above
- **Biodiversity**

For each of these, there are a range of possible adaptations to climate change impacts, many of which can address multiple needs. For example, good building siting and orientation, design and construction (including emphasis on high levels of insulation and air-tightness along with mechanical heat exchangers and heat pumps). These design aspects can reduce the impact of increasing heatwaves, reduce exposure to smoke, reduce operating costs including via reducing net electricity consumption and reduce 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. Linked to this is water management such as improved water efficiency, transmission, storage and infiltration, which can reduce consumption inside and outside, manage increasing drought periods, reduce flooding and water damage risks and reduce costs.

Beneficial pathways for NZPs should be able to be generated by systematically and iteratively working through 1) the matrix of goals/outcomes/values and aspirations, 2) the impacts of climate-related changes and 3) adaptations to these changes and the co-benefits of these.

Question 2: How should we ensure climate adaptation considerations are included in NZPs?

Regulations for DER/CER and grid integration

Presenter: Prof. Penelope Crossley, University of Sydney Law School

Australia's energy system is undergoing a fundamental transformation, with Distributed Energy Resources (DER), including rooftop solar, batteries, and vehicle to grid, projected to supply over 45 percent of National Electricity Market demand by 2050. This has meant that the challenge of DER integration is no longer a purely technical but increasingly also a regulatory one. How do we best ensure that DER evolve from passive exporters to orchestrated, system-wide participants that are responsive to market demand?

To address this question, we undertook a comparative analysis of the regulatory frameworks in nine jurisdictions, including Australia's NEM and Western Australia, as well as California, Germany, Great Britain, Hawaii, the Philippines, the EU, and the United States. Our research aimed to identify international best practice across five core dimensions: the legal definition of DER and its implications for market access and planning; technical standards, including the entities responsible for setting and enforcing them; transparency and visibility of DER data, including requirements for registration and data-sharing; regulatory frameworks for DER connection to distribution networks, both behind-the-meter (BTM) and front-of-the-meter (FTM); and the rules governing DER exports, including tariffs, thresholds, and conditions. The lessons gleaned from our research provide a robust insight into how Australian DER regulation should evolve, highlighting potential reforms that could better embed transparency, connection, and innovation into our regulation to enable greater participation, system efficiency, and resilience in a decarbonising grid.

Transparency begins with data. Germany's Market Master Data Register demonstrates how comprehensive, anonymised, real-time information underpins planning, market access, and consumer confidence far surpassing Australia's static DER Register. Connection requires technical standards to serve as instruments of governance, yet Australia's fragmented approach risks inconsistency and exclusion. A hybrid model which combines Hawaii's agility with Germany's institutional oversight could address the very real challenges of cybersecurity, interoperability, and grid-forming capability. Finally, innovation demands legal and market reform: Virtual Power Plants must be recognised as market actors with clear dispatch rules, value-stacking opportunities, and access across wholesale, network, and resilience markets.

DER represent not just technologies but governance touchpoints. 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.

Question 3: What is needed for transparency, connection and innovation in DER/CER grid integration?

Multi-objective trade-offs for NZPs

Presenter: Dr William (Bill) Lilley, RACE for 2030 Cooperative Research Centre

As Australia and the world grapple with the urgent need to decarbonise electricity systems, a critical challenge lies in designing market and grid operations that not only ensure reliable and affordable power but also maximize environmental benefits. To achieve this, robust frameworks and indicators are essential to navigate the interplay of co-benefits and trade-offs when integrating CER and DER. When integrating CER and DER into complex energy systems, a multi-faceted approach is needed to manage the competing and at times, conflicting objectives and priorities.

Different frameworks could include:

1. **Multi-Criteria Decision Analysis (MCDA)** is used to identify and integrate multiple conflicting objectives (e.g., cost, emissions, reliability, stakeholder input) and weighting the importance of these.

   Further reading: Gridlock in compromise, or is multi-objective optimisation possible in renewable energy planning? A stakeholder analysis using scenario-MCDA

2. **Integrated Assessment Models (IAM) or Energy System Modelling** is used for long term planning to assess the impact of different scenarios, while integrating constraints (such as land and materials). The use of IAM simulates energy-economy-environment interactions, for example capturing feedback loops between grid operations, electricity prices, emission intensity or mitigation, and other environmental externalities (such as land impacts).

   Further reading: An Integrated Assessment Model for comparing electricity decarbonisation scenarios: The case for Spain

3. **Multi-Objective Multi-Verse Optimization (MOMVO)** algorithms can be used to deal with multiple objectives for CER integration. For example, trade-offs such as lower cost vs. higher social inclusion, higher technical reliability vs. wider DER access can be used to develop an optimal compromise between conflicting goals.

   Further reading: A pareto strategy based on multi-objective optimal integration of distributed generation and compensation devices regarding weather and load fluctuations

4. **Cost-Benefit Analysis (CBA) with externalities** is used to extend traditional CBA to include monetized environmental benefits and costs, such as health impacts of fossil fuels.

   Further reading: Project EDGE Cost Benefit Analysis. Final Report.

5. **Life Cycle Assessment (LCA)** is used to gain a comprehensive understanding of the environmental footprint of different options by identifying hidden environmental costs and avoiding the shifting of environmental burdens from one area to another.

   Further reading: Towards urban LCA: examining densification alternatives for a residential neighbourhood

6. **Sustainability Indicator Frameworks** allow stakeholders to track the performance of policies over time or under different policy regimes.

   Further reading: Guide to Low Carbon Precincts

This presentation will argue that a multi-faceted approach, that integrates various analytical methods with a comprehensive suite of indicators is best suited for this purpose.

Question 4: What is an appropriate framework, and which indicators are best suited to allow for co-benefits or trade-offs with electricity market and grid interactions to achieve environmental benefits?