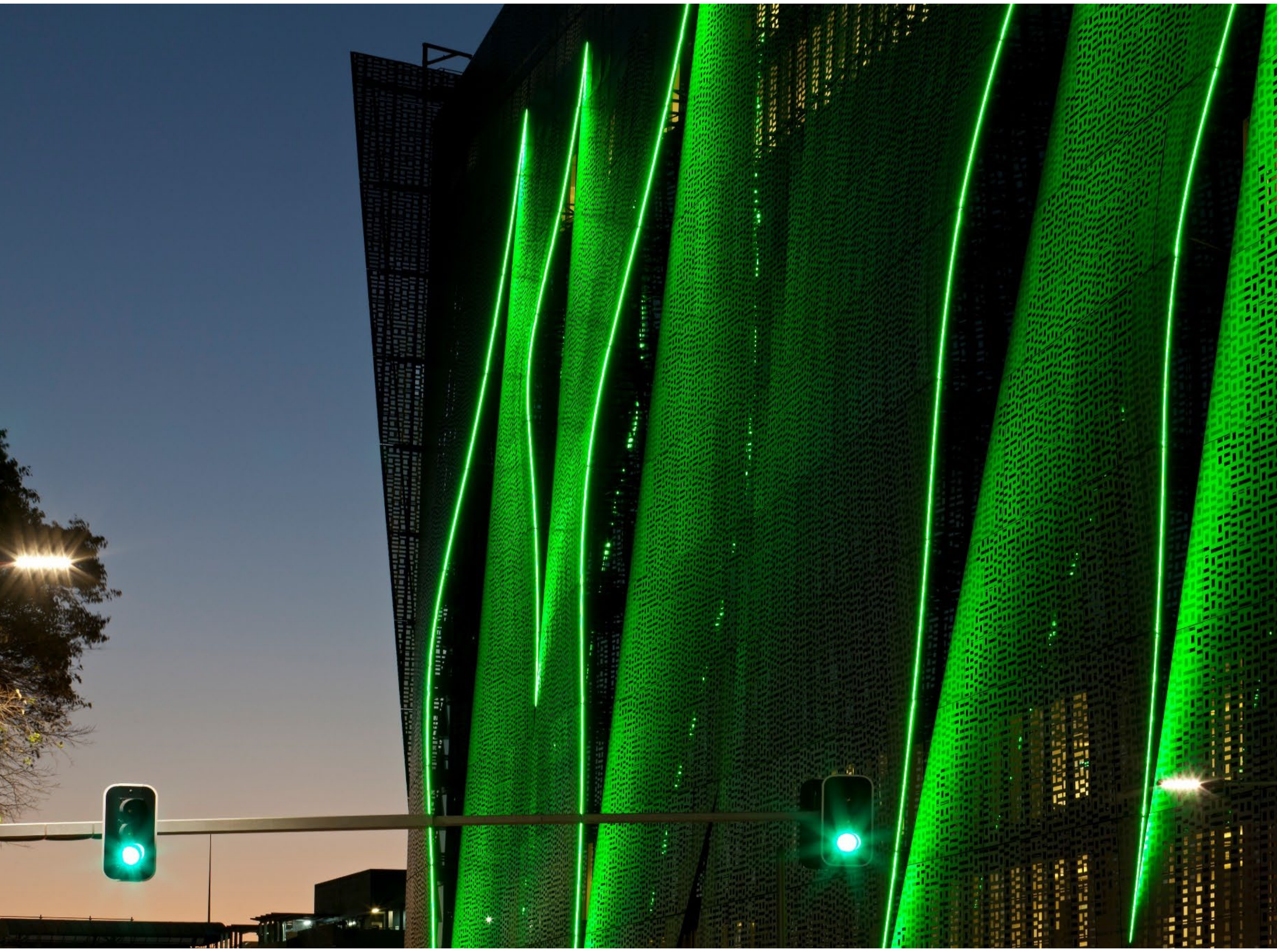
RACE for 2030
RELIABLE AFFORDABLE CLEAN ENERGY

E2 Fast track

The Green Wave:
Adding value through net zero energy strategy

Final report



Australian Government
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The Green Wave

Adding value through net zero energy strategies

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Project partners

UTS | Curtin University | Monash University | Sunovate innovating solar | (Energy)Lab

NSW Government Planning, Industry & Environment | Buildings Alive | RedGrid | Climate KIC Australia | CleanPeak Energy

What is RACE for 2030?

The Reliable Affordable Clean Energy for 2030 Cooperative Research Centre (RACE for 2030) is a 10-year, $350 million Australian research collaboration involving industry, research, government and other stakeholders. Its mission is to drive innovation for a secure, affordable, clean energy future.

racefor2030.com.au

Report at a glance

What is the report about?

The report explores new ways to address the challenge of reaching net zero carbon emissions. Specifically, how can we develop institutional net zero strategies that more deeply engage community and business partnerships to deliver greater trust, legitimacy and social value while maximising economic impact? In doing so, the project engaged with the net zero ambitions of three participating universities—University of Technology Sydney (UTS), Curtin University and Monash University.

Why is it important?

Universities are well established public-benefit institutions deeply embedded within geographic, innovation and thought-leadership communities. As such, they should be seen as critical enablers for seeding a net zero economy through their core activities of research and education. While the focus of the project was on university-based precincts with strong links to energy innovation, the project outputs are also broadly applicable to other organisations and other precincts.

Using the process and examples presented in the report, organisations can develop net zero strategies and solutions that deeply intersect with their organisational objectives and strengthen economic participation, stimulating a 'Green Wave' to deliver complementary economic, social, and environmental value beyond each organisation's boundaries.

What did we do?

Through background review, the project team developed a deep understanding of the net zero challenge, including best practice guidelines for net zero strategies. We also devised, applied, and refined a process for developing an institutional net zero plan that includes pathways for delivering additional complementary social and environmental values. Applying this process, we explored opportunities at the campuses of the three participating universities, particularly UTS and Curtin University. Several of these opportunities were further developed into case studies that can be emulated and adapted across other universities and business precincts.

What difference will it make?

The project contributed to the net zero strategies of both UTS and Curtin University. It also provides a foundation for both universities and a wide range of institutions to develop net zero strategies that deliver greater trust, legitimacy and value. The research project also outlines a longer-term research program to address the many technical and organisational challenges associated with making and meeting net zero commitments.

What next?

UTS and Curtin University will continue to develop their net zero strategies while implementing the opportunities identified through the project. The project also provides a template for other institutions to strategise their net zero response, while identifying key challenges and future research opportunities. Research opportunities include design of projects while incentivising the addition of complementary value for other stakeholders, incentivising more impactful investments to transition the energy system, and supporting institutions in meeting their net zero objectives.

Executive summary

Project aims

This project explores new ways to address the net zero challenge. Specifically, how can we develop institutional net zero strategies that more deeply engage community and business partnerships to deliver greater trust, legitimacy and social value?

The project involved three universities—University of Technology Sydney (UTS), Curtin University and Monash University. Each is at a different position on its journey towards net zero emissions. Monash has already adopted a net zero strategy, while Curtin is looking to build on existing emission reduction targets. The project was led by UTS, which has committed to developing a net zero strategy, to which the project has made substantial contributions.

Universities are well established public-benefit institutions deeply embedded within geographic, innovation and thought-leadership communities. As such, they should be seen as critical enablers for seeding a net zero economy through their core activities of research and education. While the focus of the project was on university-based precincts with strong links to energy innovation, the project outputs are also broadly applicable to other organisations.

Using the process and examples explored through this project, organisations can develop net zero strategies and solutions that deeply intersect with their organisational objectives and strengthen economic participation, stimulating a 'Green Wave' to deliver complementary social and environmental value beyond each organisation's boundaries.

Understanding net zero

According to the special report on global warming by the Intergovernmental Panel on Climate Change (IPCC SR15), "Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period." (IPCC, 2018).

The background review for this project focussed on:

- developing a thorough understanding of the net zero challenge, including emissions scope, carbon offsets and mechanisms for purchasing renewable energy
- reviewing and summarising the net zero policies of Australian universities
- examining best practice guidelines for net zero strategies
- summarising existing work on the conceptual foundations of the project in the interrelated areas of community wealth building, anchor institutions and living laboratories.

While there is much agreement on the urgent need to reduce greenhouse gas emissions, many climate emissions strategies are lacking in detail and transparency, making them difficult to compare. Adhering to standards and guidelines provided by organisations such as the Science Based Targets initiative (SBTi) and the Climate Active initiative can assist in this regard.

There are also strong similarities among the various net zero strategies examined. Many institutions face similar challenges, identify the same low-hanging fruit, and adopt similar strategies for addressing emissions. Purchased electricity, for example, is the largest single source of greenhouse gas (GHG) emissions for many institutions, including most Australian universities. Under common carbon accounting rules, this can largely be reduced and eventually eliminated through energy efficiency measures and shifting to 100% renewable energy, through combinations of on-site generation, purchasing GreenPower and/or direct renewable energy power purchasing agreements. Similarly, emissions from waste and vehicles can be reduced through proven technologies such as composting and electric vehicles, respectively, while residual, harder-to-abate emissions, such as those from flights, can be addressed using offsets.

Despite these surface-level similarities, the details matter. How each net zero opportunity is designed and eventually implemented can provide a pathway for delivering additional complementary social and environmental value. Through this project, we explored a number of opportunities applicable to the campuses of the three participating universities, particularly UTS and Curtin. Several of these opportunities were further developed into case studies, which are included in the full report.

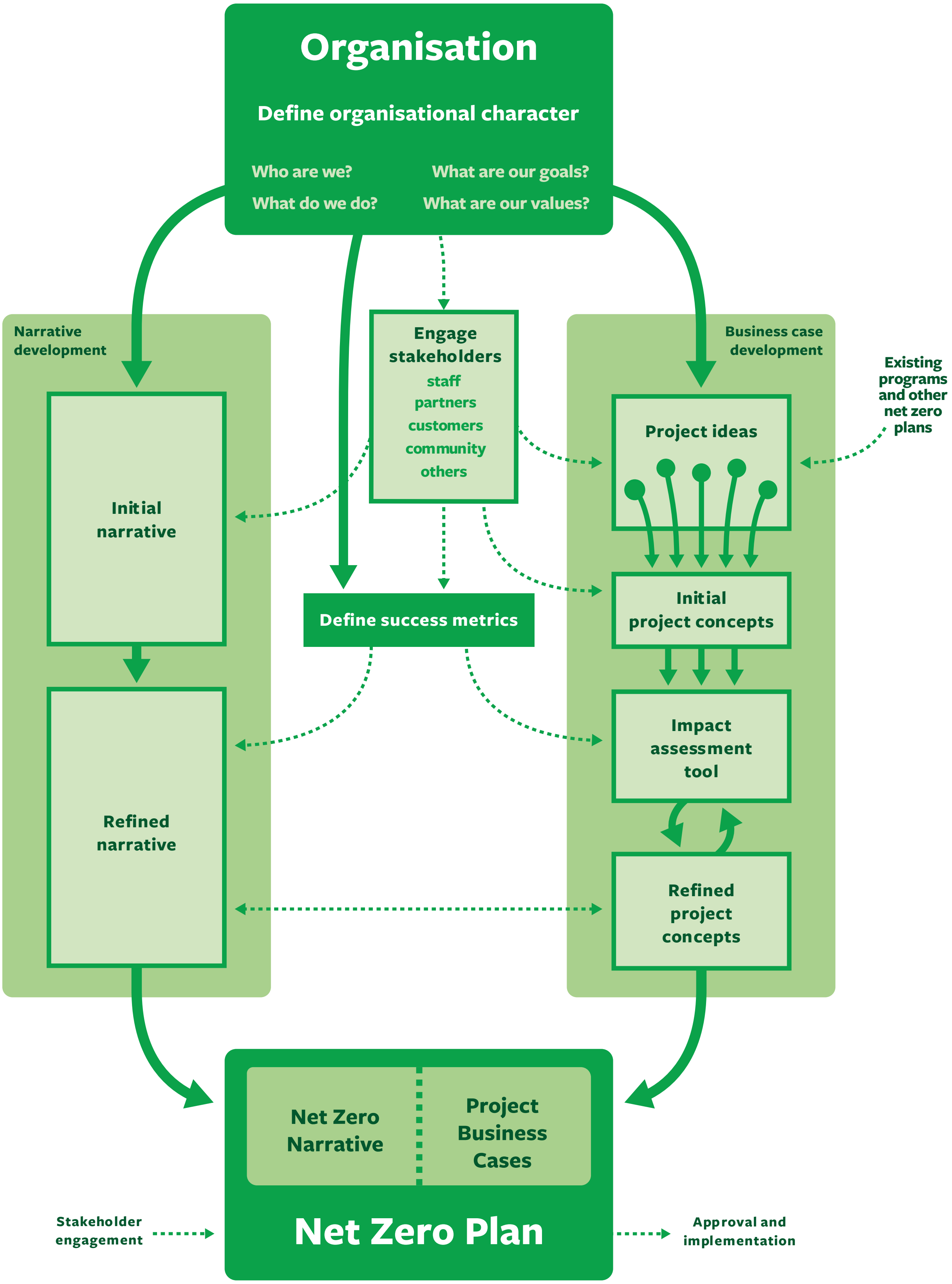
Process for developing a net zero plan

Over the course of the project, we devised, applied and refined a process for developing an institutional net zero plan, as illustrated in the diagram below. Good strategy development should begin with a thorough understanding of an organisation's character—i.e. its history, identity, goals, values, and purpose. This understanding is used firstly to aid with generating project ideas and stakeholder engagement, but more importantly as a means of defining 'performance metrics' for evaluating and refining project concepts. This is followed by a process of deep stakeholder engagement, through which a number of project ideas are generated. Project ideas from other sources, such as from other net zero strategies and existing organisational partnership and linkages, can also be added to the process. These project ideas are then grouped and filtered, reducing them to a manageable number of partially interrelated project concepts.

Using the success metrics previously defined, an impact assessment tool can be developed for evaluating project concepts in terms of their ability to generate additional value beyond simply reducing GHG emissions, such as alignment with the United Nations Sustainable Development Goals (SDGs). The impact assessment tool is used both to rank project concepts, but also to help refine concepts during the process of transforming project concepts into business cases so as to maximise this additional value.

A key part of the process is the parallel development of a 'net zero narrative', tailored for the organisation in question. The purpose of this narrative is to help explain not only what the net zero plan will entail in terms of projects and their business cases, but how they fit the organisation's mission and purpose, and why the organisation should embrace them. The narrative development process is informed by the success metrics and the organisational character from which they are derived, in addition to the project business cases themselves. The narrative also helps to inform the business case development process.

In the final net zero plan, these two pieces—the net zero narrative and the project business cases—come together, each supporting the other. The final stages of the process involve further stakeholder engagement to refine the net zero plan, before the complete plan is approved, adopted and implemented. While our initial aim was to test the process through completion of the UTS net zero plan, work on this plan remains ongoing at the time of project completion.



Net zero strategy process map. Through this project we refined and applied the above process for developing a net zero plan. The process begins with understanding the organisation's character, which is used to help guide a program of engaging with community and business partnerships, defining success metrics and developing net zero opportunities. An impact assessment tool based on the success metrics is used to help evaluate and refine project concepts. A net zero narrative is developed alongside the refined set of project business cases such that each supports the other in the final net zero plan.

Monash University

In 2017, Monash University launched its Net Zero Initiative (NZI), committing to reach net zero emissions by 2030 across all four of its Australian campuses. Monash's strategy encompasses five key pillars:

1. energy efficiency measures (retrofits and operational changes to building use)
2. campus electrification (removing gas from the campus energy mix and adding electric vehicle infrastructure)
3. deployment of on-site and off-site renewable energy
4. a microgrid
5. offsets.

The rationale and thinking behind development of the NZI parallels much of the Green Wave process summarised above. The assessment criteria for opportunities emphasised not just short-term and long-term economic benefits, but also other tangible benefits such as research and teaching opportunities, and intangible benefits such as reputation gain.

As part of the project, key staff involved in the development and delivery of the NZI were interviewed and key lessons summarised. Through this we identified the following main success factors of the NZI:

- **Championing and leadership**—Having the right people with the necessary standing and influence brings direction and drive, encouraging others to look beyond short-term financial goals to a longer-term vision involving leadership and external impact.
- **Homework**—Groundwork laid by previous smaller projects provided proof of concepts, ideas and potential partnerships.
- **Interdisciplinarity and teamwork**—A microgrid feasibility study, for example, demonstrated on-campus benefits and bridged the communication gap required for integration across different university sectors, namely research, operations and executive.
- **Showcasing technology in new builds**—Smaller projects and new builds provided early wins and opportunities to explore options, reducing perceived risks for later, more complex retrofits.
- **Changing market conditions**—As the industry matures and prices for technologies such as solar continue to fall, the economic case for change only improves.

We also identified several potential barriers and missed opportunities, namely:

- **Aligning facilities management**—Limited organisational knowledge and reliance on external consultants can create barriers to innovation. This was overcome through leadership support and understanding.
- **Limited risk appetite**—A lack of previous experience creates hesitancy, which can be overcome using case studies, outside expertise, and building larger projects from smaller projects.
- **Funding research**—New infrastructure can support research, but proving the business case for this is difficult. External grant funding adds another layer of complexity.
- **Complex university processes**—When developing large-scale strategic initiatives, there is limited flexibility at the higher levels of decision making. A casualty of this complexity was a proposed PhD program, which would have required only minor additional investment while generating significant additional value.
- **Communication**—A missed opportunity was failing to create greater visibility of the programs through communicating early wins and case studies.

University of Technology Sydney

The University of Technology Sydney is a public research university located in central Sydney. UTS has a long history of commitment to sustainability principles and practices, including the establishment of the Institute for Sustainable Futures in 1996, signing of an Australian-first Power Purchase Agreement (PPA) with a solar farm in Singleton in 2015, and leading the bid that established the RACE for 2030 Cooperative Research Centre.

UTS is currently in the process of developing a net zero plan. In partnership with this project, UTS Sustainability led a series of stakeholder engagement activities tied to development of this plan, which helped identify a suite of net zero initiatives. Drawing on an assessment of UTS's organisational character to account for its core strategic goals and decision-making pathways, we developed a set of qualitative metrics for assessing initiatives. These were then converted into an impact assessment tool to assist evaluation and design of individual project business cases.

As part of the project, we also developed a net zero narrative and illustrations to complement the draft UTS net zero strategy. The narrative summarises the strategy as:

- defining a 'Climate Positive' strategy
- building on existing strengths
- establishing a strategic framework that (1) harnesses and strengthens UTS's research and education, (2) extends UTS's boundaries of influence to its local precinct and community, and (3) reframes net zero through a social impact lens to integrate UTS's delivery of the UN SDGs
- supporting the shift to 100% renewables.

Through this project we identified and developed a number of key net zero project concepts, including:

- **Establishing a Climate Impact Lab** as a vehicle for applying a collaborative innovation process that connects UTS research, teaching and learning with community, industry and local social and environmental entrepreneurship partners around net zero carbon challenges.
- **Best practice PPAs** to decarbonise the rest of UTS's emissions from electricity consumption.
- **24/7 renewables** to support the shift towards 100% renewable electricity by introducing flexible demand across UTS's buildings and installing batteries.
- **Battery storage + retail offering** to allow UTS to extend its impact to accelerate uptake of renewables by increasing its PPA investments.
- **Electrification** to establish pathways to reduce and eventually eliminate on-site burning of natural gas across all UTS operations.
- **On-site carbon capture** and sequestration through novel microalgae technology.
- **Decarbonising chilled water supply** using Large-scale Generation Certificates (LGCs) from existing spare renewable energy capacity while supporting grid-integration of additional renewables.
- **Strengthening the energy start-ups ecosystem** to better support talented founders with innovative and creative solutions to climate challenges.

Curtin University

Curtin University is the largest university in Western Australia. Curtin has exhibited commitment to sustainability-related initiatives over a number of years, as demonstrated by its ongoing commitment to the UN SDGs and programs such as achieving a 6-star Green Star Communities rating for the Perth campus with the Green Building Council of Australia (GBCA). Although Curtin is yet to make a formal commitment to reach net zero emissions, it is undertaking several initiatives towards this. In 2009, Curtin University joined UTS and the other Australian Technology Network of Universities in committing to a collective emissions reduction target of 25% by 2021, compared to 2007 baseline levels. Curtin's energy reduction target of 3% reduction year-on-year has continued since 2019 and includes energy reduction initiatives of building management systems scheduling to allow air conditioning to turn off in unoccupied spaces, changes in temperature set points, and LED and lighting control upgrades.

Through an engagement process undertaken over the course of the project, we identified key strengths that Curtin University can leverage and build on as it furthers its efforts to decarbonise, including:

- a detailed database of Curtin energy generation and usage across campus infrastructure
- accreditation as a 6-star Green Star Communities campus
- qualified GBCA experts within the Properties, Facilities & Development team to champion decarbonisation efforts and target best practice in new or renovated builds
- existing energy abatement and efficiency actions, which have reduced energy use across campus while floor space has increased
- a Thermal Storage Tank, which has enabled management of energy loads from the grid
- strong industry connections to large companies working in the decarbonisation space, including Cisco Systems, Optus, BHP Group, Bankwest, and state and local governments, as well as many companies who are undertaking their own net zero journey
- established research partnerships with industry and collaborative research centres, such as RACE for 2030 and the Future Batteries Institute, which can be partnered with for funding and research opportunities
- accredited courses, such as the Master of Business Administration, aligning with the SDGs, and other teaching areas more specifically focused on decarbonisation, such as the Master of Environment and Climate Emergency, ensuring graduates are skilled in decarbonisation opportunities for the wider workforce.

Through this engagement process, we also identified a number of key opportunities and recommendations, including:

- **Accelerating upgrades of campus voltage network infrastructure** to enable greater penetration of renewable energy and storage to be installed on campus, and strengthen steps towards electrification.
- **Using the Curtin campus to stabilise the South West Interconnected System** in the context of increasing penetration of household rooftop solar systems, including through on-campus energy storage and flexible demand.
- **Pursuing green PPAs or offsetting emissions** to rapidly decarbonise while allowing time for upgrade of the campus voltage network infrastructure, which includes pursuing opportunities to generate nature-based carbon offsets.
- **Increasing renewable energy generation on campus** through creative use of campus space, including carparks.
- **Establishing a virtual microgrid** with surrounding household rooftop PV systems.
- **Electrification** to removing natural gas as an energy source where possible.
- **Establishing living laboratories** using existing industry partnerships and research funding sources to engage in practical, real-time teaching and research projects, and investigate scalable net zero initiatives.

Challenges and future research opportunities

The project identified a number of key challenges and future research opportunities to create new knowledge and innovations, and to demonstrate additional pathways to decarbonisation. These include:

1. Developing and implementing several key net zero opportunities identified across both UTS and Curtin University, including:
   - Electrification at both UTS and Curtin University, using a step-wise approach involving decentralisation, smaller trial projects, establishment of partnerships, and further development of suitable technologies and products.
   - Investigating the role of Curtin University in stabilising the Southwest interconnected System (SWIS) electricity grid in the context of substantial local residential rooftop PV capacity.
   - Establishment of one or more living labs at partner universities.
   - Engaging with start-ups to fund specific decarbonisation-related research and commercialisation activities.
2. Exploring ways of providing suitable incentives to add complementary 'impact' value for other stakeholders in project design, and incentivising more impactful steps to transition the energy system through mechanisms such as PPAs and time-stamped LGCs.
3. Testing the strategy development process and net zero narrative across a range of organisations, and updating the process as required.
4. Supporting businesses and other organisations and precincts in meeting their net zero objectives through:
   - building capacity to address internal resource limitations that constrain the ability of businesses to address the net zero challenge
   - streamlining net zero responses through building a database of knowledge, case studies and other guidance to help businesses more easily identify opportunities, streamline their implementation, and reduce perceived risks
   - finding pathways to scale net zero solutions
   - exploring regulatory, policy and market mechanisms to innovate incentives and drive investment in energy storage and flexible demand
   - strategising net zero responses to manage climate and carbon risks through innovation to drive competitive advantage.

Contents

Glossary of terms

A2EP	Australian Alliance for Energy Productivity
aCCU	algal carbon capture and use
ACCU	Australian Carbon Credit Unit
AD	anaerobic digestion
ARENA	Australian Renewable Energy Agency
AS/NZS	Australian Standard/New Zealand Standard
ATN	Australian Technology Network of Universities
BRC-A	Business Renewables Centre Australia
CBD	central business district
CEFC	Clean Energy Finance Corporation
CER	certified emissions reduction
CHP	combined heat and power
CIL	Climate Impact Lab (UTS)
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
COP	coefficient of performance
COP26	26th United Nations Climate Change Conference
CRC	Cooperative Research Centre
CSJI	Centre for Social Justice and Inclusion (UTS)
CUSP	Curtin University Sustainability Policy Institute
CWB	community wealth building
DAB	Faculty of Design, Architecture and Building (UTS)
DAC	direct air capture
DCJ	NSW Department of Communities and Justice
DPIE	NSW Department of Planning, Industry and Environment
EACs	energy attribution certificate
ESG	environmental, social and corporate governance
ERF	Emissions Reduction Fund
ETS	Emissions Trading Scheme
EVs	electric vehicles
GBCA	Green Building Council of Australia
GDP	gross domestic product
GEEP	green electric energy park
GET	Glebe Energy Transitions
GHG	greenhouse gas
HFC	hydrofluorocarbon
HIVE	Hub for Immersive Visualisation and eResearch (Curtin University)
HPWH	heap pump water heater
HVAC	heating, ventilation and cooling
IEA	International Energy Agency
IFRS	International Financial Reporting Standards
IPCC	Intergovernmental Panel on Climate Change
ISF	Institute for Sustainable Futures (UTS)

IT	information technology
kW	kilowatt
kWh	kilowatt-hour
LCA	life cycle analysis
LED	light emitting diode
LGC	Large-scale generation certificate
MJ	megajoule
MW	megawatt
MWh	megawatt-hour
NGA	National Greenhouse Accounts
NSW	New South Wales
NZI	Net Zero Initiative (Monash University)
PF&D	Properties, Facilities and Development (Curtin University)
PPA	power purchasing agreement
PRME	Principles for Responsible Management Education
PV	photovoltaic
QS	Quacquarelli Symonds
RACE for 2030	Reliable Affordable Clear Energy for 2030 Cooperative Research Centre
RECs	renewable energy certificate
RMIT	Royal Melbourne Institute of Technology (now RMIT University)
SaaS	Software as a Service
SBTi	Science Based Targets initiative
SDG	(United Nations) Sustainable Development Goal
SDSN	Sustainable Development Solutions Network
SWIS	South West Interconnected System
TDI	Faculty of Transdisciplinary Innovation (UTS)
TEA	technoeconomic analysis
trigen	trigeneration
ULL	urban living laboratory
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UTS	University of Technology Sydney
V2H	Vehicle-to-Home
VER	voluntary emissions reduction
VPO	voltage power optimisation
VPP	virtual power plant
WA	Western Australia
WAIT	Western Australian Institute of Technology
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
WWF	World Wide Fund for Nature

1 Introduction

1.1 What is RACE for 2030?

The Reliable, Affordable, Clean Energy for 2030 Cooperative Research Centre (RACE for 2030) is an industry-led research collaboration to drive energy innovation across the supply chain to deliver improved, lower cost and lower emission energy services for energy customers. RACE for 2030 will increase distributed clean energy uptake by increasing load flexibility and support the growth of Australian energy technology businesses. RACE for 2030's research outputs will be driven into the market through market transformation programs to deliver the targets of:

- reducing energy costs
- cutting carbon emissions
- increasing customer load flexibility to allow increased penetration of renewables in the grid and increased reliability
- increasing clean energy jobs.

This cross-sectoral project intersects with a number of the key research themes of RACE for 2030, including:

- Theme B4—Flexible demand and demand control
- Theme B5—Anaerobic digestion for electricity, transport and gas
- Theme H4—Rewarding flexible demand: Customer-friendly cost reflective tariffs and incentives
- Theme H5—Smart algorithms for optimising home energy supply and use
- Theme E2—Innovative foresighting and planning
- Theme E3—Developing the future energy workforce.

In 2021, RACE for 2030 also adopted four cross-sectoral strategic challenges:

1. **Minimum Demand**—Optimising use of rooftop solar, while supporting grid security.
2. **EV Integration**—Accelerating smart charging of electric vehicles (EVs), Vehicle-to-Home (V2H) and two-way charging.
3. **Millions of Homes**—Retrofitting homes at scale to increase comfort, lower energy bills, and lower emissions.
4. **Net Zero Pathways**—Pathways to decarbonise enterprises and value chains.

This project closely aligns with the **Net Zero Pathways** challenge, which aims to identify and facilitate clear pathways to decarbonise enterprises and value chains, and fund research to solve key decarbonisation challenges.

1.2 Project rationale

This project set out to identify how net zero and decarbonisation strategies can more deeply engage community and business partnerships to deliver greater trust, legitimacy and social value. While the focus of the project was on university-based precincts with strong links to energy innovation, the project outputs are intended to be broadly applicable to scalable solutions for achieving net zero carbon emissions.

Corporations, institutions and government agencies are now major contributors to emissions reductions and investments in renewable energy resources, such as solar and wind. Such bodies lead the broader community in innovation, demonstrating what can be achieved by using renewable energy and other strategies to reduce emissions. While large organisations can use a wide variety of strategies to meet net zero carbon commitments, the variety of commitments causes confusion for both organisations and the broader community. Some strategies lack credibility, leading to a deficit of stakeholder trust.

Although large institutions must move towards delivering broad social and environmental value, the economic stress induced by the COVID-19 pandemic makes this more difficult, as capital is constrained and businesses withdraw to their core functions. A more sophisticated understanding is needed to develop net zero strategies that deliver credible and deeper long-lasting community benefits.

Universities are well established public-benefit institutions deeply embedded within geographic, innovation and thought-leadership communities. Several Australian universities are already undertaking important strategic projects to reach net zero and SDG targets within their operations (see Section 2.11). To support such strategic shifts, this project identifies how net zero strategies can be delivered through deep stakeholder engagement, drawing on unique features of organisational character and applying a Community Wealth Building (CWB) framework, where universities feature as core anchor Institutions for socially-focused local economic recovery within a defined region. The result is a roadmap for developing inclusive business cases that more deeply intersect with organisational objectives and strengthen economic participation, stimulating a 'Green Wave' to deliver complementary social and environmental value beyond each organisation's boundaries.

The three participating universities for this project are each on a journey towards net zero emissions. Each began and ended this project at a different position in terms of its strategy development, as illustrated in Figure 1.

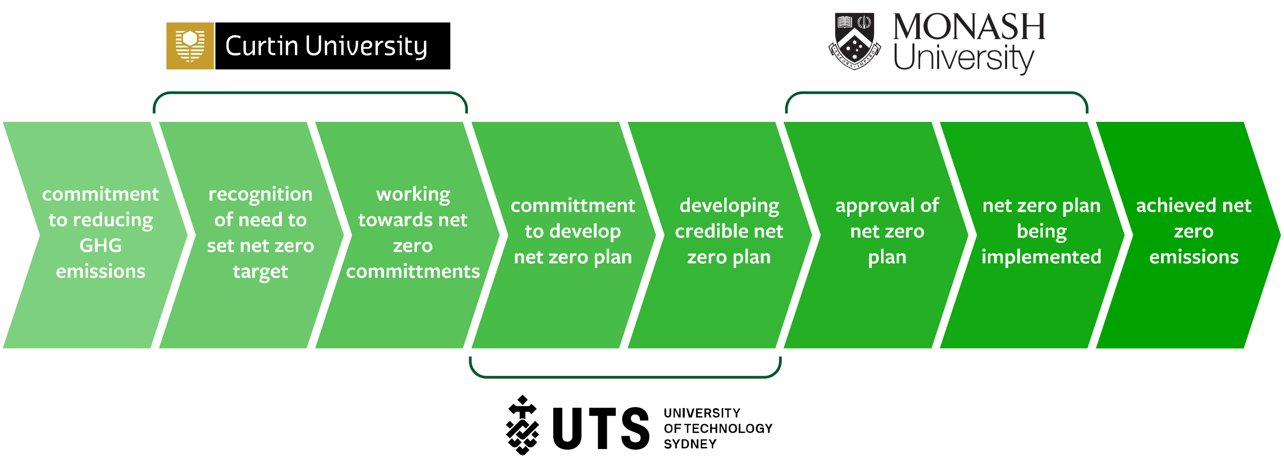


Figure 1. University net zero positions. The three participating universities began this project at different positions on their journey towards net zero emissions.

In 2017, Monash University committed to its Net Zero Initiative[1] (see Section 3). UTS and Curtin University have not yet announced any firm net zero commitments, although UTS has approved development of a net zero plan, to which this project has made significant contributions (see Sections 4, 6.1, 7, 8.1 and 9.1–9.6). Curtin University has also commenced preliminary work towards development of a net zero strategy in the context of this project (see Sections 5, 6.2, 8.2 and 9.7–9.9).

[1] monash.edu/net zero-initiative

2 Net zero and project context

2.1 Paris Agreement

In 2015, over 190 countries, including Australia, the USA and China, signed the Paris Agreement to limit global warming to well below 2°C above pre-industrial levels, aiming for 1.5°C (IPCC, 2018). Australia has committed to contribute towards the global goal of reaching net zero emissions by mid-century. Since 2015, there have been an increasing number of countries and companies committing to net zero targets.

IEA's special report took stock of these pledges. As of 23 April 2021, 44 countries and the European Union have pledged to meet a net-zero emissions target: in total they account for around 70% of global CO_2 emissions and GDP. Of these, 10 countries have made meeting their net zero target a legal obligation, eight are proposing to make it a legal obligation, and the remainder have made their pledges in official policy documents. Furthermore, around 110 companies that consume large amounts of energy directly or produce energy-consuming goods have announced net-zero emissions goals or targets. Companies that have announced net-zero emissions targets account for about 60–70% of global production of heating and cooling equipment, road vehicles, electricity and cement. Nearly 60% of gross revenue in the technology sector is also generated by companies with net-zero emission targets. In other sectors, net zero pledges cover 30–40% of air and shipping operations, 15% of transport logistics and 10% of construction (IEA, 2021).

2.2 Defining net zero

This report uses the phrase *net zero* throughout. According to the IPCC SR15, "Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon)" (IPCC, 2018).

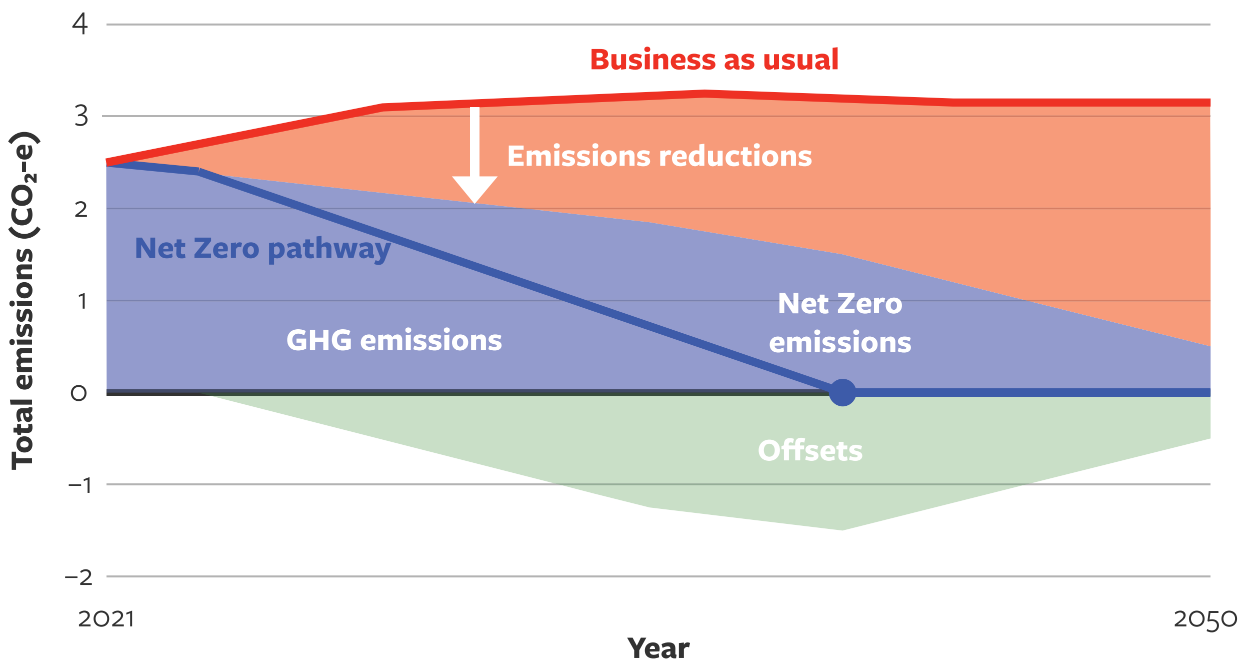


Figure 2. Example net zero pathway. A typical net zero pathway involves reducing and avoiding GHG emissions from a 'business as usual' scenario, and offsetting residual emissions to reach net zero GHG emissions by a target date.

Net zero is akin to *climate neutrality*. The similar term *carbon neutral* is now generally perceived as having more negative connotations, because of its historical association with strategies that focus on carbon offsets, whereas *net zero* implies prioritising actions that reduce emissions before considering offsets. *Net zero* is also the current preferred terminology for international agreements and Australian state policies, including those of Victoria and NSW (ClimateWorks Australia, 2017, p. 4).

There are also various definitions of what terms such as *net zero*, *carbon neutral* and *climate positive* mean in practice, in terms of both their scope and compatibility with the Paris Agreement.

2.3 Scope of emissions

For a company or other reporting entity, greenhouse gas emissions are classified as either Scope 1, Scope 2, or Scope 3, depending on their source. These classifications were defined by methodologies of the Greenhouse Gas Protocol, originally developed 20 years ago by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) (WRI & WBCSD, 2004).

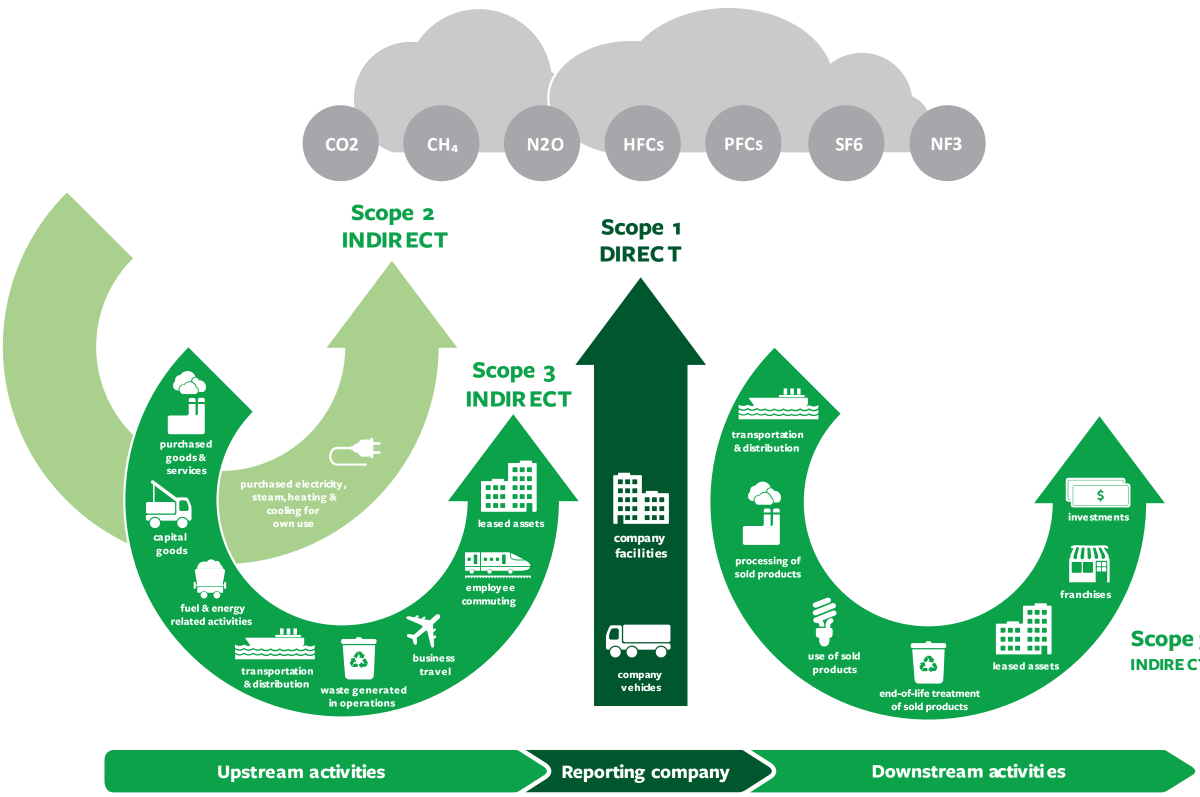


Figure 3. Emissions scope. For a company or other reporting entity, GHG emissions are classified as either Scope 1 (direct), Scope 2 (indirect from purchasing of electricity, steam, heating and cooling), or Scope 3 (upstream and downstream supply chain emissions), depending on their source. Source: WRI & WBCSD (2013).

Scope 1 emissions are direct emissions by the reporting entity, such as burning of fossil fuels or emissions of other GHGs. Examples include on-site burning of natural gas for heating, vehicle fleet emissions and leakage of refrigerant gases.

Scope 2 emissions are indirect emissions from purchased energy services—predominantly electricity, but also steam, heating and cooling for own use. While Scope 2 emissions for a reporting entity can be thought of as Scope 1 emissions for an energy service provider, they are typically not considered this way to prevent double counting.

Scope 3 emissions are all other upstream and downstream emissions from a reporting entity's value chain, but which are out of the organisation's direct control. Examples of upstream emissions include:

- purchased goods and services
- capital goods
- fuel and energy-related activities
- transportation and distribution of inputs
- waste generated in operations
- business travel
- employee commuting
- leased assets.

Examples of downstream activities include:

- transportation and distribution of outputs
- use of sold products
- end-of-life treatment of sold products
- leased assets
- franchises
- investments.

Many net zero pledges cover only Scope 1 and 2 emissions, while others only include some limited Scope 3 emissions. This is partly because of the difficulties and complexities of measuring and accounting for Scope 3 emissions. There are many potential sources of Scope 3 emissions, some of which can be difficult to measure. There are also challenges in defining supply chain boundaries. And there is the problem of double counting. The Scope 3 emissions of a reporting entity are the Scope 1 or 2 emissions of some other entity in the supply chain. According to Michael Liebreich, "Scope 3 emissions look more like collective punishment than an accounting system. What is needed is a way of allocating responsibility to specific players in an economic activity, which will generally be the first player in the supply chain who could have avoided causing them, but did not do so" (Liebreich, 2021).

While most net zero pledges cover all GHG emissions, there are some exemptions. New Zealand's pledge does not cover biogenic methane. Some countries, such as France, Portugal and Sweden, exclude international aviation and shipping.

There is now a long-term shift from vague and voluntary ESG reports to quantified and regulated financial statements. The International Financial Reporting Standards (IFRS) Foundation is now consulting on a new Sustainability Standards Board, which it may announce during COP26 in November 2021.

2.4 Carbon offsets and carbon credits

A carbon offset is an investment in an activity that reduces carbon emissions. The reduction in carbon emissions is represented by a *carbon credit*. The credit, usually verified by a third-party auditor to ensure it meets some minimum standard, signifies that greenhouse gas emissions are lower than they would have been had no one invested in the offset. One credit equals one metric tonne of carbon dioxide prevented from entering the atmosphere. The credit purchaser can use the credit for carbon accounting.

Valid carbon credits must meet the following five criteria:

1. **Measurability**—The emissions reduction must be capable of being measured using some standardised method.
2. **Verifiability**—The emissions reduction must be capable of being verified by a reliable and independent auditor.
3. **Additionality**—The investment creating the carbon credit must produce an emissions reduction that is over and above what would have occurred had the investment not been made. That is, the emissions reduction must be additional to the counterfactual 'business as usual' scenario.
4. **Leakage prevention**—Emissions cannot simply be moved somewhere else, such as another country outside the reporting regime.
5. **Permanence**—Sequestered carbon must be kept out of the atmosphere for a reasonable length of time. For example, a forest used to sequester carbon must be protected from fires or decay that might release that carbon back into the atmosphere.

2.4.1 Abatement versus carbon sequestration

Carbon offsets can be classified as **avoided emissions** (abatement) or **carbon sequestration**. Avoided emissions are emissions that *would have occurred* had a specific investment not been made. For example, Google invests in capturing methane from landfill and agricultural sites, and uses this to offset its residual emissions.

Carbon sequestration, in contrast, involves physically removing carbon dioxide from the atmosphere, for example through carbon sinks such as forests and soils, as well as technological solutions, such as direct air capture or bioenergy with carbon capture and storage.

2.4.2 Compliance versus voluntary carbon credits

There are two types of carbon credit:

- **Certified emissions reduction** (CER)—these are created through a regulatory framework and involve a third-party certifying body and are sometimes required to be purchased as part of a mandatory regime, such as the European Union Emissions Trading Scheme (ETS).
- **Voluntary emissions reduction** (VER)—A carbon offset that is exchanged in the over-the-counter or voluntary market for credits, which can be used for the purposes of ESG accounting.

In Australia, the VER market remains relatively small.

2.4.3 Emissions Reduction Fund

In 2011, following repeal of the carbon price, the Australian government established the Emissions Reduction Fund (ERF) with an initial investment of A$2.55 billion. Designed to reduce Australia's GHG emissions largely through carbon offsets, the fund allows farmers, businesses and traditional custodians using a government-approved carbon farming method to register carbon farming projects and then bid to be part of the fund in periodic reverse auctions. Each bid involves a proposal to reduce emissions by a specified amount using the approved carbon farming method over a set time period (1–10 years). If successful, the project owner enters into a contract and is paid a fixed amount for each Australian Carbon Credit Unit (ACCU) they deliver, once the projects' emissions reductions have been achieved and verified. Each ACCU is equivalent to one tonne of CO_2 equivalent avoided or stored in the land.

The future of the ERF remains uncertain. A majority of the initial A$2.55 billion allocation has now been spent. Since its inception, about 95% of ACCUs sold have been bought by the Australian Government. However, between the 2017 and 2020 reviews of the ERF by the Climate Change Authority, no new significant amounts of abatement were contracted. The resulting uncertainty has affected confidence in future demand and impeded decisions to develop new abatement projects (CCA, 2020).

2.4.4 Carbon offset quality, credibility and transparency

There is much debate about the quality and credibility of carbon offsets, the transparency of those buying and selling them, and their role in global pathways to net zero. Wood *et al.* (2021) describe carbon offsets as "a difficult part of the net-zero conversation". At one extreme, carbon offsets have been likened to Roman Catholic indulgences, since they allow polluters to buy absolution rather than reducing their emissions (Monbiot, 2006). A less extreme view is that a credible net zero plan should use them as a 'last resort', investing in emissions reducing activities first and offsetting last, as per the SBTi standard outlined in Section 2.7 and the waste hierarchy principle outlined below.

The waste hierarchy is a commonly-applied tool that can be used to evaluate and prioritise processes to protect the environment and conserve resources, ranking actions from most to least favourable. This is typically presented as an inverted pyramid, as shown in Figure 4 below. This approach emphasises integrated as opposed to technical end-stage solutions. When applied to greenhouse gas emissions, offsets sit at the very bottom.

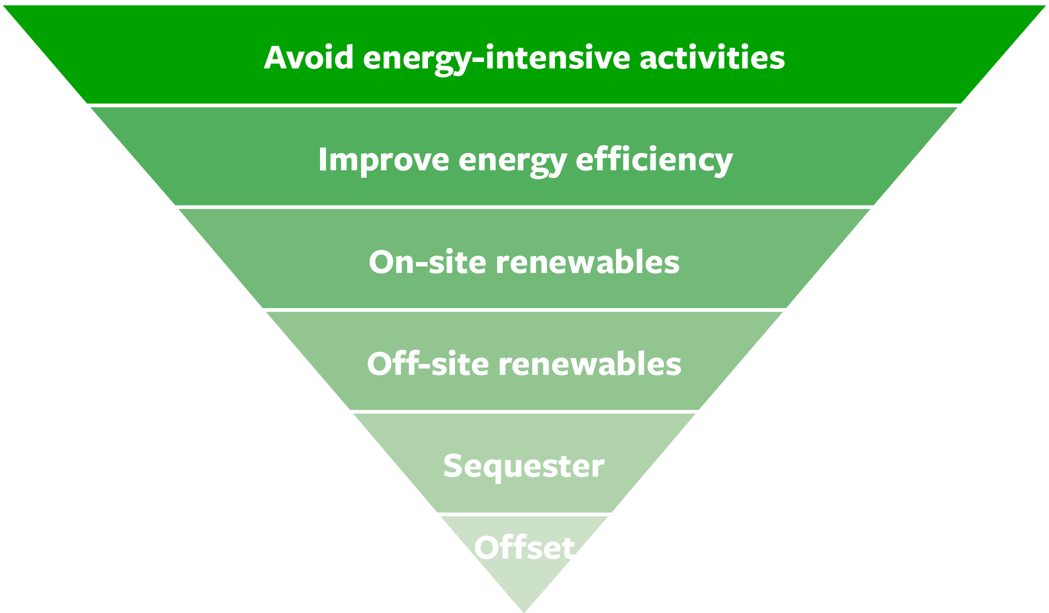


Figure 4. An energy waste hierarchy. Applying the waste hierarchy to energy favours strategies that reduce consumption of energy while placing offsets at the very bottom.

Using avoided emissions as offsets is also problematic. While avoided emissions can, at least in the short term, assist with putting the world on a path towards net zero emissions, it is clear that global net zero will never be achieved if a large proportion of reporting entities are relying on avoided emissions.

Additional criticisms of offsets include:

- **Lack of regulation**—There is no single standard governing the voluntary market, and some offset providers have been criticised on the grounds of claims being misleading, exaggerated, or failing to meet key criteria such as additionality or permanence.
- **Timing**—Projects such as tree planting may involve 'forward selling' carbon offsets despite the trees taking several decades to mature.
- **Permanence**—The permanence of a carbon sequestration activity may be difficult to guarantee. Forests, for example, are susceptible to future clearing or burning.
- **Perverse incentives**—Some offset schemes have created perverse incentives. For example, one Chinese company generated $500 million in carbon offsets by installing a $5 million incinerator to burn hydrofluorocarbons (HFCs). This provided an incentive to increase production of HFCs solely for the purpose of burning them and generating offsets (Bradsher, 2006).
- **Efficiency**—Not all of the money invested in carbon offsets goes towards reducing carbon emissions, with a portion required for administration and profits for a scheme's operators.

Given the lack of standards, there is wide variation in the quality of voluntary carbon credits. Higher quality credits carry labels such as *Gold Standard* or *Fair Trade*, meaning they are both audited and deliver on various Sustainable Development Goals (SDGs). UTS's Institute for Sustainable Futures, for example, currently purchases Gold Standard carbon credits from South Pole to offset its flight emissions. These credits involve investments in wind power projects in Taiwan and conservation projects in Australia, providing both emissions abatement and protection of biodiversity.

Rogelj *et al.* (2021b) and Wood *et al.* (2021) each call for greater transparency around offsets. They identify a number of risks associated with offsets projects, such as knock-on impacts of agricultural offsets, risks of fire to forests, and withdrawal of social licences to operate, and propose that net zero declarations should say how these risks will be managed.

2.5 EACs, RECs, LGCs and PPAs

For over 20 years, various systems of Energy Attribute Certificates (EACs) have been in use around the world, allowing consumers to choose one form of electricity over another. EACs work by tracking the attributes of electricity generation separately from physical power delivery, thereby allowing the owner of the certificate to claim use of that unit of energy generation (EnergyTag, 2021). In the case of renewable energy, EACs are commonly referred to as Renewable Energy Certificates (RECs). Each REC represents one unit of renewable electricity generation.

RECs are now widely used for purchasing of renewable energy, for greenhouse gas reporting and for various government mandates. As more organisations have become interested in sustainability, the use of RECs has increased substantially. For a reporting entity to procure renewable energy and claim this publicly, it needs to purchase and retire a certain number of RECs. If there is an under supply of RECs, the price should rise to drive more investment in new wind, solar or other renewables projects. In Australia, RECs are now known as large-scale generation certificates (LGCs), each representing 1 MWh of renewable electricity.

RECs are typically represented as electricity offsets. For example, a reporting entity might invest in on-site rooftop solar to reduce its total electricity demand, then purchase RECs to offset their residual usage, allowing them to claim their electricity is 100% renewable. Australia also operates a GreenPower accreditation program, which allows electricity retailers to apply RECs (LGCs) on behalf of their customers, allowing them to effectively make claims for supplying renewable electricity.

An alternative model for purchasing renewable energy is the corporate power purchasing agreement (PPA). Although there are various types of PPA, the simplest is the direct PPA, which involves a large energy user contracting directly with a renewable energy project developer, such as a solar farm. The PPA model allows the energy user to obtain renewable energy at a guaranteed price while guaranteeing offtake for the project developer, thereby allowing both parties to reduce future price risks.

In addition to state government purchasing, corporate PPAs are now the main drivers for renewable energy investment in Australia. While GreenPower and RECs provide some incentives to invest in new renewable energy capacity, the shift away from them towards direct PPAs is being driven by several limitations. A BRC-A draft discussion paper on best practice PPAs (BRC-A, 2021) lists four such limitations:

- **Limited financial benefit**—RECs on their own (as in the case of GreenPower) are a cost, with no direct financial return on investment and which do not tap into the increasing commercial viability of wind and solar.
- **Weak market signal**—Wind and solar farms are long term assets requiring 10–15-year loans to compete with existing (coal and gas) generation. A short-term, high REC price does not give long-term revenue confidence to banks to finance new projects.
- **No tangibility**—If RECs are purchased on the open market, the buyer does not have a link to a particular wind or solar project to demonstrate the impact of their investment.
- **Not scalable**—While one organisation may be committed to paying more to be renewable, it is hard to convince all corporates and institutions to do this.

PPAs are not without their challenges. They can be complex and difficult to understand, making execution difficult within buyer organisations. They also take time, with almost half of buyers surveyed reporting lead times of 18 months or more (BRC-A, 2020).

Both RECs and PPAs are also limited in their ability to transform the electricity system. In addition to new generation capacity, many other technologies and systems are needed to firm this capacity and transform the energy system away from fossil fuels towards 100% renewable energy, including energy storage, electric vehicles (EVs), network upgrades, retailer swaps, flexible demand, and smart control systems. A net zero plan that involves a combination of RECs to offset Scope 2 emissions and carbon credits to offset residual emissions fails to consider investments in supporting systems, such as batteries, since these are largely opaque to existing carbon accounting rules. Emissions reductions from purchasing solar power may be overestimated by as much as 50%, if using annual emissions data for a constant load (de Chalendar & Benson, 2019). This has led some to push for '24/7 renewable' targets, as discussed below.

2.6 24/7 renewables

Many of the first large companies to set and achieve net zero targets are technology firms, such as Google and Microsoft. For example, in 2007 Google became one of the first major companies to become carbon neutral, a position it has maintained ever since.[2] It has done so primarily using a combination of energy efficiency, purchasing renewable energy,[3] and purchasing or creating carbon offsets.

Google and Microsoft, together with a host of other entities, such as IBM, Salesforce, IKEA and the US government, are looking to go beyond net zero or 100% renewable energy targets to source '24/7 renewable'

[2] Scope 1 and 2 emissions, plus partial Scope 3 emissions (travel and commuting).

[3] Effectively offsetting 83% of its location-based Scope 1 and 2 emissions in 2019, and making it the world's largest annual corporate purchaser of renewable energy.

energy, whereby their loads are matched on an hourly basis with carbon-free energy (Miller, 2020). To help achieve this goal, Google, for example, plans to employ flexible demand across its data centres and integrate new technologies such as battery storage. This idea is explored further in Section 9.3.

2.7 Best practice guidelines

While there is much agreement on the urgent need to reduce greenhouse gas emissions, many climate emissions strategies are lacking in detail and transparency, making them difficult to compare (Rogelj *et al.*, 2021b). In addition to clearly specifying which greenhouse gases are being considered, the scope of emissions and the role of offsets, as addressed above, a credible emissions reduction plan should address other important questions, such as fairness, risk and interim targets.

The Science Based Targets initiative (SBTi) is a partnership between the UK-based non-profit organisation CDP (formerly the Carbon Disclosure Project), the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). The SBTi provides a framework and tools for companies to set 'science-based' net zero targets, meaning targets that conform with clearly-defined pathways to reduce emissions in line with the Paris Agreement goals.

In October 2021, SBTi developed and launched the world's first net zero standard covering Scope 1, 2 and 3 emissions.[4] There are four key requirements of the SBTi net zero standard, namely:

1. **Focus on rapid, deep emission cuts**—This is the overarching priority of the standard, with most organisations requiring deep decarbonisation of 90–95%.
2. **Set near- and long-term targets**—This means setting both near-term and long-term science-based targets, such as rapid emissions cuts now, halving emissions by 2030, and producing close to zero emissions by 2050, with offsets used only for residual emissions that cannot be eliminated.
3. **No net zero claims until long-term targets are met**—An organisation can only be considered to have reached net zero when it has achieved its long-term science-based target.
4. **Go beyond the value chain**—SBTi recommends making additional investments to help mitigate climate change elsewhere, in addition to deep cuts in their value chain emissions, but not instead of them.

For most organisations, this seems likely to become the de facto framework standard for setting net zero targets. Rogelj *et al.* (2021a) also provide 10 guidelines for rigorous and clearer emissions reductions targets. These are listed below.

I. Scope of target

I.1 Define the global climate goal that the individual net zero target contributes to. Which maximum global temperature level? Peaking and declining, or stabilising global temperature?
I.2 Define by when net zero is intended to be achieved. Which year or multi-year period? Over which period is net zero calculated?
I.3 Define the emissions that are covered by the individual net zero target. Which gases? All greenhouse gases covered under the Paris Agreement? A subset, or CO_2 only?
I.4 Define which emissions metric is used to aggregate greenhouse gas emissions to assess net zero. The Paris Agreement's default GWP-100 metric or an alternative? And why?

4 sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf

I.5 Define the boundaries or scope of the emissions covered by the net zero target. Which territory? Which entities? Which activities? Including indirect as well as direct emissions?

I.6 Describe the expected contribution of direct CO_2 removals and/or offsets to achieve the net zero target. What is the share of gross emissions reductions and CO_2 removal by the entity that sets the target? How much is offset with mitigation projects carried out beyond the jurisdiction of a country or outside the direct control of an organisation?

I.7 Clarify how direct CO_2 removal and/or offset options included in the net zero target will deliver. Which contributions from which kind of project? How is permanence of CO_2 removals (including for offsets) ensured? How do these options deliver net emissions reductions with high environmental integrity?

II. Adequacy and fairness

II.1 Justify how your target is a fair and adequate contribution to the global climate goal. Which fairness principles are applied? What are the implications if everybody were to follow the same principles (both for global emissions reductions and for actions needed by others to achieve the global goal)? How does this deliver the global climate goal (defined in I.1)?

III. Long term roadmap

III.1 Describe the trajectory and implementation plan to reach the net zero target. What are key milestones? Which policies will be implemented to achieve them?

III.2 Describe the vision for your emissions trajectory after reaching your net zero target. Maintain net zero afterwards, or go net-negative?

2.8 The university as an anchor institution

An anchor institution is a large organisation with a well-defined purpose and strongly connected to a specific place. This connection is at least partially related to its portfolio of infrastructure and assets, which require the institution to commit to that place for the long term (McNeill *et al.*, 2020). Typical examples of anchor institutions include universities, hospitals, local governments, community housing providers, sports teams and cultural organisations. Anchor institutions are typically among the largest employers and spenders in a place.

> *When Anchor Institutions align their resources and strategies to benefit the communities in which they are anchored, the potential community impacts and societal outcomes are significant.*
>
> —(McNeill *et al.*, 2020, p. 6)

This project draws on the idea of the university as an anchor institution, and the related idea of Community Wealth Building (CWB), initially developed and promoted by Ted Howard of the Democracy Collaborative in the USA (Fensham, 2020, p. 7). The main aim of CWB is to build a more equitable, democratic economy with new institutions to support social and economic justice, rooted in community-controlled land and enterprises. When adapted to a university, the university features as an anchor institution for socially-focused local economic recovery within a defined region.

The five main 'pillars' of CWB are (Fensham, 2020, p. 10):

1. **Progressive procurement of goods and services**—that is, using the procurement processes and decision making of anchor institutions to expand local supply chains and encourage socially-beneficial business development, spending and investment.
2. **Fair employment and just labour markets**—that is, anchor institutions providing decent wages and conditions to their employees.

3. **Socially productive use of land and assets**—where anchor institutions are major land holders, using land and property in ways that generate wealth and benefits for local citizens.
4. **Making financial power work for local places**—by harnessing and investing the wealth and savings of local communities, for example through mutually owned banks.
5. **Plural ownership of the economy**—for example using business ownership models that build local wealth, such as cooperatives, mutually-owned businesses, SMEs and municipally-owned companies.

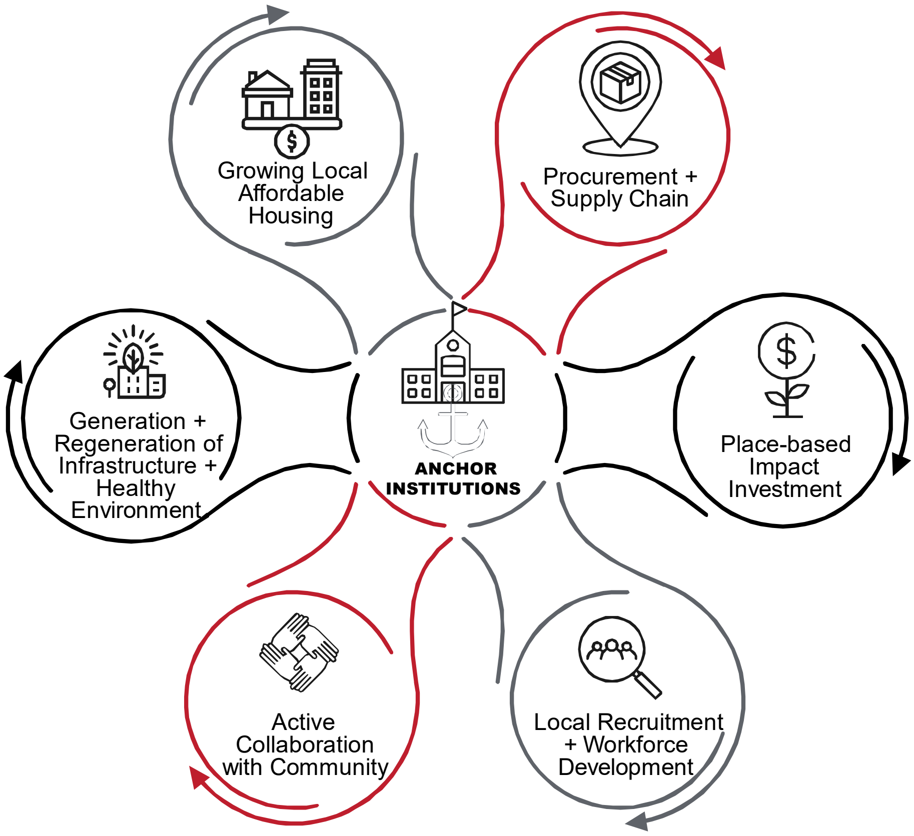


Figure 5. The strategic activity domains of an anchor institution. Anchor institutions include at least six strategic activity domains through which they can support the places and communities in which they operate. Universities include an additional two specific activity domains: research and learning and teaching. Source: McNeill *et al.* (2020).

2.9 The university as a living laboratory

Urban Living Laboratories (ULLs) enable participants to design, test and learn through experimentation in real world contexts (von Wirth *et al.* 2019). ULLs are embedded sites for exploring complex urban challenges and potential solutions where diverse sets of actors are empowered to address specific challenges at a more 'manageable scale' (Voytenko *et al.*, 2016, p. 47). Various universities including Harvard, Stanford and Delft have used their campuses as living labs for sustainability to enable new practices and infrastructure. Universities as living labs provide integrated approaches to test and learn across systems through green building design, renewable energy, and mobility solutions. University living labs also provide leadership at precinct scale by facilitating multi-stakeholder governance across a complex mix of urban infrastructures, planning schemes and future visions (Sharp & Raven, 2021). According to Verhoef & Bossert (2019), "University communities are excellent venues for testing, accelerating, and scaling solutions [and] have an astounding capacity to contribute to achieving global sustainability goals and to CO_2 emission reduction."

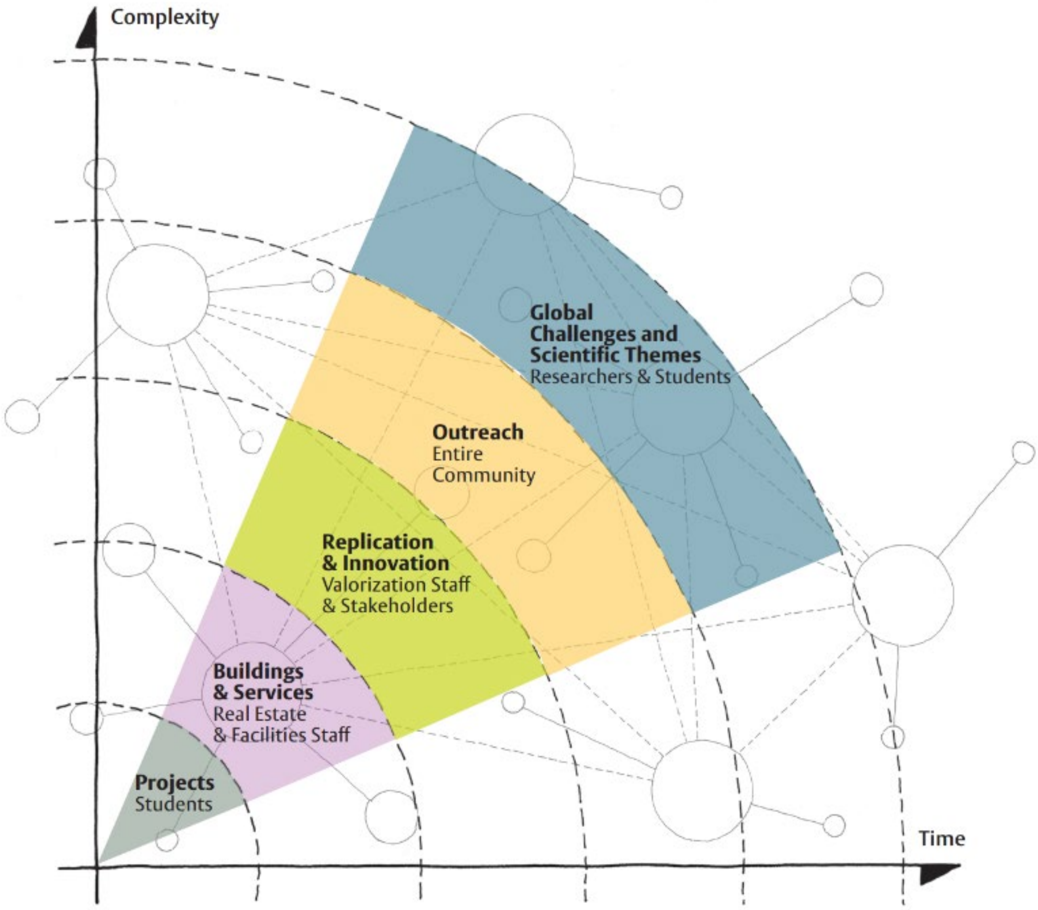


Figure 6. The living lab model of Verhoef & Bossert (2019).

Monash University is using its domestic campuses as living labs for sustainability, with a primary focus on the Clayton campus. It is researching, developing and implementing its Net Zero Initiative (NZI) through a range of socio-technical innovations, with a view of both learning how to do organisational decarbonisation and with an ambition to shape best practice in the transition towards net zero emissions in Australia and globally.[5] The NZI is envisioned to be replicated by other universities and organisations within and beyond the local precinct level. The NZI provides the opportunity to research how new technologies, governance arrangements, policies, business models and behavioural interventions can be translated and scaled to accelerate urban decarbonisation efforts through socio-technical innovations deployed on site (see Section 3). The related Net Zero Precincts ARC Linkage project brings together a new approach to transition management, by using design anthropology to engage with the Monash precinct community and consider their lived experiences. This will be tested over 2021–2025 through action-oriented living lab experiments at precinct scale across energy, mobility, buildings, local governance and data.[6]

5 monash.edu/net-zero-initiative

6 monash.edu/msdi/research/project-pages/net-zero-precincts

2.10 Control, influence and impact

Institutions such as universities play a unique role in addressing the net zero challenge. Unsurprisingly, large institutions such as universities typically have correspondingly large carbon footprints, and those that address their own Scope 1, 2 and 3 emissions are able to demonstrate leadership in decarbonisation. However, far greater impacts can be achieved by seeking to influence the emissions of those within the institution's sphere of influence (Figure 7). For a university, this sphere includes its students, staff, local community, local businesses, supply chain partners, research-focussed industry partners, networks and policymakers.

By integrating net zero and other sustainability themes into their two core businesses—research and education—universities can extend their impact through:

- engaging students in understanding the climate challenge, building motivation and the next generation of leadership
- teaching the skills and building the capacity required to address the climate challenge
- fostering interdisciplinary and transdisciplinary research collaboration to develop practical and innovative climate change solutions
- informing and improving the work of policymakers.

Figure 7. Spheres of influence. Institutions such as universities play a unique role in addressing the net zero challenge. Rather than simply reducing their own Scope 1, 2 and 3 emissions, by integrating net zero into their core businesses of research and education, they can have far greater impact by influencing emissions well beyond their boundaries—what might loosely be called Scope 4 emissions.

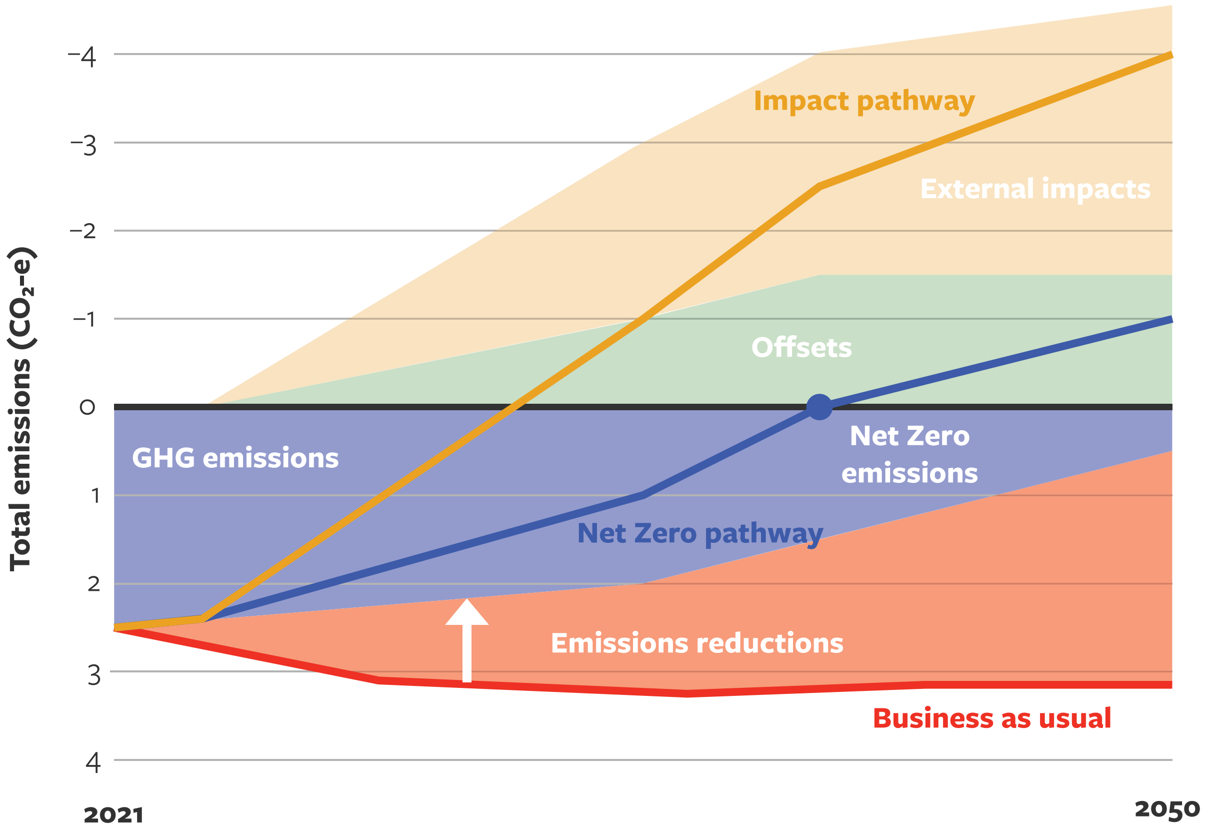


Figure 8. An example impact pathway for reducing emissions. By looking beyond their own net zero pathway, and the emissions reductions and offsets required to achieve it, universities can plot an 'impact pathway' that accelerates global emissions reductions.

2.11 Review of net zero policies of Australian universities

As part of this project, we undertook a review of Australian universities and their net zero strategies. Information was obtained from energy plans published on the websites of individual universities in addition to organisations including 100% Renewables (100percentrenewables.com.au) and Reenergise (reenergise.org), which have been tracking the targets of universities.

Australian universities have been discussing reductions in their carbon emissions for over a decade, with many implementing energy efficiency measures and renewable energy systems on their campuses. These measures originally contributed to carbon neutrality targets, which in recent years have transitioned to net zero targets. The net zero initiatives currently being undertaken by most Australian universities are similar to those of other organisations worldwide, with only some deeply engaging with the unique role of universities, as outlined in Section 1.2, in the implementation of their targets.

There is a lack of publicly available information on the scope for these targets. We assumed published targets apply only to Scope 1 and 2 emissions (see Section 2.3), unless otherwise stated. As of February 2021, 23 of 40 universities in Australia have committed to some form of climate action target (100% Renewables, 2021). A summary of 12 Australian universities is provided in Table 1, which includes the target dates for their net zero and/or 100% renewable energy targets, and if power purchase agreements (see Section 2.5) or offsets are used to reach those targets.

Many Australian universities have undertaken detailed carbon accounting to be able to accurately understand their emissions profile and make commitments to emissions reductions. Two Australian universities, Charles Sturt University and the University of Tasmania, are Climate Active (climateactive.org.au) certified, while some are partnered with the Race to Zero Campaign of the United Nations Framework Convention on Climate Change (UNFCCC) or the UN Sustainable Development Goals (SDGs). The use of Green Star certification for buildings and campuses is also popular.

Table 1. The net zero and renewable energy targets of 12 Australian universities. Also shown are their use of power purchasing agreements (PPAs) and offsets. UTS and Curtin University are yet to formally adopt targets and are therefore not included. Compiled from publicly available data, October 2021.

University	Net zero or carbon neutral target	100% renewable energy target	PPAs	Offsets
Charles Sturt University	2015	2030	Yes	Yes
University of Tasmania	2016	2016	–	Yes
Australian National University	2025	2025	–	Yes
Swinburne University	2025	2020	Yes	–
University of Newcastle	2025	2020	Yes	–
Australian Catholic University	2030	2021	Yes	–
Deakin University	2030	2025	Yes	Yes
Monash University	2030	2030	Yes	Yes
University of Melbourne	2030	2021	Yes	Yes
University of Sydney	2030	2025	–	–
University of Western Australia	2030	2025	Intention	Intention
Western Sydney University	2030	2021	–	–

In addition to setting net zero and renewable energy targets, some common themes emerged from the net zero plans of Australian universities for addressing Scope 1 and 2 emissions. These include:

- detailed monitoring of campus energy use
- energy efficiency upgrades to campus buildings
- load shifting
- use of thermal cooling and heating systems
- installation of renewable energy systems, usually solar photovoltaics (PV), on campus buildings.

While many campuses use natural gas in their heating and cooling systems, in many cases this is either being replaced or emissions offset. The use of gas in laboratories for research and teaching purposes is seldom discussed. Many universities have also invested in off-site renewable energy schemes, particularly to overcome barriers such as older buildings, lack of space on campus, or being located in a region with low solar production during winter. Most of the universities researched for this project plan to reach net zero emissions largely through a combination of power purchase agreements (PPAs) (see Section 2.4) and offsets (see Section 2.4).

The commitments of Australian universities to reducing Scope 3 emissions are less clear. Many universities have broad sustainability commitments around waste management, water use, transport and procurement policies. While these commitments rarely discuss specific emissions related to these activities, there are often targets set as a percentage of current levels, which are being measured. The UN SDGs are also often used by universities to highlight their activities and guide action areas. Actions include:

- minimising waste produced on campus
- ensuring waste is recycled or disposed of correctly off campus
- replacing campus fleet vehicles with electric buggies
- installing electric vehicle chargers across campus

- offsetting flight emissions
- including sustainability considerations in all procurement activities.

Some universities have also considered divesting their investments from companies with fossil fuel interests. However, quantifying the required amount of divestment is seldom published.

Finally, some universities have focused on their unique attributes as a research and teaching organisation to differentiate their net zero plan from those of other organisations. The use of campuses as living laboratories to monitor emissions and test initiatives has enabled some universities to decarbonise while also supporting their researchers. Given many decarbonisation activities are driven by the building management departments of universities, specific supports may be required for researchers to engage with these departments to address GHG emissions through proposing and implementing research activities while allowing the core business of the university to continue.

3 Monash Net Zero Initiative

3.1 Genesis

In 2005, Monash University became the first Australian university to commit to an energy reduction target. Monash University launched the Net Zero Initiative (NZI) in 2017, investing $135 million to achieve net zero emissions by 2030 across all four of its Australian campuses—Caulfield, Clayton, Parkville and Peninsula.

The NZI is underpinned by the Monash University Net Zero Emissions Strategy, developed by ClimateWorks Australia in June 2017 (ClimateWorks Australia, 2017), a report which also drew on previous work by ClimateWorks and ANU on *Pathways to Deep Decarbonisation in 2050* (ClimateWorks Australia, 2014).

In 2018 Monash University and ClimateWorks won the United Nations Momentum for Change Award for the NZI, an award that recognises innovative and transformative solutions that address climate change and wider economic, social and environmental challenges, highlighting activities that are moving the world towards a highly resilient, low-carbon future.

Key staff who were interviewed to inform this summary of the history and key lessons from the Monash NZI include Scott Ferraro (Program Director, Net Zero Initiative), Rob Brimblecombe (Manager, Engineering & Sustainability, Buildings and Property Division), Ariel Liebman (Director, Monash Energy Institute) and Jacek Jasieniak (Pro Vice-Chancellor, Research Infrastructure).

Figure 9. Gillies Hall, Monash University. This new student accommodation complex at Monash University's Peninsula campus uses a Passive House-certified design that greatly reduces energy consumption. (Source: Jackson Clements Burrows Architects, Photographer: Peter Clarke)

3.2 Summary of NZI

In 2015, 76% of Monash's total emissions in Australia came from the built environment. The remaining 24% of emissions, consisting of transport, air travel, waste and other Scope 3 emissions, were excluded from ClimateWorks' analysis.

Monash's strategy encompasses five key pillars:

1. **Energy efficiency measures**—such as retrofitting lighting (largely LEDs) and optimising operation and control across 24 buildings.
2. **Campus electrification**—removing gas from the campus energy mix and installing electric transport infrastructure, such as bicycle parking and electric vehicle charging infrastructure. New buildings are net zero ready, with five super-efficient, all-electric buildings with rooftop solar constructed.
3. **Deployment of on-site and off-site renewable energy**—achieved through a PPA with Murra Warra Wind Farm for 33 MW of renewable power and 4 MW of on-site solar generation.
4. **A sustainable microgrid**—a 20-building large microgrid on the Clayton campus will be used to receive and store energy from various renewable energy sources and allow for control of how and when energy is used.
5. **Addressing residual emissions through offsetting**—through (i) reviewing and expanding the role of renewable power purchasing agreements (including investigating new PPA models, such as group-purchasing), and (ii) offsetting residual emissions through verified offsetting.

The ClimateWorks report also included an action roadmap, with recommendations including:

- establishing a long-term net zero emissions target with periodic review
- implementing minimum standards for new builds, retrofits and equipment
- aligning strategic policy with net zero emissions targets
- demonstrating leadership across the national and international university sector
- retrofitting efficient lighting and other equipment, and investing in operational optimisation and control technologies
- expanding renewable energy installation in line with the Renewable Energy Strategy and net zero emissions target
- engaging in large scale off-site renewable energy power purchase agreement
- reviewing and expanding the role of GreenPower agreements
- offsetting residual emissions through verified offsetting
- managing the implementation of efficiency standards for equipment purchasing and end-of-life replacement
- investigating opportunities to partner with emerging technology businesses/research organisations and alternative funding sources, such as ARENA and CEFC
- supporting an on-site dynamic microgrid project that will coordinate multiple sources of energy including renewable generation, allowing Monash to manage how and when energy is used
- installing sustainable transport infrastructure including bike parking and electric vehicle charging infrastructure
- investigating new models for the purchase of renewable energy, such as group-purchasing models.

3.3 Success factors of the NZI

Several key factors led to the successful development and adoption of the NZI, including:

- **Championing and leadership**—The speed and effectiveness of the process leading to the right outcome depends a lot on the standing and influence of the people trying to develop it. The importance of powerful champions and access to senior leadership needs to be underscored. A change in VC leadership bode well for the NZI. It brought direction and drive to the various sustainability initiatives by acknowledging the need for sound investment decisions, but with riders for well-being, dignity and making the world a better place. It advocated looking beyond just the short-term financial position of the university towards the role of the university as a leader, an exemplar, and focusing on external impact.
- **Homework**—While leadership played a big role in developing the NZI to its current form, this was possible due to the groundwork laid by previous smaller projects over many years. When the opportunity to develop a strategy for net zero arose, the team already had proof of concepts, ideas and potential partnerships in place to seize it.
- **Interdisciplinarity and teamwork**—The Monash Energy Institute galvanised much of the early discussion that led to the feasibility study on the microgrid and the benefits around campus in actually developing such an initiative. It bridged the communication gap between Buildings and Properties and enterprise, to develop this cross-faculty, cross-functional unit initiative. Thus, there is integration across research faculty, research areas, operational areas, and the executive (though coordination remains a continuing challenge).
- **Planning and showcasing technology in new builds**—Initially the team focussed on low hanging fruit, while keeping in mind that there was a larger holistic strategy they were working towards. New electric builds are easier than retrofits, and offered a path of least resistance to achieve some early wins and a public profile. The university was also more willing to cover the risk for smaller projects, which allowed the project managers and engineers to explore options. From a reputational as well as a financial point of view, smaller showcase projects allowed the NZI to build momentum to go on to tackle the bigger challenges of retrofitting.
- **Changing market conditions**—An external catalyst for improving the business case for the initial projects is the maturation seen in the industry from a design and technology perspective. Electrification and retrofitting are now less technically challenging than they were a few years ago, when the initiative was being proposed. Falling solar prices and rising gas prices also helped build the economic case for electrification.

3.4 Initial barriers and missed opportunities

The assessment criteria for opportunities under the NZI emphasise not just short-term and long-term economic benefits, but also other tangible benefits in terms of research and teaching opportunities, and intangible benefits such as reputation gain. These include:

- **Aligning facilities management with the broader vision**—Limited organisational knowledge of technological advancements in energy management and a reliance on an external consultant base created barriers to innovation. Leadership support and an understanding of how asset management relates to climate change are key in this area.
- **Limited risk appetite**—The NZI and its precursors challenged the existing technology approach to energy management of buildings. Project managers and project engineers had not previously worked on such a project and were hesitant to take on what they perceived as additional risk for the university. The

team drew on case studies of similar projects in New Zealand and reached out to those involved in these projects to build confidence among the project engineers. Another approach was to start with a smaller project or building and progress from there to larger projects, while strengthening relationships with the buildings and engineering team.

- **Funding research**—The NZI is a collaboration between facility management and research and teaching. However, since the conception of the initiative was focused on infrastructure, the business case did not include funding for research. Additionally, from an economic perspective, the business case for the research component was harder to prove. However, research and teaching are the core business of a university. To fund research, external funding needed to be sought through grants, which added another layer of complexity.
- **Complex university processes**—The NZI is one of the first initiatives of its type in Australia. One of the barriers while conceptualising the program and building executive support for it was not knowing the exact processes across the different parts of the university. When developing such large-scale strategic initiatives, there is limited flexibility at the higher levels of decision making. This also reflects on the choice of governance structure for the initiative. A casualty of this complexity was the PhD program, which would have been a minor additional investment with large potential benefits in terms of research and reputation. However, it requires a direct approach to securing funding as compared to investment in facilities management and infrastructure development. Further work was required to secure PhD funding through external sources.
- **Communication**—A missed opportunity was failing to create greater visibility of the programs across the key stakeholders at the university through collectively disseminating some of the early wins and case studies. The communication was more focused on providing input into the process of developing the net zero business case; primarily targeted at the operational parts of the initiative.

4 University of Technology Sydney

4.1 History and geography

The University of Technology Sydney (UTS) is a public research university located in central Sydney. The university can trace its origins to the Sydney Mechanics' School of Arts, established in 1833. This was later taken over to form the Sydney Technical College in 1882, which became part of the New South Wales Institute of Technology (NSWIT) in 1968. The NSWIT was granted university status in 1988 to become UTS.

The main UTS city campus is located at the southern border of Sydney's central business district, close to Central Station and Railway Square. The city campus includes three distinct precincts: Broadway, Haymarket and Blackfriars. Two additional precincts at Moore Park and Botany integrate specialist facilities with surrounding industry organisations.

Figure 10. UTS Broadway campus. The highly urban site of UTS's main campus lies within Sydney's central business district. (Source: UTS, Photographer Andy Roberts)

UTS is regarded as one of the world's leading young universities (under 50 years old), ranked first in Australia and 11th in the world by the 2021 QS World University Rankings (Craig, 2021).

4.2 Existing sustainability commitments, actions and achievements

4.2.1 UTS sustainability framework

UTS has a long history of commitment to sustainability principles and practices. A significant milestone was the establishment of the Institute for Sustainable Futures in 1996. Internal strategic sustainability documents include:

- **UTS Sustainability Policy**—provides a framework for sustainable practice at UTS across four key areas: teaching and learning, research, campus operations and community engagement.[7]
- **UTS Sustainability Strategy 2017–2020**—provides the framework for implementing the UTS Sustainability Policy and outlines goals, initiatives, responsibilities and timelines for achieving them (UTS, 2017).
- **UTS Plastic Free Plan**—approved in 2019 to eliminate the most common single-use plastic items from campus, including plastic straws, bags, food containers, cutlery, bottles and plastic-lined coffee cups.[8]
- **UTS Social Impact Framework**—articulates and structures UTS's current and future endeavours in social justice.[9]

4.2.2 UTS sustainability commitments

Following is a timeline of UTS's sustainability commitments:

- **1998: Signatory to the Talloires Declaration**—a 10-point action plan for incorporating sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities signed by over 500 university leaders in over 50 countries.
- **2003: Founding member of the Green Building Council of Australia (GBCA)**—whose purpose is to lead the sustainable transformation of the built environment.
- **2008: Signatory to the ATN Agreement**—a declaration of commitment to local, national and global sustainability which pledges to make sustainability a focus in UTS's teaching and learning, research, operations, infrastructure, service and outreach to local, regional and global communities.
- **2011: Founding member of the City of Sydney Better Buildings Partnership**—a collaboration of leading property owners and industry influencers providing green leadership and sustainable innovation for Sydney's commercial and public buildings.
- **2013: Member of Sustainable Development Solutions Network (SDSN)**—which promotes integrated approaches to implement the SDGs and the Paris Agreement on Climate Change, through education, research, policy analysis and global cooperation.
- **2016: Signatory to the University Commitment to the UN SDGs**—which affirms UTS's intention to support and promote the SDGs through its research, education and operations, as well as report on activities in support of the goals.
- **2019: Signatory to Global Compact**—the world's largest corporate sustainability initiative, with a mission to support action on the SDGs and promote responsible business practice.

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7 gsu.uts.edu.au/policies/sustainability-policy.html

8 uts.edu.au/partners-and-community/initiatives/uts-sustainability/campus-operations/waste-and-recycling/going-plastic-free

9 uts.edu.au/node/340051/uts-social-impact-framework

- **2019: First Australian university to sign a climate emergency declaration**—committing to mobilise more resources for action-oriented climate change research and skills creation, committing to working towards carbon neutrality, and pledging to increase the delivery of sustainability education across curriculum, campus and community outreach programs.
- **2019: Signatory to Race to Zero**—a pledge to reach net zero emissions as soon as possible, and by mid-century at the latest, in line with global efforts to limit warming to 1.5°C.

4.2.3 UTS sustainability achievements

Following is a timeline of UTS's recent significant sustainability achievements:

- 2013: $9 million energy efficiency building retrofit project completed.
- 2015: Signed Australian-first PPA with a solar farm in Singleton.
- 2016: Signed Australian-first precinct cooling agreement with Central Park.
- 2018: Signed Australian-first precinct recycled water agreement with Central Park.
- 2018: Vicki Sara building awarded 6-star Education Design v1 and As-Built v1.
- 2018: UTS Green Revolving Fund established.
- 2018: Office fit-out for Institute for Sustainable Futures (ISF) awarded 6-star Interiors v1.1.
- 2019: Opened Australian-first plastic-free food court (CB02).
- 2020: Successful UTS-led bid leading to establishment of RACE for 2030 CRC.

4.2.4 UTS contribution to UN SDGs

In 2016, UTS affirmed its intention to support and promote the SDGs through its research, education and operations, as well as report on activities in support of the goals, by becoming a signatory to the University Commitment to the UN SDGs. In 2019, the university also became a signatory to the Global Compact—the world's largest corporate sustainability initiative, with a mission to support action on the SDGs and promote responsible business practice.

UTS's goal of reaching net zero and its current GHG emission abatement activities address a number of the UN SDGs, as outlined in Table 2 below.

Table 2. Current UTS contributions to UN SDGs. UTS's goal of achieving net zero and its current GHG emission abatement activities address a number of the UN SDGs, as outlined below.

UN SDG	Target	How UTS contributes
7 AFFORDABLE AND CLEAN ENERGY	**Ensure access to affordable, reliable, sustainable and modern energy for all**	
	7.2 Increase substantially the share of renewable energy in the global energy mix by 2030	• Investment in on-site solar installations on properties owned or leased by UTS. • Purchase of electricity via PPAs from existing and new off-site solar farms. • Support of RECs scheme via retirement of LGCs. • Future support of carbon offset schemes.
	7.3 double the global rate of improvement in energy efficiency by 2030	• Continue to improve the energy efficiency and GHG intensity of UTS's existing buildings and infrastructure via targeted retrofit projects. • Continue to improve the energy efficiency and GHG intensity of UTS's new buildings, refurbishments, fit-outs and infrastructure via UTS design guidelines, and Green Star and WELL certification. • Continue to monitor, manage and report UTS's energy and GHG performance.
	7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	ISF has a research focus on Energy Futures. Its vision is *one in which energy is clean, affordable and accessible to all, where energy systems and services support a high quality of life and in which people and communities are empowered.*[10]
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	**Ensure sustainable consumption and production patterns**	
	12.2 By 2030, achieve sustainable management and efficient use of natural resources	UTS will continue to reduce operational energy use and improve GHG intensity, as well as monitor, manage and report UTS's energy efficiency and GHG performance. The UTS Sustainability Strategy, UTS Carbon Neutral Plan and UTS Plastic Free Plan will guide the university's efforts.
	12.a Support developing countries to strengthen their scientific and technological capacities to move towards more sustainable patterns of consumption and production	ISF has a number of research focus areas that support developing countries with responsible consumption and production, including Climate Change and Adaptation,[11] Energy Futures,[12] International Development,[13] and Resource Futures.[14]

[10] For project examples, see uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/energy-futures

[11] uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/climate-change-adaptation

[12] uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/energy-futures

[13] uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/international-development/climate-change-adaptation-international-development

[14] uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/resource-futures

UN SDG	Target	How UTS contributes
13 CLIMATE ACTION	**Take urgent action to combat climate change and its impacts**	
	13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	A Climate Change Risk Assessment and Adaptation Report was undertaken for the UTS Central building. A Climate Risk Assessment and Climate Change Adaptation Plan for UTS will be undertaken in the future. The university has Business Continuity Plans for all faculties, research centres and units. ISF works with policymakers, practitioners and communities in developing countries in the Asia-Pacific region to build capacity and reduce vulnerabilities to climate change impacts.[15]
	13.2 Integrate climate change measures into national policies, strategies and planning	ISF undertakes research focussed on climate change that informs local, state and federal government planning, policies and strategies, including Climate Change and Adaptation,[16] Energy Futures,[17] and Cities and Buildings.[18]
	13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	The UTS4Climate website outlines how UTS staff and students are taking action in response to climate change, with innovative research, the subjects taught and studied, how UTS engages with its community and how it runs its campus.[19]
17 PARTNERSHIPS FOR THE GOALS	**Strengthen the means of implementation and revitalise the global partnership for sustainable development**	
	17.17 Encourage and promote effective public, public–private and civil society partnerships, building on the experience and resourcing strategies of partnerships	UTS led establishment of RACE for 2030 and remains a research partner. RACE for 2030's research programs will deliver new energy solutions to cut energy bills for consumers, boost business productivity, reduce carbon emissions, and optimise the energy grid to increase reliability.

4.3 UTS emissions

UTS has conducted a series of carbon emissions audits, including for the 2019 and 2020 calendar years, and for the period 1 July 2020 to 30 June 2021. The impacts of the COVID-19 pandemic mean the figures for 2020 are not highly representative. The figures for 2020/21 are used throughout. As well as being the most recent available figures, they cover a period during which the COVID-19 pandemic had a more limited impact on the university's operations. The audit covers all Scope 1 emissions (principally on-site burning of natural gas), Scope 2 emissions (direct electricity use), and the main Scope 3 emissions over which UTS has some direct control (principally chilled water, flights and waste).

15 For project examples, see uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/international-development/climate-change-adaptation-international-development

16 uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/climate-change-adaptation

17 uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/energy-futures

18 uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/cities-and-buildings

19 uts4climate.uts.edu.au

UTS's overall emissions for the 2020/21 period were 57,644 t CO_2-e. A breakdown of these emissions by source is provided in Table 3 and represented graphically in Figure 11.

Table 3. UTS emissions for the period 1 July 2020 to 30 June 2021.

Source	Scope	Emissions	
		(t CO_2-e)	%
Electricity	2	32,126	55.7
Chilled water[1]	3	11,870	20.6
Flights	3	4,469	7.8
Natural gas	1	5,600	9.7
Waste[2]	3	3,173	5.5
Other[3]	1/3	407	0.7
Total		**57,644**	**100.0**

Notes

1. UTS purchases chilled water from its neighbour at Central Park. This is currently classified as Scope 3.
2. Includes operational and construction waste.
3. Includes petroleum fuels for both transport and stationary applications (Scope 1), refrigerants (Scope 1) and water usage and disposal (Scope 3).

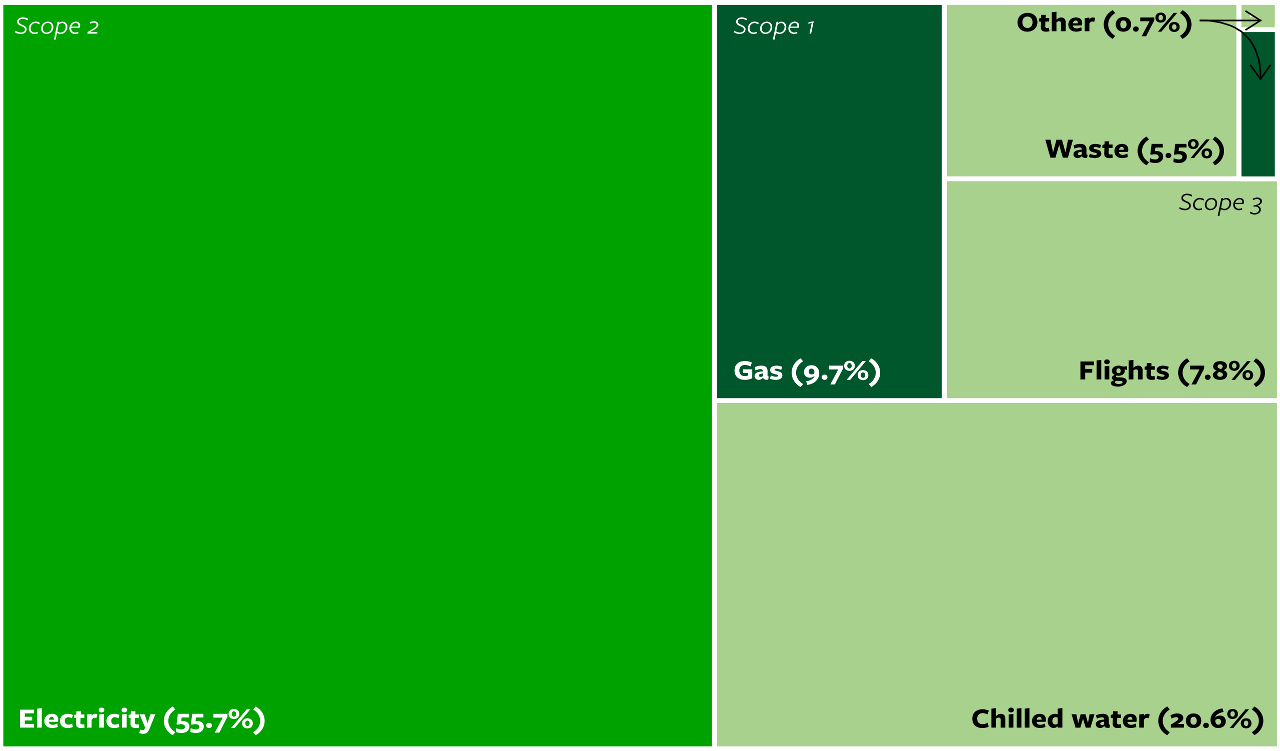

Figure 11. UTS emissions for the period 1 July 2020 to 30 June 2021.

4.4 Stakeholder engagement

In April–May 2021, the UTS Sustainability team conducted a series of stakeholder engagement activities tied to development of the university's net zero plan. These activities included:

- Six consultation sessions, each with a different theme. Details of these consultation sessions are provided in Table 4.
- Comprehensive stakeholder mapping around each theme, to ensure appropriate engagement with relevant stakeholders.
- A 'Jamboard' online collaboration, organised around the six themes, allowing community members to add or endorse ideas and comments.

Open invitations to the first five consultation sessions and Jamboard were extended to the UTS community and advertised through email newsletters and the UTS website. Invitations to the final session on Leadership and Targets were extended to selected members of the UTS management and executive community, including the Deputy Vice Chancellor, the directors of the project and facilities management offices, and various department heads and managers. The sessions were recorded and made available to UTS staff through an online portal.

Both the consultation sessions and Jamboard generated numerous ideas, which were then collated, analysed and assessed (see Section 6.1.2).

Table 4. Details of the UTS consultation sessions held in April–May 2021.

Session	Focus	Key discussion questions
1: Travel	• Commuting and travel behaviour change • Scope 3 emissions • Airline travel • UTS travel survey outcomes • Current campus infrastructure • Travel behaviour change initiatives etc.	• How can we reduce our commuting and flight emissions? • How can we change behaviour towards more active, sustainable travel?
2: Behaviour Change	• Approaches to behaviour change • Success factors • Engaging students in behaviour change to reduce emissions • Empowering staff to reduce emissions • Current UTS behaviour change activities, such as Green Impact, Green Week, Walk & Ride to UTS	• How can we engage students in behaviour change to reduce emissions? • How can we empower staff to reduce emissions? • How can UTS support people to make changes/change behaviour? • How willing would you be to stop flying/travel in different ways?
3: Research, Teaching and Learning	• Transdisciplinary learning, integrating sustainability themes into courses • Engaging students in learning about climate change • Inter- and trans-disciplinary research collaboration • Innovative UTS research projects • Collaborating on climate-change related research	• How can we engage students in learning about carbon neutrality and developing solutions? • How can we effectively collaborate on carbon neutrality related research?

Session	Focus	Key discussion questions
4: Building Design and Campus Operations	• Reducing carbon emissions in buildings, infrastructure and operations • UTS's current and future projects e.g. solar, district energy sharing, electrification, sustainable building certification	• What can we do in our built environment and operations to reduce our carbon emissions?
5: Finance, Investment and Procurement	• ESG • Sustainable finance models • Climate change investment risk • Fossil fuel divestment • Enabling a green post-COVID-19 recovery • Sustainable procurement • UTS's procurement policies and procedures • Procurement hierarchy • Supply chain, procurement challenges, procurement opportunities	• What sustainable finance models can we employ in this challenging economic climate? • What actions can we take to decarbonise our investments? • How can we procure goods and services more sustainably?
6: Leadership and Targets	• Global and national context • Science-based targets • Research • UTS4Climate • RACE for 2030 CRC • Student interest areas • University context • Targets and commitments of other Australian and international universities	• How can UTS demonstrate leadership through our target-setting? • By when should UTS go carbon neutral? • How much should cost influence timing? • How should our pathway to Carbon Neutrality align with UTS's values?

5 Curtin University

5.1 History and geography

Curtin University is a public research university with its main campus located in Bentley, a suburb of Perth, Western Australia. It also has campuses and facilities in the Perth CBD, Midland, Kalgoorlie, Dubai, Singapore, Malaysia and Mauritius.

Curtin University's origins begin with the commencement of technical education in Western Australia in 1900 by the Perth Technical School. Classes were held at the Old Perth Boys School at 137 and 139 St Georges Terrace, where the Perth CBD campus of Curtin University still sits today (Figure 12). Perth Technical School, renamed The Perth Technical College in 1929, offered voluntary classes for trade apprentices and university courses through the University of Adelaide until the University of Western Australia was established in 1914. By the post-war period, student demand and lack of space resulted in the need for a larger institution to be created. The increase in mining and infrastructure operations based in the state also required a skilled workforce to meet demand.

Figure 12. 137 and 139 St Georges Terrace in the 21st Century. (Curtin University, 2021a)

The Western Australian Institute of Technology (WAIT) was founded in 1966, accepting the first students in 1967 (Figure 13). The campus was located on land previously occupied by pine plantations that were burnt in the late 1950s, approximately six kilometres south of Perth. WAIT was a part of the technical college system of teaching in Australia that focused on vocational and teaching-oriented colleges, separate to the academic and research-oriented university system. In 1969, the Western Australia School of Mines, the Muresk Agricultural College, the School of Occupational Therapy and the School of Physiotherapy were merged with WAIT, and student numbers expanded to 10,000 by the mid-1970s. Along with other technical colleges such as the Royal Melbourne Institute of Technology (RMIT), WAIT provided flagship teaching and learning opportunities outside of the Australian university higher education sector in the areas of health sciences, business and administration, the arts and architecture.

Figure 13. The WAIT campus in the 1960s. (Curtin University, 2021b)

Owing to expanding student numbers and crossover with what were previously university-dominated teaching areas, the government of Western Australia conferred university status on WAIT and it began operating as Curtin University of Technology in 1987. The university was Western Australia's third university and Australia's first university of technology. It is named after John Curtin, who served during the Second World War as Australia's 14th Prime Minister and remains the only Prime Minister to represent Western Australia in the House of Representatives. The John Curtin Prime Ministerial Library, located at the university, was the first of its kind in Australia.

During the 1990s, the Curtin campus expanded in the number of buildings, staff and students, as well as transitioning to offer postgraduate degrees and catering to a growing number of international students, predominantly from Asia. The Centre for Aboriginal Studies was established in 1994, an Indigenous-managed research and education centre that has expanded over the decades to offer undergraduate, postgraduate and research courses. In 2008, the university became the first teaching and research institution in Australia to develop a Reconciliation Action Plan.

In 1996, the university adopted the John Curtin quote *look ever forward* as its motto, and began establishing campuses in various locations, including Malaysia (1999), Esperance and Margaret River in regional Western Australia (2003), Sydney (2005), Singapore (2008), Dubai (2017) and Mauritius (2018). Additional expansions to the main campus in Bentley were also undertaken with a sporting and recreation complex and a Resources and Chemistry Precinct both opening in 2009. The precinct highlighted the collaboration between academia, government and industry that Curtin continues to foster. In 2010, The university was renamed Curtin University, reflecting the evolution of Curtin from an applied technology institution to one focused on research and teaching across a broad range of areas. Since then, the disciplines of law and medicine have commenced at Curtin, as have additional course offerings through Open Universities Australia and Massive Open Online Courses. Curtin's current teaching and research is grouped into five study areas, further divided into schools, disciplines, institutes, centres and groups, supported by the Vice-Chancellory:

- Centre for Aboriginal Studies
- Faculty of Business and Law

- Faculty of Health Sciences
- Faculty of Humanities, and
- Faculty of Science and Engineering.

As of 2021, Curtin is ranked in the top one per cent of universities worldwide in the highly regarded Academic Ranking of World Universities, second in the world for Mineral and Mining Engineering, and ranked highly in the areas of Health, Hospitality and Tourism Management, Science and Engineering, and Architecture. Curtin also has 53 percent of undergraduate students in Western Australia, with a total student body of over 57,000 students in 2019 (Curtin University, 2021c).

Figure 14. The Resources and Chemistry Precinct, opened in 2009. (Curtin University, 2021d)

5.2 Stakeholder engagement

We began the process of stakeholder engagement at Curtin by mapping and identifying the structure of Curtin University as an organisation, the areas that are currently engaged with net zero initiatives and areas that could be engaged in future activities. The Planning Director within Properties, Facilities & Development (PF&D), who is part of this research project team, is the project lead for the two related Plans on a Page and provided an initial list of departments and personnel with which to engage, while the stakeholder mapping process identified further relevant areas. Interviews were conducted across the university. Where interviews could not be secured, desktop research was undertaken. Additionally, groups that are associated with the university but not part of campus operations or direct research and teaching activities were also investigated, including Curtin Student Guild and key CRCs or research centres. In total, 35 areas of the university were identified and investigated as part of this project. This includes areas from within PF&D relating to the management of campus assets and public places; finance, travel and procurement; teaching and learning excellence; research partnerships; and the teaching, learning, research and graduate studies in each faculty, key institutions or research groups within each faculty and the Centre for Aboriginal Studies.

Each interview began with an overview of this project, actions that other universities around Australia are undertaking towards reducing emissions, and the current activities that Curtin is undertaking related to reducing carbon emissions. The remainder of each interview was guided by the following questions:

1. Within your role and areas of responsibility at Curtin, what current activities are you undertaking that are related to reducing emissions? What future activities would you like to undertake that could contribute to a Carbon Net Zero Plan and what do you think the challenges and opportunities are to its successful implementation?
2. Thinking of the broader Curtin space, what do you think would be needed to successfully implement a Carbon Net Zero Plan? Who should be involved and what areas should be targeted?
3. What outside organisations do you think should be involved in a Curtin Net Zero Plan?
4. Who else in the university should we talk to about a Curtin Net Zero Plan?

Interviews and desktop research were analysed thematically to identify common themes, current and proposed initiatives, and recommendations for furthering decarbonisation activities at Curtin.

The following sections summarise the lessons learnt through the stakeholder engagement process at Curtin University. It is broken into sections detailing the operational, travel and financial considerations around carbon emissions, leadership considerations, research, teaching and learning activities, and behaviour change learnings. These areas should not be considered in isolation as there are many linkages between them.

5.3 Operational emissions

Sustainability is one of the pillars of Curtin University's strategic plan. The university's commitments to sustainable development are also evident throughout its teaching, research, buildings and plans for the future. Numerous initiatives, courses and research programs are currently in place, with delivery being undertaken by the different faculties and business areas such as PF&D, and People and Culture. Operational carbon emissions come primarily from energy, but also include emissions from travel, waste and procurement, as discussed below.

5.3.1 Energy

In 2009 Curtin University joined the other Australian Technology Network of Universities (ATN) in committing to a collective emissions reduction target of 25% by 2021, compared to 2007 baseline levels. In November 2021, the ATN reported that their members have significantly outperformed the 25% target, with a collective emissions reduction of 46% over the past 14 years (ATN, 2021).

Curtin's emission savings have been achieved while going through major growth, with 65,000 m^2 gross floor areas added to the university's portfolio in this time. This represents a 37% reduction in carbon intensity (t CO^2-e/m^2), with more emissions reductions activities planned as part of the Greater Curtin Master Plan, which was awarded a 6-Star Green Star – Communities certification by the Green Building Council of Australia (GBCA) for its continued commitment to creating a sustainable and thriving campus.

The majority of the university's carbon emissions come from purchased electricity used in building and campus operations. We engaged in several discussions with Curtin PF&D personnel to understand electricity use on campus and how increased energy efficiency, reduced demand or load shifting, and increased renewables could be facilitated. One of the core responsibilities of PF&D is to ensure continuity of service to the campus, to enable research, teaching and operational activities to continue. Cost and carbon reduction are subsequent priorities. The priority of energy management activities at Curtin is energy abatement (reducing energy use), followed by on-site renewables and finally load shifting activities that can reduce demand on the electricity network at peak times. The Perth campus is one of the largest energy consumers in the South West Interconnected System (SWIS), larger than Perth Airport or Fiona Stanley Hospital, and as such any consumption or generation patterns can have wider impacts on the islanded grid system. Curtin's energy source is made up of energy from the SWIS (generated from coal, gas, wind and solar sources), solar PV systems located on campus, and two small-scale wind turbines. A thermal storage tank system is a key component of the centralised heating, ventilation and cooling (HVAC) system. This is used to reduce the demand on the Curtin and SWIS network at peak times by running a closed-loop water system.

All buildings on campus have centralised HVAC to provide cooling and heating. Lectures halls and other intermittently-used venues have a push-to-start button that provides 2–4 hours of air conditioning at the centralised temperature. Implementation of this system over the past few years has reduced the energy demand profile for the university. However, if further efficiencies are to be made, some changes to comfort levels in buildings may result. The energy generation and consumption patterns of Curtin have also been examined under COVID-19 lockdowns. This has shown that the larger centralised system for energy control across the university is not optimised for a reduction in energy demand on campus.

Over the next few years, an updated Integrated Infrastructure Management Plan and upgrades to the voltage network on campus are expected to enable additional renewable energy to be generated on campus while managing impacts on the SWIS. Some upskilling of campus staff or subcontractors who are engaged to manage the energy system may be required for these or other future upgrades to energy infrastructure. These changes may enable the campus to act more like a microgrid; however, there is uncertainty about how this will impact whole-of-grid stability and operational costs. Curtin has previously participated in the Western Power 100 MW Challenge, which aimed to create a 100 MW load to stabilise the network to fluctuations from renewable energy. A feature of this program included increasing the thermal storage tank to consume energy generated from surrounding domestic solar PV panels during the day to minimise the impact this export had on the grid. The program demonstrated feasibility; however, Curtin is assessing whether this is of benefit to the university's core business and currently a formal agreement to continue this with Western Power has not been arranged.

The Curtin Plan on a Page adopted in 2020 included a target to reduce energy use in 2020/21 by 3% compared to 2019/2020, which has been achieved. Off the back of vastly different operational demands, owing to the COVID-19 pandemic and intermittent lockdowns, the university used the opportunity to further finetune building controls as part of its continued efforts to reduce its operational carbon footprint. This has been achieved primarily through energy efficiency programs to replace lighting and appliances in buildings across campus, despite the gross floor area increasing during this time. The Living Campus dashboard[20] allows for real-time energy tracking across all buildings on the Perth campus, which has increased visibility of energy generation and consumption profiles. Annual reporting now associated with the six-star Green Start certification for the campus assists in continuing monitoring of energy use across campus. New buildings or retrofits on campus are built to a five- or six-star As Design and As Built Green Building Council of Australia standard. New buildings on campus also allow for future installation of additional solar panels. The new Exchange Precinct opening in early 2022 will have 530 kW of solar panels and two EV charging stations. The retrofit of the library will have 110 kW of solar panels when it is completed in 2023. Few other buildings across campus have been assessed as having roofs suitable for installing solar panels, owing to their age, and so other options for renewable energy generation are being considered by PF&D. Solar panels on coverings over car parks have been suggested as one option, while power purchase agreements have been considered but not undertaken as yet. The university does not currently have any offset program in place.

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[20] livingcampus.curtin.edu.au

5.3.2 Travel

Scope 3 emissions from employee commuting and air travel account for 10% of Curtin's overall emissions. This is based on pre-COVID-19 figures, however, and the current state of travel emissions may be lower. The majority of these emissions at the time of calculation were from business travel. Currently, offsets are not included in travel bookings; however, these are being investigated by the team to be implemented in the near future. The cost of this would most likely be absorbed into the total cost of bookings. Another proposal under consideration is increasing transparency of carbon emissions generated through business travel by including not just air travel emissions but other associated emissions from road travel and hotel accommodation in the booking system. This requires working with major hotel partners to understand how to account for and cost these emissions, which can then be offset using nature-based offsets that produce verifiable, long-term reductions in carbon emissions.

Curtin University has the largest student population of all WA universities. Associated travel to, from and within campus is a topic that has been addressed over a number of years. While the main campus is not located on a train line, there are numerous and frequent connecting bus services from Canning Bridge Train Station that service the campus and surrounding suburbs. A route also connects Curtin and Edith Cowan University in Mount Lawley via the CBD every five minutes during peak times. The Curtin Access Bus Service is an additional free, wheelchair- and bicycle-accessible bus services connecting campus and surrounding locations. To support cyclists, there are 700 securing parking spots across campus and seven end-of-trip facilities for use, as well as bike maintenance stations close to these.

As part of the Greater Curtin master planning process, provision has been made to enhance opportunities for better public transport. This has included ensuring there is adequate space to accommodate mid-tier transit systems (such as light rail or trackless trams). The university has also been part of a consortium, with local government partners across the metropolitan area, which has undertaken research and advocacy associated with identifying mid-tier transit routes that link the campus to the Perth CBD and other parts of the metropolitan area. The university is also part of proposals to trial trackless tram technologies in Perth.

A pay-as-you-go parking system was introduced a few years ago to encourage people to adopt flexible transport practices instead of relying on long-term permits for parking. Carpooling options have also been encouraged.

Within campus boundaries, cars are not allowed outside of the main car parks and PF&D and Curtin Digital & Technology Solutions staff have access to electric buggies for transport. The campus features numerous staircases and hills, however, which can pose some impediment to their use. Staff who manage the grounds use either diesel or petrol utility vehicles or electric buggies to move around campus. There has been some investigation into increasing the number of electric buggies or replacing the utilities with electric vehicles; however, there are concerns around adequate charging facilities for these. Kip, a small autonomous driverless electric bus, has been trialled on campus for use by staff and students since 2017.

There is one electric vehicle charger currently located on the Perth campus. The Future Battery Industries CRC arranged for its installation adjacent to the CRC building on the southeast side of campus. Uptake in usage of this charger has been slow; however some more electric vehicle chargers will be installed in the new Exchange precinct, which will open in early 2022.

5.3.3 Waste management

Carbon emissions from waste on campus account for approximately 3.5% of total emissions. While not a large part of emissions, the management of waste at Curtin has recently undergone significant changes. The collection and disposal of waste is now outsourced and not managed by Curtin PF&D. This was due to the increasingly difficult process of managing separate waste streams on campus and the removal of space when additional building expansions began on campus.

The university has set a target of operational waste diversion from landfill of 80% by 2025. The 2020/21 financial year average waste diversion rate was 49.7%, which is in line with the objectives set for the year, based on 487.01 t of waste diverted and 492.7 t sent to landfill, with 11.4 t of e-waste being recycled. Curtin also rolled out container deposit scheme receptacles, with funds raised donated to local charities each month. Solar bins that compact waste have been installed in high-traffic locations on campus since 2017, allowing up to five times the amount that a standard 120 L wheelie bin would hold. These have reduced the need for frequent bin collections to occur in these areas of campus.

In open plan offices at Curtin, the use of individual bins has been minimised, with most bins now located in centralised locations in offices or in kitchen areas only. Organic bins were rolled out campus-wide in 2021, to bring the Student Guild–run cafes on campus in line with the rest of the campus waste system. This will improve diversion rates and ensure consistency across campus. Waste audits and reporting continue to be undertaken to identify opportunities for improvement, along with educational stalls and consistent messaging across campus. Digital Technology & Solutions manage the e-waste on site; however, many of the laptops and computers are provided by a leasing company, to which they are returned at the end of the lease. Outdoor furniture at Curtin is carefully selected and managed to prolong useable life and, if possible, recycled pieces are used or items recycled at the end of their life.

5.3.4 Procurement, finance and investment

The four main spending areas for procurement and finance for Curtin are in building furniture, technology, consumables in research and education, and business services including printing, contractors, marketing and payments associated with international students' insurance. Decarbonisation in procurement actions has been a focus of the net zero plans of some other universities. While the overall contribution to the total carbon emissions account is low at Curtin, this was investigated. Current policy around procurement has considerations around modern slavery in supply chains and meeting Indigenous spending targets and inclusion of diversity of vendors. Sustainability or decarbonisation of items is not currently considered. There is support from staff members in this space for sustainability to be included, and discussions have been undertaken with other universities to consider how their organisational frameworks support this. The estimated increase in costs for including decarbonisation in procurement actions is a single figure percentage; however, this has to be supported by the university if it is to be implemented.

5.4 Leadership and targets

All areas of the university need to be involved in development of a net zero plan. However, leadership for this should come from the very top of the university, namely the Vice-Chancellor and senior executive. Consensus or education on what the university means by carbon neutral or net zero is important to provide clarity and transparency for accountability and benchmarking activities. Setting of decarbonisation targets is viewed as beneficial by many people to provide direction and goals and be able to promote when they are reached. However, it was also discussed in interviews that targets that are set just for the sake of saying Curtin has targets would not be beneficial, and there are many activities already being undertaken by Curtin to reduce carbon emissions. There are many current university plans that relate to carbon emissions that are detailed online,[21] including the Energy Management Plan, Waste Reduction Plan, transport initiatives and the Reconciliation Action Plan. Integration with these plans provides an opportunity to produce a holistic and practical decarbonisation action plan for the university.

5.5 Research, teaching and learning

Curtin University is divided into four faculties along with the Centre for Aboriginal Studies. There are two separate deans in each faculty, one for Teaching and Learning and the other for Research and Graduate Studies. Additionally, there is a Deputy Vice-Chancellor Research and a Deputy Vice-Chancellor Academic, under which there are key positions in research partnerships, research excellence, graduate research school, research services, research infrastructure, learning innovation and teaching excellence, and learning partnerships, among others. A full organisation structure chart of the university can be found here.[22]

There is currently a review being undertaken by the Curriculum Transformation team to assess which units across all of Curtin's teaching offerings include aspects on sustainability or SDGs. Between 2016 and 2021, 7% of all units were assessed to include SDGs. The Curtin Challenge Platform[23] is a digital tool used to develop students' problem-solving skills. In 2021, modules will be added as part of the Balance of the Planet actions to embed sustainability in a collaborative curriculum experience, and develop students' capabilities as global citizens through the lens of sustainability in higher education. This aspect has also been highlighted by the Faculty of Business & Law, which catalogues dissertation and research outputs according to their relevant SDGs. This is linked to a requirement in the MBA accreditation that this information be provided, as well as supporting the Principles for Responsible Management Education (PRME) working group based in the faculty. Other select reviews of decarbonisation in the curriculum have occurred in other schools or faculties. For example, the School of Design and the Built Environment recently conducted a review of how decarbonisation is included in all its units. Within the Faculty of Humanities, the Master of Environment and Climate Emergency, based in the Curtin University Sustainability Policy Institute (CUSP) provides an overtly decarbonisation-related course. Other related degrees or majors include the specialisation in Governance and Sustainability within the Master of Information Systems and Technology, built environment related courses in construction management, urban and regional planning, geography and architectural science, engineering and physical science courses.

Over the 2016–2021 period, almost 26% of all research articles published by Curtin academics specifically related to the SDGs, showing a strong basis from which to increase decarbonisation research. There are a range of institutes or areas within the faculties that undertake these types of projects or could in the future. These are primarily based in the Faculties of Science and Engineering, Business and Law and Humanities, and include practical demonstration projects, including the Green Electric Energy Park (GEEP), three living lab buildings for testing initiatives and the Curtin Hub for Immersive Visualisation and eResearch (HIVE). Partnerships with Optus, Bankwest and Cisco have also resulted in significant practical centres for applied research that could work in the decarbonisation space. An existing project predominantly based in the Faculty of Humanities is supporting researchers already working in the net zero space to come together to share their findings and collaboratively propose practical solutions to researching net zero.

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21 properties.curtin.edu.au/local/docs/sustainability-program-and-activities.pdf

22 about.curtin.edu.au/leadership/organisational-structure

23 challenge.curtin.edu.au

Curtin University has strong collaborative ties with local, national and international industry partners to support demand driven, practical research and teaching initiatives. In addition to the industry partnership centres shown above, industry-linked research centres, institutes and groups within Curtin include:

- Curtin Institute for Computation
- Centre of Excellence in Artificial Intelligence (part of the Optus-Curtin Innovation Alliance)
- Oil and Gas Innovation Centre
- Bankwest Curtin Economics Centre
- WA School of Mines
- Future of Work Institute
- Cisco-Curtin Centre for Networks
- Centre for Aboriginal Studies
- Green Electric Energy Park (GEEP)
- STEM Education Research Group
- Sustainable Engineering Group (SEG)
- Centre for Exploration Geophysics
- Curtin University Sustainability Policy Institute (CUSP)
- Curtin Hub for Immersive Visualisation and eResearch (HIVE)
- Curtin Living Labs
- Legacy Living Lab.

Notably, RACE for 2030, the Future Battery Industries CRC, the Sustainable Built Environment National Research Centre and the newly formed Sustainable Communities and Waste Hub of NESP2 have strong connections with Curtin researchers and fund projects related to decarbonisation. These centres engage with researchers across the faculties and the Centre for Aboriginal Studies and can be used for funding and industry partnerships for decarbonisation research and implementation of initiatives on the Curtin campus.

Figure 15. Select institutes with which Curtin University is currently engaged that undertake research related to reducing carbon emissions.

5.6 Behaviour change

Discussions on behaviour change were had at a high level with all interviews. The importance of and need for it was mentioned by many people but few approaches were suggested. Topics most frequently raised related to travel and transport of students and staff members, along with continuation of the working-from-home or flexible work arrangements used during the COVID-19 pandemic. The need for strong leadership on decarbonisation actions was discussed, to support individuals making behaviour changes as well as operational changes to be made across the university. The Explore Curtin Program run by the Place Activation Team in PF&D as well as the Student Guild are both established organisations within or associated with Curtin that can be used to disseminate or lead behaviour change initiatives. Engagement with the Centre for Aboriginal Studies and local Indigenous community should also be considered. Consultation with staff and students regarding the implementation of the SDGs at Curtin has been undertaken in 2021 by the PF&D staff and the learnings from this process should also influence any actions undertaken to decarbonise.

In February 2020, Curtin University made a commitment to develop a consolidated approach to sustainability in relation to Curtin's physical footprint and profile in teaching and research, guided by the SDGs. A total of 470 staff and 102 students were engaged in workshops and surveys to better understand Curtin community views and aspirations. Emerging themes include respondents' view that the university should show leadership in sustainable development (either national or global) and the desire for the physical environment to drive change and/or performs as an industry leader. Participants favoured investment in supporting research in specific SDGs and building partnerships for the SDGs with industry, government and other universities. In addition, the engagement showed that communications are scattered and participants are rarely aware of sustainability initiatives already being undertaken by Curtin. The detailed mapping against SDGs of activities in Research, Teaching & Student Experience and the Physical Environment was completed in 2021. All Curtin teaching units (~4,600), courses (~460) and research publications have been mapped against each SDG, providing a clear understanding of Curtin's strengths. The information gathered is informing the university's Sustainable Development Plan and Carbon Plan. The plans will outline Curtin's maturation journey to 2030.

5.7 Current emissions

In 2020, a strategic review of Curtin's carbon account was undertaken using the Climate Active standard. A summary of this account is shown in Figure 16 for Scope 1, 2 and 3 emissions. The greatest source of emissions is purchased electricity, comprising 72% of overall emissions. This is followed by natural gas (7%), air travel (6%), diesel (4%) and employee commuting (4%). Other sources of emissions (waste, advertising, electrical and uplifts) comprise the final 7%.

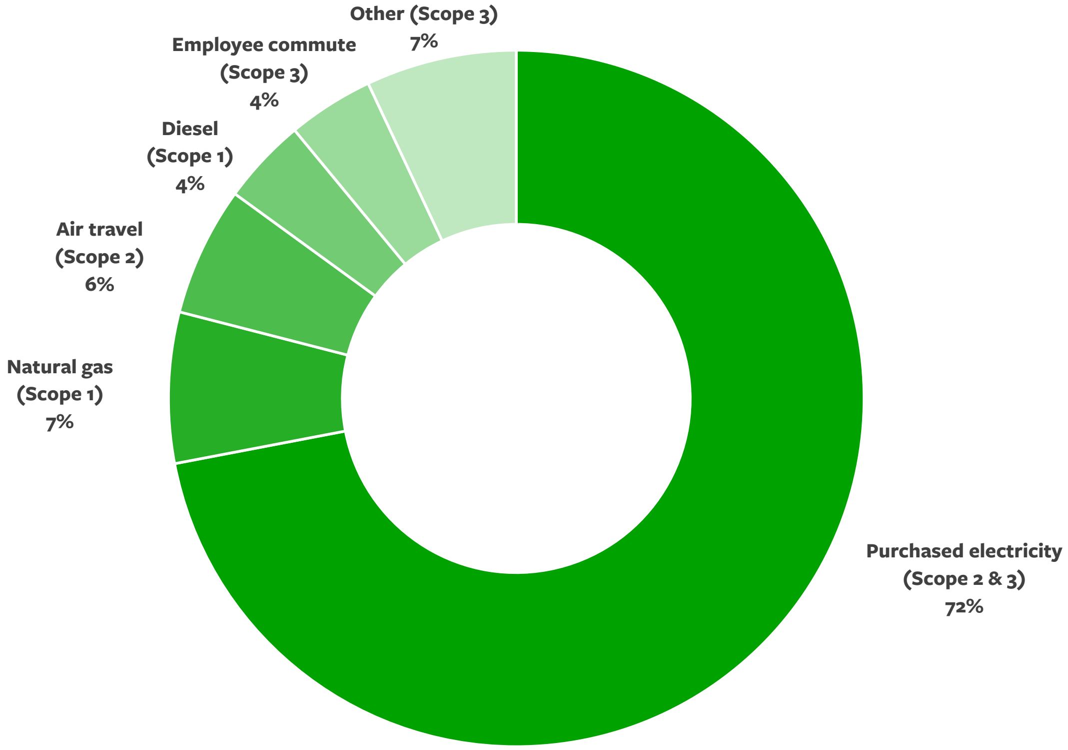


Figure 16. Curtin University's GHG emissions for 2020.

6 Defining success metrics

A key part of the process for developing an institutional net zero plan, which we applied and developed through this project, is defining how success is measured. Good strategy development should begin with a thorough understanding of an organisation's character—i.e. its history, identity, goals, values, and purpose. In this section, we outline the key sources of information we drew on to define organisational character for both UTS and Curtin University. We then used this understanding firstly to aid with generating project ideas and stakeholder engagement, but more importantly as a means of defining success metrics for evaluating and refining project concepts.

6.1 University of Technology Sydney

6.1.1 Strategic direction

To understand and better define the organisational character of UTS, we combined insights from the UTS Carbon Neutral consultation sessions with the background information on UTS provided in Section 4 and a thorough review of the following documents:

- UTS 2027 Strategy (UTS, 2019)
- UTS Corporate Plan 2020 (UTS, 2021)
- UTS Sustainability Strategy 2017–2020 (UTS, 2017).

UTS's 2027 vision is to be a **leading public university of technology recognised for its global impact**. The main themes of UTS's 2027 Strategy are summarised below:

- **Leading by *doing***—'walking the talk', and instilling responsible, transformative leadership.
- **Collaborative partner**—partnerships with industry, the professions and community. Partnership with industry and community will guide our research, help deliver university services, and shape our curriculum and learning experience. These collaborations will help us produce impactful research and allow creative practice.
- **Industry connected**—research and learning are deeply integrated with industry for practical application.
- **Inclusive**—A university for all, ensuring everyone who desires and merits a place at UTS is enabled to do so. Attract a wide range of students from Australia and overseas.
- Agent supporting **indigenous education and knowledges** for all Australians.
- **Social impact and justice**—committed to social justice and the economic, social and cultural prosperity of our community.
- **A citizen of Ultimo**—a force for benefit sharing in local area. Our campus has no walls; it is deliberately designed to be porous and support connections, knowledge exchange and collaboration.
- **Technology *for* society**—supporting responsible use of technology that supports a rapidly changing society.
- **Transdisciplinary**—bringing ideas together in new ways. We'll take our ability to work in a transdisciplinary manner to the new levels required to solve the complex problems facing society.
- **Hub for innovation**—connected with the entrepreneurial ecosystem in the area, and providing scalable entrepreneurial experiences for our students, staff and alumni, with a strong focus on positive impact. Want to be recognised as Australia's leading university in entrepreneurship and innovation.
- **Ethical and transparent in our actions**.

- **Relevant and timely learning—**equipping students with creative problem-solving and design-thinking skills.
- **Sustainable**—cultivate sustainability values in our students and staff, striving for continual improvement in our sustainability outcomes and ensuring best practise in our processes and systems, research, learning, campus operations and community collaboration.
- **Values**—Discover, Engage (collaborate), Empower (each other), Deliver (do), Sustain(able).

Figure 17. Word cloud generated from the UTS 2027 Strategy.

UTS has embarked on eight strategic initiatives under its 2020 corporate plan (covering the period 2019–21) to help it achieve its vision of becoming a leading public university of technology recognised for its global impact. These are:

1. Learning for a lifetime
2. Personal learning experience
3. Digital partners in learning
4. New ways of working
5. Precinct, community and partnerships
6. Transforming society through connected research
7. A distinctive international profile and student experience
8. Delivering positive social change.

Corporate Plan 2021		
Learning for a lifetime (S1, S2, S5, S6, S9, S12, O1, O3, O4, O5 & O8)	**New ways of working** (S1, S2, S3, S5, S12, O1, O2 & O5)	**Distinctive international profile & student experience** (S1, S2, S6, S10, S12, O3, O7 & O8)
Personal learning experience (S1, S3, S5, S9, S12, O1, O3, O5 & O8)	**Our precinct, community & partnerships** (S2, S5, S6, S7, S12, O4 & O7)	**Delivering positive social change** (S6, S8, S9, S10, S11, O2 & O6)
Digital partners in learning (S1, S3, S4, S5, O1, O3 & O7)	**Transforming society through connected research** (S3, S4, S5, S6, S8, S9, S12, O2, O3, O4 & O12)	**Operational excellence** (S1, S2, S3, S4, S11, S12, O1, O3, O7, O8, O11)
Fit for 2027 (S1, S3, S5, S12, O1, O4, O5, O11, O12)		

Figure 18. The eight strategic initiatives under UTS's 2020 corporate plan.

UTS's sustainability strategy covers:

- **Governance**—which includes fostering a culture of sustainability across UTS by embedding sustainability principles into the policies, strategies and procedures that govern its activities; engaging students, staff and the UTS community in decision-making processes; demonstrating leadership in sustainable practices and behaviour; promoting equity, diversity and social justice; and integrating environmental, social and governance principles into investment selection practices.
- **Teaching and learning**—which includes encouraging student engagement in sustainability; developing graduates who are responsible global citizens; supporting staff development and engagement in sustainability; embedding sustainability into the curriculum; developing learning and teaching practices that support a sustainable future; and increasing educational impact on sustainability outcomes locally and globally.
- **Research**—which includes building research excellence in sustainability to benefit local, national and global communities; mapping and aligning activities to the UN Sustainable Development Goals; facilitating internal engagement via transdisciplinary research and internal collaboration on sustainability challenges; enhancing external collaboration with industry and international partners to develop solutions to sustainability problems; further promoting sustainability researchers as thought leaders; and communicating sustainability research discoveries to inform and engage the broader community.
- **Operations**—which includes achieving a balance between minimising the environmental impact of the university's operations, enhancing social equity and maintaining long term financial viability; pursuing opportunities to improve organisational sustainability through the use of innovative design, technology, processes and business models; ensuring that UTS is prepared for current and future sustainability challenges; embedding sustainability principles into UTS's supply chain and procurement of goods and services; improving sustainable practices on campus by fostering positive behaviour change in staff, students and visitors; striving for continual improvement in efficiency and sustainability performance.
- **Community engagement**—which includes communicating UTS's sustainability values, activities and performance; fostering capacity in others to create positive change towards a sustainable future; engaging students and staff in more sustainable practices; actively engaging with all sectors to drive progress towards sustainability; acting as a public advocate, source of expertise and leading example of sustainability in the wider community; and developing strategic national and international partnerships with the industry, community, government and non-government organisations to create innovative solutions to sustainability challenges.

The organisational character of UTS, as defined by the *UTS's 2027 Strategy* and other documents outlined above, can also be interpreted to position UTS as an anchor institution for socially-focused local economic recovery within its precincts (see Section 2.8).

6.1.2 Success metrics—UTS

To gauge the potential success of particular net zero initiatives, a set of qualitative success metrics was developed that account for the core strategic goals and decision-making pathways of UTS. Drawing on UTS's organisational character assessment summarised above, combined with insights from the Carbon Neutral consultation sessions described in Section 4.4, we developed the following qualitative metrics for assessing net zero initiatives:

- **Social values:**
  - S1: Targets social disadvantage and inclusion
  - S2: A portion of capital tied to social purpose outcomes and/or impact
  - S3: Systemic support of new businesses, including social enterprise and non-profits
  - S4: A portion of expenditure covered by supply chain standards
  - S5: Potential to support indigenous empowerment
- **Local area values:**
  - L1: Supports local area employment
  - L2: A portion of spending invested within local area
  - L3: Contributes to socially just use of land and property
- **University values:**
  - U1: Student marketing and branding benefits
  - U2: Creates long-term community and industry partnerships
  - U3: Enhances teaching and learning experience
  - U4: Test bed for UTS research
  - U5: Enhances transdisciplinarity
  - U6: Better outcomes for campus building users
- **Environmental values:**
  - E1: Scale of potential catalytic benefit (including emissions reductions beyond UTS)
  - E2: Improves circularity of supply chain materials
- **Other values:**
  - O1: Improves energy system reliability
  - O2: Lowers energy bills
  - O3: Provides other financial benefits.

6.2 Curtin University

6.2.1 Strategic direction

A key factor influencing Curtin's current strategic direction is change in leadership. In July 2020 the then Vice-Chancellor, Deborah Terry, left Curtin to take up the Vice-Chancellorship of the University of Queensland. Professor John Cordery was appointed interim Vice-Chancellor while an international search for Curtin's next leader was conducted. In October 2020, the Curtin Council announced that Professor Harlene Hayne of the University of Otago would be Curtin's next Vice-Chancellor, commencing in April 2021.

With a new Vice-Chancellor, some new strategic directions will undoubtably begin to emerge. However, for the purposes of this report, the university's strategic directions have been drawn from the Strategic Plan 2017–2022, released in 2020 and developed as a two-year extension of the existing plan (2017–2020). It was designed as a positive response to the challenges and opportunities facing Curtin University at a time of unprecedented global and sectoral uncertainty, particularly arising from the impacts of the COVID-19 pandemic. Figure 19 shows the strategic framing of the Curtin Strategic Plan 2017–2022, highlighting how the priority areas of the university's strategic focus and interlinked.

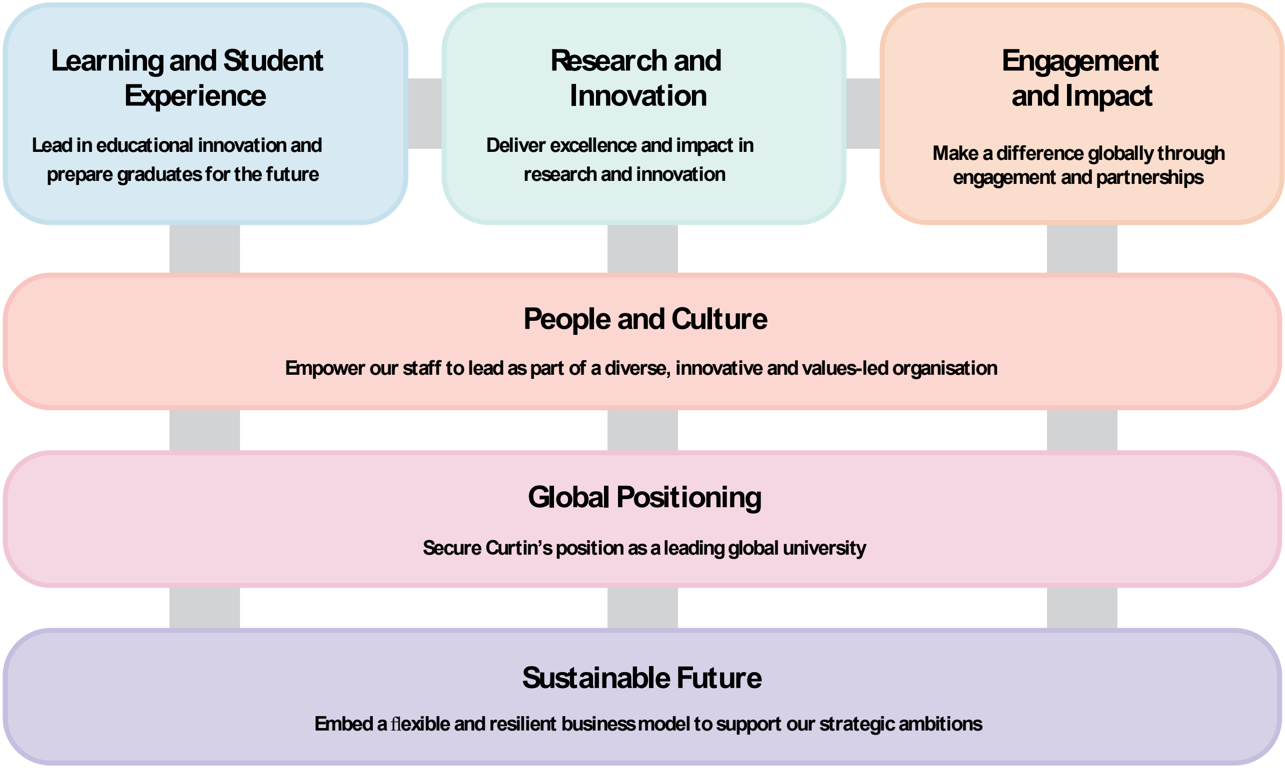


Figure 19. Curtin University Strategic Plan themes. (Curtin University, 2020)

Importantly in terms of the net zero context, in early 2020 Curtin also developed the Vice-Chancellor's 2021–2022 'Plan on a Page' Priorities. These include specific commitments to engage at the corporate level with the UN's SDGs and the net zero challenge (Figure 20). The Plan on a Page priorities are critically significant, as they set the whole rationale for developing Curtin's Net Zero initiative that is envisioned through this project within a corporate context aimed at:

- building a coordinated culture of sustainability, guided by the SDGs, across the following priority areas:
  - research and intellectual property
  - learning and student experience
  - global positioning
- facilitating stakeholder engagement
- developing carbon emission targets relevant to Curtin University activities (with an initial target of 3% reduction in energy use against 2019 levels for 2021) and the development of an ongoing plan.

7. Strengthen our profile as a university engaged with sustainable development.	7.1 Map and align activities across Learning and Student Experience, Research and Innovation, and Engagement and Impact to the UN Sustainable Development Goals (SDGs).
	7.2 Explore new ways to reduce Curtin's carbon footprint.

Figure 20. Segment of Curtin University's 2020 Plan on a Page relating to the Sustainable Development Goals and Carbon Footprint reduction. (Sourced from internal Curtin documents.)

Importantly this Plan on a Page commitment also provides the corporate governance structure, accountability and reporting to deliver on these priorities with the establishment of corporate governance. This involved the establishment of a three-person senior executive team comprising the Chief Operating Officer, the Pro Vice-Chancellor for Teaching and Learning, and the Pro Vice-Chancellor for Research to provide governance and reporting of these initiatives. The outcome of the work being undertaken on the SDGs and initiatives to reduce the university's carbon footprint, including the Green Wave research, is being reported to this group. The coordination and delivery of the initiatives under this program have been assigned in the first place to the organisation PF&D, who manage all Curtin-owned buildings and infrastructure, with key people being engaged with the Research and Teaching and Learning Space to drive and coordinate initiatives in those areas.

As cited above, in 2009 Curtin University joined the other ATN universities in committing to a collective emissions reduction target of 25% by 2021, compared to 2007 baseline levels.

In 2010, planning began on the Greater Curtin Master Plan, outlining the expansion of the main campus in Bentley with additional office, retail, transport and accommodation facilities, with the aim of establishing a university town. This process has resulted in the Bentley campus being awarded Six-Star Green Star Communities certification under the Australian Green Building Council's Green Star Communities rating system. This process was initiated in 2012. In 2015, the Bentley campus achieved a Five-Star rating and went on to achieve a Six-Star rating in 2020, in the process becoming the first Communities project ever to improve its Green Star rating. The significance of this initiative is primarily that it helps lock-in the university's ongoing commitment to enhancing the green credentials of its campus; in particular ensuring that all building refurbishments and new builds meet the highest practical sustainability ratings. Just as importantly, it provides an ongoing framework for assessing the university's commitments and performance across the framework's principles:

- enhance liveability
- create opportunities for economic prosperity
- foster environmental responsibility
- embrace design excellence
- demonstrate visionary leadership and strong governance.

Further, as part of a wider process of engagement led by the Properties department of the Curtin administration, in 2015 a range of stakeholders were consulted from the university and local community to determine which sustainability issues are most important to Curtin. Sixteen key areas of sustainability were identified by stakeholders and mapped according to importance for both the university and external stakeholders, as shown in Figure 21.

These areas have been consolidated into the four pillars of the sustainability framework depicted in Figure 22. This framework was validated against internationally recognised standards, including the Global Reporting Initiative Standards and the Green Star Communities rating tool. Strategies and policies for many of these areas have been or are in the process of being developed, including an Integrated Transport and Movement

Plan, Place Activation Program, Parking, Communities, Economy and Disability Accessibility and Physical Access plans. Notably, the Integrated Infrastructure Management Plan provides performance evaluation and financial plans for the 10 Year Capital Plan and financial forecasts for up to 20 years to guide decisions made regarding Curtin's campuses.

Collectively, these corporate and properties-related initiatives illustrate the emerging importance placed on sustainability and the university's carbon reduction agenda. They provide the context on initiating steps towards a net zero strategy, to which this research project provides an important contribution. The initial steps in the process have been undertaken, with commissioning of the first carbon audit of the Bentley campus's 116 hectares of buildings and infrastructure, completed in January 2021 by consultancy firm Cundall. This establishes the baseline from which the organisation can now begin to clarify its strategy.

Figure 21. The 16 areas of importance identified through consultation for Curtin's Sustainability Framework. (Curtin University, 2019)

Figure 22. Curtin's Sustainability Framework. (Curtin University, 2019)

6.2.2 Success metrics—Curtin

Similar to the UTS assessment process, we also viewed Curtin as an anchor institution with the potential to support strategic activities in the community for further decarbonisation of society, along with its core research, teaching and learning activities. As Curtin is establishing organisational goals and assessment of what a net zero strategy for them as an organisation would entail, the success metrics are similar to those used for UTS, but with less detail. The qualitative metrics for assessing net zero initiatives for Curtin University are:

- Social values:
  - S1: Contributes to social equity, equality
  - S2: Direct links to Indigenous empowerment and the Curtin Reconciliation Action Plan
- Local area values:
  - L1: Contributes to local area employment or use of materials
  - L2: Contributes to socially just use of land and property
- University values:
  - U1: Enhances teaching and learning experience including transdisciplinary activities
  - U2: Test bed for Curtin research including transdisciplinary activities
  - U3: Better outcomes for campus building users
  - U4: Creates long-term community and industry partnerships
  - U5: Engages with the student population
- Environmental values:
  - E1: Scale of potential catalytic benefit across other environmental areas outside of emissions reductions and has the potential to reduce emissions beyond Curtin
  - E2: Improves circularity or visibility of supply chain materials
- Other values:
  - O1: Improves energy system reliability

- O2: Lowers energy bills
- O3: Provides other financial benefits.

The Sustainability Executive Team also provided some guidance on four parameters that Curtin University was considering when developing a net zero plan, namely:

- Installing energy saving infrastructure (e.g. solar panels) in the car parks based on their age, solar generation capacity and if they are not earmarked for development within the next 15 years.
- The need for gas to remain for use in the central boiler plants and within laboratories for the foreseeable future.
- Only Curtin-owned infrastructure and equipment to be installed on Curtin buildings and any energy-saving infrastructure (e.g. solar panels) to be installed on roofs that are less than 10 years old.
- Priority of energy management activities begins with energy abatement (reducing of energy usage), followed by on-site renewables and finally load shifting activities that can occur to reduce demand on the electrical network at peak times.

The initiatives proposed considered these parameters and were included in the above metrics without being restricted by them.

6.3 Assessment matrices

To evaluate, rank and frame redesign of the various opportunities identified through the stakeholder engagement process, an assessment matrix was developed for each university to help capture the various social, local and other values listed in Sections 6.1.2 and 6.2.2 above. Each matrix occupies a large Excel spreadsheet, samples of which is shown below in Figure 23 and Figure 24.

In addition to the impact potential of opportunities in terms of emissions abatement, for each opportunity each value is qualitatively rated as high, medium or low. Ratings are also applied to the opportunity's scalability and whether capital investment is required. These ratings depend on a number of factors, including the design of each opportunity, its ability to be linked to research, teaching and learning activities, existing partnerships with RACE for 2030 partners, the timescale over which it could be implemented, our understanding of current actions already being undertaken, and consideration of the position of each university in its net zero journey. The assessment process was somewhat iterative, with some opportunities being combined or redesigned and rerated to improve their score. In the case of UTS, a total score was calculated based on the number of medium and high value scores, though this total was used only for guidance rather than ranking.

Project No.	Scope	Source of emissions	Opportunity	Impact potential %	Impact potential (t/a CO_2-e)	Opp. to Scale	Capital require.	Total score	Social	Local	UTS	Enviro	Other
6	2	Electricity	High impact PPA	55.7	32,126	H	Yes	69	L M M H H	L L M	H H H M M L	H H	H H H
5e + 6	2	Electricity	Battery + retail offering		-	H	No	76	H H M H L	M H M	H H L M L L	H H	H H H
5c	2	Electricity	Monitoring, building energy management and demand response, moving towards 24/7 renewables		-	H	No	58	L L L L L	L L L	H M H H H H	H H	H H H
2	1	Natural gas	Electrify natural gas heating plant	9.7	5,600	M	Yes	52	L L L L L	H H M	H H H H H H	L M	M M M

Figure 23. Sample of the final assessment matrix used by UTS to evaluate opportunities and aid in their redesign to maximise capture of additional value.

Scope	Source of emissions	Opportunity	Opp. to scale (H/M/L)	Capital required (Y/N)	Values (H/M/L) Social	Local	Curtin	Enviro	Other	Partnership opp. (H/M/L)	Timescale (S/M/L)
2 & 3	Electricity	Standardising and lowering voltage infrastructure on campus	M	Y	L	M	H	L	H	H	S
2 & 3	Electricity	Energy efficiency upgrades to buildings	H	Y	L	M	H	M	H	H	S
2 & 3	Electricity	Revisit existing power purchase contracts and opportunity for green PPA	H	Y	L	H	M	H	H	M	S
2 & 3	Electricity	Offset of electricity emissions	H	Y	H	H	H	H	L	H	S
2 & 3	Electricity	Increase onsite and offsite renewable energy generation and storage	H	Y	L	H	H	H	H	H	M
2 & 3	Electricity	Seek opportunities for more campus energy sharing and district cooling connections	H	N	L	H	H	H	H	H	M
2 & 3	Electricity	Optimise demand response across Curtin buildings to consume energy generated by renewable sources and based on occupancy	H	N	L	L	H	H	H	M	M

Figure 24. Sample of the final assessment matrix used by Curtin University to evaluate opportunities and aid in their redesign to maximise capture of additional value.

7 UTS net zero strategy and narrative

A key part of our process for developing a net zero strategy is the development of a net zero narrative, tailored for the organisation in question. The purpose of this narrative is to help explain not only what the net zero plan will entail in terms of projects and their business cases, but how they fit the organisation's mission and purpose. The narrative is important both for communicating the strategy to stakeholders, as well as easing the decision-making process for the organisation's executives. The narrative should therefore make a compelling case for why the organisation should embrace the proposed initiatives. The narrative development process is informed by the success metrics and the organisational character from which they are derived, in addition to the project business cases themselves. The narrative also helps to inform the business case development process.

UTS has committed to developing a net zero carbon emissions strategy. Work on developing this strategy is ongoing, with substantial input from this project. Firm commitments to carbon neutral target dates have not yet been made, as they are awaiting further strategy development and costings. As part of this project, we developed the following net zero narrative and illustrations to complement the UTS net zero strategy. Additional work on developing and representing the strategy through infographics remains ongoing.

7.1 Overview

The draft UTS net zero strategy:

1. **Defines a Climate Positive strategy**—The ambition of the strategy goes beyond net zero emissions towards defining a 'climate positive' strategy, based on the 'impact pathway' approach to account for emission reductions beyond the university's boundaries (Section 7.2).
2. **Builds on existing strengths**—The strategy draws on UTS's organisational character by incorporating and building on the existing UTS 2027 Strategy and UTS's track record of collaborative climate innovation (Section 7.3).
3. **Supports research, education, local communities and the SDGs**—The strategy is built around a strategic framework that incorporates much of the narrative of Sections 2.8–2.10, framing UTS as an anchor institution, deeply embedded within geographic, innovation and thought leadership communities, both as a vehicle for community wealth building and as a critical enabler for seeding the net zero economy, through its research and education activities (Section 7.4).
4. **Supports the shift to 100% renewables**—The strategy supports a shift towards 100% renewable energy, particularly for electricity use (Section 7.5).

7.2 Climate positive strategy

UTS's draft emissions strategy goes beyond net zero emissions towards defining a 'climate positive' strategy. That is, the impact of UTS on reducing global carbon emissions will exceed its operational emissions, ensuring UTS's net impact is positive for the global climate.

As part of this project, various ideas were explored for creating impacts and reducing emissions beyond UTS's boundaries, for example through the Glebe Energy Transitions pilot of the UTS Climate Impact Lab (see Section 9.1). Several of these ideas have been adopted as part of the draft strategy. Work was also conducted on exploring ways of accounting for these impacts as carbon offsets. However, we were unable to resolve this issue and failed to develop a framework under which such impacts could be claimed as offsets using existing carbon accounting rules. Further work in this area is recommended (see Section 10).

To resolve this issue, an alternative approach was proposed. Current carbon accounting rules are used to define and measure pathways to net zero, but do not apply beyond that. The adopted approach therefore includes a 'standard' pathway to net zero, involving emissions reductions and certified offsets, followed by 'in-house' measurement of impacts once net zero is attained. This 'Impact Pathway' approach (see Figure 8 on page 27) allows UTS to account for emission reductions beyond its boundaries and define a climate positive strategy.

7.3 Building on existing strengths

The UTS emissions strategy builds on the vision and commitments of the existing UTS 2027 Strategy to strengthen UTS's position as an innovation hub for the equitable and inclusive application of technology for society. It also builds on UTS's record of collaborative climate innovation, such as driving award-winning precinct-scale sustainable water and energy infrastructure with its neighbours at Central Park. In 2015, UTS also developed Australian-first innovations in contracting mechanisms to purchase power from a Singleton solar farm. And UTS is a founding partner of several energy and climate-focussed collaborations, including:

- Business Renewables Centre Australia (BRC-A), which supports clean power purchasing
- EnergyLab, an accelerator for energy-focussed technology start-ups
- Climate-KIC Australia, an enabler for transformational climate action through deep global networks, knowledge sharing and breakthrough innovation
- Australian Alliance for Energy Productivity (A2EP), a not-for-profit coalition of research, business and government leaders helping Australian businesses improve energy productivity
- Reliable and Clean Energy (RACE) for 2030, a $350 million Cooperative Research Centre.

7.4 Strategic framework

The UTS emissions strategy is built around a strategic framework with three key elements, as illustrated in Figure 25 and outlined below:

1. Harnesses and strengthens UTS's **research and education** by:
   - integrating climate challenges into its teaching, learning and research activities
   - establishing a Net Zero Impact Lab, a transdisciplinary collaboration space for UTS students across all disciplines to help solve the trickiest carbon challenges (see Section 9.1)
   - showcasing on-campus demonstration projects, such as carbon sequestration (see Section 9.6)
   - supporting local social enterprise partners to help facilitate the net zero transition.
2. Extends UTS's boundaries of influence to its **local precinct and community** by:
   - working beyond its campus to deliver innovative emissions offsets
   - supporting uptake of emissions-reducing technologies such as electric vehicles
   - extending shared precinct infrastructure such as cooling, recycled water and waste dehydrators.
3. Reframes net zero through a social impact lens to integrate UTS's delivery of the United Nations **Sustainable Development Goals** (SDGs) by:
   - implementing a comprehensive procurement and supply chain review
   - supporting Indigenous participation in its supply chains
   - investing in its community to support local businesses, social enterprises and clean-tech start-ups.

An alternative approach to illustrating similar principles is shown in Figure 26. Here climate action is shown to extend beyond operational GHG emissions to include teaching and learning, research, and community engagement.

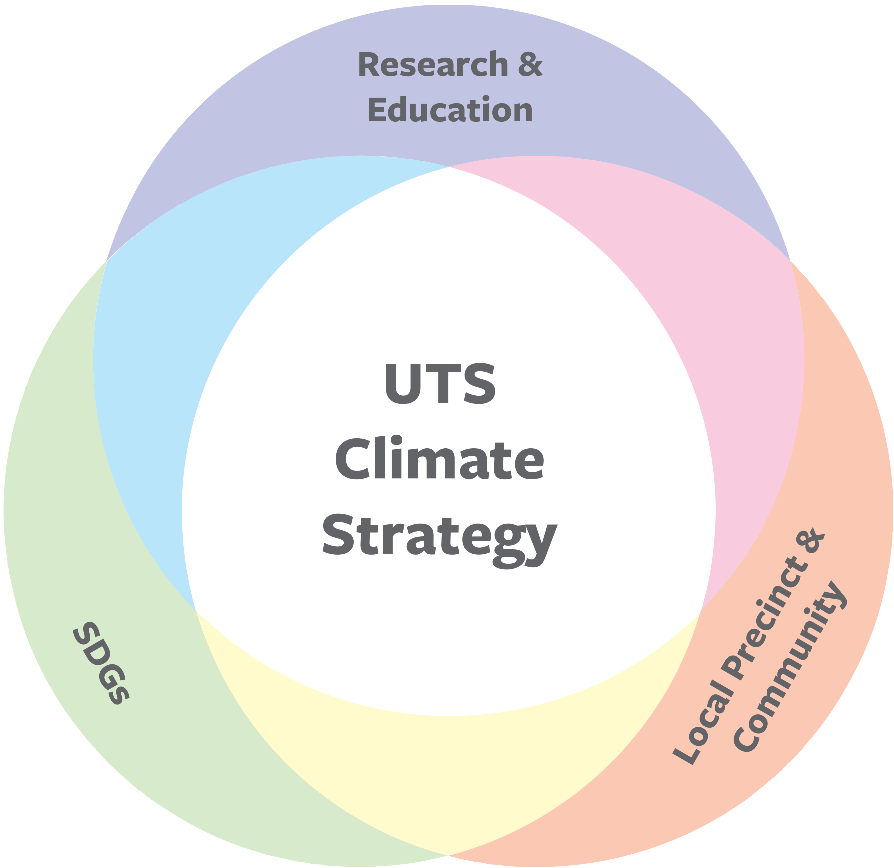


Figure 25. UTS climate strategy framework. The UTS climate strategy is built around a strategic framework with three key elements: (1) research and education, (2) local precinct and community, and (3) delivery of the UN Sustainable Development Goals.

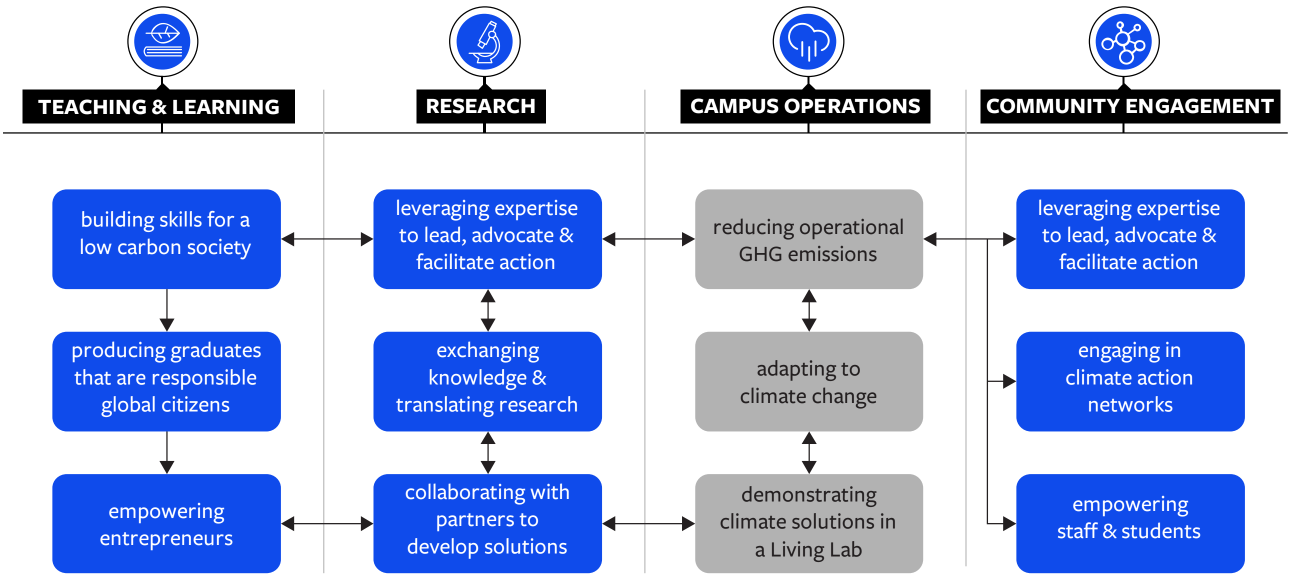


Figure 26. An alternative/complementary option for representing UTS's emissions strategy. Adapted from University of Waterloo (2020).

7.5 Supporting the shift to 100% renewables

At the core of every credible net zero strategy is a shift towards 100% renewable energy, particularly in the electricity sector. While energy is not the only source of global carbon emissions, for many organisations it is the dominant source (see also Section 2.5). In the case of UTS, direct and indirect use of energy—predominantly in the form of electricity, chilled water, natural gas and aviation fuel—accounts for almost 94% of its emissions. Non-energy emissions are dominated by construction and operational waste (5.5%), and direct release of refrigerant gases (0.5%).

UTS's draft emissions reduction supports a transition to 100% renewable energy by:

- setting new standards for purchasing offsite renewable energy to drive new investment (see Section 9.2)
- shifting energy demand to better match supply from renewable energy (see Section 9.3)
- fully electrifying the campus to remove all on-site burning of natural gas and other fossil fuels (see Section 9.5)
- ensuring continuous improvements in energy management and productivity through research partnerships and smart campus design, technology and innovation.

8 Key opportunities

A substantial portion of this project was devoted to exploring and developing various net zero opportunities for both UTS and Curtin University. The following section provides an outline of some of the key opportunities explored. A portion of these have been more fully developed into case studies, provided in Section 9.

8.1 University of Technology Sydney

8.1.1 Climate Impact Lab

The Climate Impact Lab is designed as a vehicle for applying a collaborative innovation process that connects UTS research, teaching and learning with community, industry and local social and environmental entrepreneurship partners around net zero carbon challenges. As a 'net zero themed' application of the Centre for Social Justice and Inclusion's (CJSI) Social Impact Lab, the initiative will integrate the goals and carbon neutral plans of the UTS Sustainability and Facilities Management Offices with community and industry partners, and faculties looking for applied student research problems and work-experience. Further details of the Climate Impact Lab, and its application to local area decarbonisation, are provided in Section 9.1.

8.1.2 Best practice PPAs

In 2015, UTS developed Australian-first innovations in contracting mechanisms to purchase power from a Singleton solar farm. UTS is looking to decarbonise the rest of its emissions from electricity consumption (55.7% of total emissions), through signing one or more PPAs, designed to meet best industry practice. Further details of best practice PPAs are provided in Section 9.2.

8.1.3 24/7 renewables

To fully decarbonise the electricity system and achieve 100% renewable electricity requires not just sufficient solar and wind generation capacity, but supporting infrastructure and systems, such as storage and flexible demand, to ensure both supply and demand are matched 24 hours per day, seven days per week. UTS is looking to support the shift towards 100% renewable electricity by introducing flexible demand across its buildings and installing batteries. Further details of this shift towards 24/7 renewables are provided in Section 9.3.

8.1.4 Battery storage + retail offering

UTS can extend its impact to accelerate uptake of renewables by increasing its PPA investments, combining this with on-site battery storage, and partnering with an energy retailer to offer 100% renewables to its network of staff and students. Further details of this opportunity are provided in Section 9.4.

8.1.5 Electrification

The electrification opportunity involves a series of investigations to identify the most viable and least complex opportunities for installation of heat pumps at UTS, and establish pathways to reduce and eventually eliminate on-site burning of natural gas across all UTS operations. Further details are provided in Section 9.5.

8.1.6 On-site carbon capture

UTS is exploring ideas for on-site carbon capture and sequestration. Nature-based opportunities are limited given UTS's urban setting. A novel opportunity for carbon capture using microalgae is detailed in Section 9.6.

8.1.7 Decarbonising chilled water supply

In 2016, UTS signed an Australian-first precinct cooling agreement with Central Park. Investment in new chilling infrastructure can be capital and space intensive, requiring new chilling plant, pumps, connecting pipework, cooling towers and electrical infrastructure. As an alternative to expanding its chilling infrastructure, UTS negotiated a 15-year contract to purchase excess chilling capacity from a trigeneration facility at Central Park. There are synergies between the two sites, with residential Central Park demand peaking during evenings and weekends, while UTS's demand peaks during weekdays. A pipeline underneath busy Broadway was installed, allowing chilled water to be transported from the Central Park site to UTS, providing energy savings and economic benefits to both parties.

Chilled water now makes up 20.6% of UTS's total measured Scope 1, 2 and 3 emissions (11,870 t/a CO_2-e). CleanPeak, the contractor for UTS's chilled water supply, has offered to decarbonise this supply using LGCs from existing spare renewable energy capacity. To offset the additional cost of these LGCs, a second contract variation is also being explored that would allow CleanPeak to vary the temperature of the chilled water supply to UTS over a greater range. This would provide CleanPeak with increased flexibility on its trigen plant, allowing it to operate more optimally and support grid-integration of additional renewables, with little impact on the operation of UTS's facilities.

8.1.8 Strengthening the energy start-ups ecosystem

Startups are a critical component of the ecosystem required for market transformation and widespread decarbonisation, particularly in the energy sector. UTS has a strong existing ecosystem for supporting start-ups that address climate change in general, and energy system transformation in particular. The two main institutional incubators for start–ups are:

- **UTS Startups**—which is currently supporting over 300 technology-enabled start-ups through:
  - collaboration, meeting and event spaces
  - connections to experienced mentors, investors, and accelerator programs
  - 3D printing and other hardware prototyping infrastructure
  - talks and masterclasses, and a digital library of curated start-up resources
  - newsletters, events, a Facebook group and other community-building activities
- **EnergyLab**—Australia's largest climate tech startup accelerator and innovation network, which is hosted at UTS's Blackfriars campus. EnergyLab has supported over 120 enterprises dedicated to net zero solutions through:
  - connections to experienced mentors, advisors, partners, peers and investors
  - accelerator and scaleup programs, including Women in Climate and Energy Fellowship, Climate Solutions Accelerator and Energy Scaleup Program
  - regular pitch and other community events.

There are opportunities for UTS to strengthen its start-up infrastructure and better support talented founders with innovative and creative solutions to climate challenges. Actions could include:

- integrating the activities of some start-ups into teaching programs through internships
- incentivising academic staff, particularly those with industry connections and insights, to serve as start-up mentors and advisors
- establishing regular pitch nights, where start-ups can pitch their ideas to UTS operations staff and seek opportunities to develop and test their ideas on campus

- building greater links between EnergyLab, UTS Startups and UTS faculty through regular events and meetups, particularly post COVID-19 restrictions.

Through this project, a number of EnergyLab alumni were also identified with potential opportunities for UTS to decarbonise its operations or reduce the emissions of those within its sphere of influence, such as staff and students (including some Scope 3 emissions). These include the following:

- **Amber Electric** (amber.com.au) is an electricity retailer that passes the wholesale price of electricity through to customers, helping to unlock some flexible demand through price signalling and support increased grid-penetration of renewables.
- **Ecologic** (getecologic.com) provides customised carbon and energy advice for homeowners, allowing them to identify and minimise their main sources of energy use.
- **Evergen** (evergen.energy) provides renewable energy software to optimise energy storage systems and orchestrate large fleets of batteries to enable virtual power plants (VPPs).
- **Everty** provides a cloud-based Software as a Service (SaaS) platform for EV charging infrastructure.
- **Exergenics** (exergenics.com) provides smart air conditioning technology, which can be deployed to optimise HVAC systems.
- **Good Car Company** (goodcar.co) makes EVs more affordable by importing good quality used EVs from Japan and selling them to Australian buyers. UTS is exploring the option of offering its staff and students an opportunity to buy a quality used EV via a bulk EV purchase through Good Car Company, while supporting uptake of EVs through, for example, installation of charging infrastructure where appropriate.
- **Gridcognition** (gridcognition.com) provides planning and optimisation of distributed energy systems.
- **Hart Bioenergy** (hartbioenergy.com.au) manufactures scalable waste-to-energy biogas plants using a proprietary bioreactor technology.
- **Key Energy** (key.energy) is developing a flywheel prototype for short-term energy storage that offers several advantages over battery technology, including longer life. This could be combined with other energy management technologies to help meet on-campus 24/7 renewables targets.
- **re:Start** (restartev.com) provides on-demand EV charging, which could help support uptake of EVs by UTS staff and students, particularly those who park on the street or otherwise lack access to other charging options.
- **Shifted Energy** (shiftedenergy.com) provides devices and software solutions that convert existing electric water heaters into flexible demand assets, potentially unlocking substantial potential as a kind of VPP.
- **Wattwatchers** (wattwatchers.com.au) and **PowerPal** (powerpal.net) offer technology for real-time digital monitoring and control of energy use.

8.1.9 Carbon credits

UTS's draft net zero strategy includes a set of policy recommendations around use of carbon credits. These recommendations:

- recognise that where UTS is unable to eliminate emissions and is unable to capture and sequester sufficient carbon in-house to offset such residual emissions, it will need to purchase voluntary carbon credits to meet its net zero commitments
- sets high standards for acceptable carbon credits to ensure UTS purchases only quality credits that deliver on various SDGs
- encourages transparency about use of carbon credits to meet its net zero commitments

- encourages identifying risks associated with carbon credit projects funded by UTS and developing strategies for managing these risks.

One option being considered for further investigation is in-house development by UTS of a nature-based offsets project. For example, this could involve a collaboration with several Australian universities to purchase land in western NSW, which is then managed to increase biomass and/or soil carbon to generate carbon credits. The project could involve substantial co-benefits, such as research and teaching opportunities, and engagement with Indigenous and/or other local communities. Such carbon projects typically cost at least $10–20 million and take 6–12 months to establish (South Pole, personal communication). Involving other universities would allow establishment and operating costs to be shared while providing additional opportunities for collaborative research.

8.1.10 Other UTS opportunities

In addition to the opportunities described above and detailed as case studies in Section 9, other opportunities have been identified and are being pursued as part of the UTS net zero strategy. These include:

- **Refrigerant replacements**—Replacing existing refrigerant gases with those with a lower GHG warming potential.
- **Procurement and supply chain review**—Undertaking a thorough review of UTS's procurement practices and supply chain, in a bid to reduce additional Scope 3 emissions. This is likely to be set up as a project for the Climate Impact Lab (see Section 9.1).
- **Internal EV program**—UTS owns and operates only a few vehicles, the majority of which are four-wheel drive or utility vehicles for which electric equivalents are not yet available. UTS will monitor market developments and replace these with electric equivalents once suitable options are available.
- **Energy efficiency program**—UTS will continue its ongoing energy efficiency improvement program to reduce energy use across its campuses, through activities such as lighting and other equipment upgrades.
- **Net zero transport program**—UTS is looking to minimise emissions associated with transport of its staff and students by incentivising public and active transport options, such as through discounted seasonal travel fares.
- **Student net zero learning and application**—UTS is looking to integrate the net zero challenge into much of its teaching and learning activities, to ensure its graduates are well prepared to help solve one of the key challenges of our time.
- **On site solar**—While UTS has already installed solar across its campuses, it will continue to investigate opportunities for additional on-site solar installation.
- **Zero waste to landfill**—UTS currently recycles over 80% of its general waste stream. It will strive to achieve zero waste to landfill by looking for additional opportunities to recycle waste materials where feasible.
- **Appointing a dedicated carbon manager**—To review, strategise and implement UTS's net zero strategy, the draft plan recommends appointment of additional resources in the form of a dedicated carbon manager. The manager's role would be both strategic and operational, allowing them to build on and develop UTS's response to the decarbonisation challenge, while managing the development and implementation of many of the individual initiatives outlined in the plan.

8.1.11 On-site anaerobic digestion

In some circumstances, on-site Anaerobic Digestion (AD) can be a commercially viable option for recycling food and other organic waste materials (such as used cooking oil, fats, oils and grease from grease traps, and sewage sludge) to generate:

- biogas, which can be used for cooking or other similar uses, much like natural gas, and
- nutrient rich digestate for beneficial reuse on land.

In addition to producing two valuable products, on-site AD can reduce the cost of managing waste and reduce the potent methane emissions that result from disposal of organic waste to landfill.

On-site AD has been investigated by UTS in the context of several organics management feasibility studies (Turner *et al.*, 2017 and Turner *et al.*, 2018), though to date no project has been successfully implemented.

There is currently little opportunity for UTS to pursue AD as a waste management strategy. Most food waste is currently captured and sent either to (1) two dehydrators, where it is dried and then transported to a garlic farm west of Sydney and used as a soil conditioner, or (2) EarthPower for use in their AD operations at Camellia.

There is an opportunity for UTS to reduce waste emissions from surrounding businesses, such as TAFE, ABC, Chinatown and Central Park, by accepting organic waste from these businesses and dehydrating it using the spare capacity of the UTS dehydrators. The impacts of COVID-19 restrictions during the period of this project meant the dehydrators were switched off and further exploration of this option was not feasible. Furthermore, UTS will first need to decarbonise its electricity supply before pursuing this option further to prevent additional electricity use from this option increasing its Scope 2 emissions.

8.1.12 Voltage power optimisation

Overview

Voltage power optimisation (VPO) involves installing equipment between the meter and loads to reduce and optimise the voltage provided to the loads. VPO equipment has the potential to reduce energy consumption and therefore carbon emissions. VPO equipment is provided by Ultima Capital Partners, who provided some background materials on the VPO value proposition and some examples of VPO installations. A VPO opportunity was explored at UTS as part of this project, which would involve installation of equipment in one building as part of a pilot. However, this opportunity is not currently being pursued per the following analysis.

Potential benefits

The potential benefits of VPO include:

- **Energy savings** through:
  - **Reduced voltage**—For a resistive load (R), the relationship between power (P) and voltage (V) can be expressed as $P = V^2 / R$. For example, a 10% reduction in voltage will result in a 19% reduction in instantaneous power consumption.
  - **Reduced harmonics**—Harmonics in motors and other loads involving magnetization of iron cores can cause core saturation and result in excess energy consumption. By removing these harmonics, energy consumption can be reduced.
  - **Phase balancing**—In three-phase rotating machines, imbalances between the voltage of each phase can cause additional energy losses.

- **Extended equipment life**—Higher voltages and harmonics cause increased heating, which can increase the rate at which equipment degrades. According to Arrhenius' law, degradation roughly doubles for every 10°C increase in temperature.

Following harmonisation with the IEC 60038 standard of 230 V_{ac} and the release of standard AS61000.3.100 in 2011, Australia's low-voltage grid now operates at an *allowable* operating voltage range at the customer supply point of 230 V_{ac} +10%/–6% (i.e. 216.2–253 V_{ac}) and a *preferred* operating voltage range of 230 V_{ac} +6%/–2% (i.e. 225–244 V_{ac}). In practice, voltages tend towards the upper end of these ranges, while much equipment is designed for the lower voltages typically found in European grids (historically 220 V_{ac}). Marketing of VPO equipment appears to be particularly prominent in countries such as the United Kingdom and Australia, which historically operated on a 240 V_{ac} low-voltage grid and where the potential benefits of VPO are likely to be more prominent.

Shafiullah *et al.* (2017) conducted a techno-economic evaluation of VPO technology for an Australian abattoir and found that "most feeders on a typical red meat processing site would be able to save energy and ensure enhanced power quality with the targeted implementation of voltage optimisation equipment."

Evaluating benefits

For a particular installation, the value of VPO in reducing energy use depends on several factors, including:

- the voltages at the site being evaluated, and the extent to which these voltages exceed the design voltages for the installed equipment, in addition to the magnitudes of any harmonics or phase imbalance
- the mix of loads at the site, and the proportion of loads that are sensitive to a reduction in voltage, and
- the magnitude of any ancillary benefits, such as reduced harmonics, phase balancing and extended equipment life.

Not all loads can be optimised using VPO. Most switched-mode power supplies, such as those used to power computer equipment, will simply draw more current to compensate for a reduction in voltage, resulting in no energy saving. And while reducing the voltage on a resistive heating load such as a toaster or water heater will reduce its instantaneous power consumption, the load will likely need to operate for longer to achieve the same result, resulting in no net energy saving.

VPO is often sold as a service. Under a typical contract, the service provider installs and owns the VPO equipment, while the recipient pays the service provider from a share (e.g. 50%) of the indicative energy savings. Although this model offers little to no up-front cost and no apparent risk to the service recipient, this is only the case where the *indicative* energy savings translate into *real* energy savings. Indicative energy savings are calculated based on the extent of voltage reduction, and therefore require some assumptions about the load's overall sensitivity to voltage reduction and optimisation. Given a typical site will have a mix of loads with varying degrees of voltage sensitivity, translating an easy-to-measure variable such as voltage into real energy savings is far from trivial. Furthermore, there is an ongoing shift away from voltage-sensitive towards voltage-insensitive loads, meaning the magnitude of any potential energy savings may reduce over time as equipment is upgraded, such as replacing halogen lighting, which is voltage sensitive, with LED lighting, which is not. The protective benefits of VPO, in terms of reducing voltage to extend equipment life, can also be achieved using other methods.

In 2016, the NSW Office of Environment and Heritage (OEH) published a useful guide to evaluating VPO (OEH, 2016). This guide was used to evaluate the potential benefits of VPO for UTS, as summarised in Table 5, ultimately leading to this opportunity not being pursued as part of UTS's net zero strategy.

Table 5. An analysis of common loads at UTS found few that are likely to be voltage sensitive and which would therefore benefit from installation of VPO equipment. Adapted from OEH (2016).

Equipment type	Voltage sensitive	Common UTS load	Match
Incandescent lamps	✔	✘	✘
Fluorescent lamps (inductive ballast)	✔	✘	✘
Fluorescent lamps (electronic ballast)	✘	✔	✘
Fluorescent lamps (high frequency)	✘	✔	✘
High intensity discharge lamps (inductive ballast)	✔	✘	✘
Induction lamps	✘	?	✘
LEDs	✘	✔	✘
Motors: linear (fixed)	✔	✘	✘
Motors: permanent magnet	✘	?	✘
Motors: variable speed	?	?	?
Refrigeration (uncontrolled)	✔	✘	✘
Refrigeration (controlled)	?	✔	?
HVAC (flow controlled)[24]	✘	✔	✘
HVAC (flow uncontrolled)[24]	✔	✘	✘
Heating: coil/resistance	✘	✘	✘
IT equipment	✘	✔	✘
Uninterruptable power supply (UPS)	✘	✔	✘
Equipment with inverters (surge protection)	✘	✔	✘

8.2 Curtin University

The key opportunities listed in this section for Curtin University are expected to build on the university's existing energy management strategies. In both 2019/20 and 2020/21, a 3% yearly reduction of energy use per unit of gross floor area was achieved at the Curtin Perth campus. We recommend that Curtin focus on continuing these energy reduction initiatives, while also exploring other strategic opportunities, organisational culture changes, and key research, teaching and learning initiatives to decarbonise operations. In 2009, Curtin joined the other ATN universities in committing to a collective emissions reduction target of 25% by 2021, compared to 2007 baseline levels. The ATN universities released a report in November 2021 showing that they have significantly outperformed the 25% target, with a collective emissions reduction of 46% over the past 14 years. The adoption of a stronger, individual emissions reduction target would enable Curtin to condense the numerous environmental initiatives already occurring across campus into a unified plan. This would align Curtin with other Australian and international universities, as well as many of Curtin's industry partners, which have targets and plans in place. Curtin has the opportunity to position itself as an anchor institution within the West Australian community, fostering innovation and leadership, and as a critical enabler for the net zero economy through its research and education activities. As Curtin has a number of campuses located in WA and internationally, each campus's decarbonisation journey may look different to that of the Perth campus,

24 The two HVAC options have been mistakenly reversed in the summary table provided on page 2 of OEH (2016). This mistake has been corrected here.

where the majority of this research has been focused. However, this provides an opportunity for Curtin to test initiatives in different circumstances and to work with local stakeholders at each location to develop initiatives that support campus operations and local decarbonisation actions.

We have grouped the opportunities for Curtin into three categories: short-term opportunities (1–2 years), medium-term opportunities (3–10 years) and long-term opportunities (10+ years). This time scale was chosen to highlight the many opportunities that can be undertaken immediately, while also providing recommendations that are important to decarbonisation but may not be possible to undertake at this stage. Given the majority of Curtin's emissions come from electricity use, the focus of these initiatives has been on either reducing the amount of electricity needed or increasing renewable energy generation and storage (Figure 27). These energy-specific initiatives, as well as others related to further carbon sources, are opportunities to partner with the research and teaching community at Curtin to co-design and utilise the campus as a living laboratory for solutions.

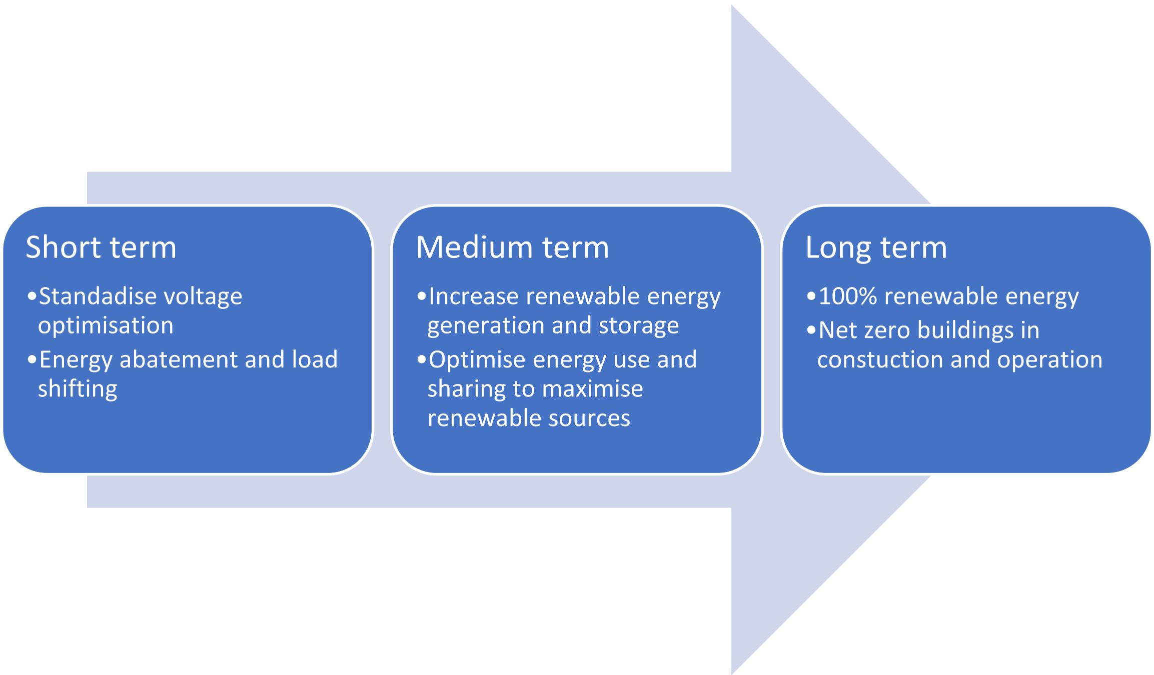


Figure 27. Proposed initiatives to address emissions from electricity at Curtin University.

8.2.1 Curtin's journey: short term (1–2 years)

The immediate focus for Curtin is to standardise and lower voltage infrastructure on campus. This will enable additional renewable energy generation to be installed on campus and provide more control for grid stabilisation activities. As the second largest energy user on the SWIS, Curtin has the ability to undertake load shifting activities, which have already been trialled with Western Power. While the business case for the continuation of these activities is being assessed by Curtin, reducing electricity-related emissions can occur through either offsets or green PPAs. The carbon account completed for Curtin in 2020 aligned with the Climate Active certification that other universities and organisations use. Additional data collection for some emissions may be needed for this, and should be collected in the short term to allow for accurate accounting and reduction. The Curtin executive has flagged that use of gas on campus will remain; therefore, all gas infrastructure should be optimised and upgraded as appropriate to improve efficiency and minimise leakage. If the campus maintenance workforce needs upskilling to install or manage new infrastructure, these activities should also occur.

Scope 3 emissions from employee commuting and air travel have declined since COVID-19 lockdowns, work from home flexibility, and moving of university teaching and research activities to online spaces. Encouraging these practices to continue will reduce these emissions in the future. Offsetting residual travel emissions or incentivising lower emission travel options will further contribute to net zero efforts. For employee commuting, this may include public transport subsidies or increasing EV charging locations across campus. The travel team is already investigating how emissions generated through travel-related activities can be accounted for and the offsetting cost incorporated into the booking price.

While the assessment of Scope 3 emissions did not include transport or community emissions associated with student travel, it is important that the university continue its research and advocacy associated with enhancing public transport options to and from the campus, including continuing to progress research and trial activities associated with mid-tier transit solutions such as trackless trams.

Other Australian universities also consider sustainability factors in their procurement practices. The procurement team at Curtin have been considering this; however, there is currently little demand from employees to consider waste, emissions or local products when ordering items. The WA Buy Local policy is an initiative of the WA government to consider local suppliers and communities when procuring items and issuing contracts. This is an area in which Curtin, as a large WA organisation, could lead. Finally, regarding emissions from waste on campus, recent steps have been taken to improve consistency in what waste can go in particular bins around campus and the Guild-run cafes, along with waste education and reduction campaigns.

Scope	Source of emissions	Opportunity	Opp. to scale (H/M/L)	Capital required (Y/N)	Values (H/M/L)					Partnership opp. (H/M/L)
					Social	Local	Curtin	Enviro	Other	
1	Natural Gas	Optimise gas infrastructure	M	Y	L	M	H	M	H	M
2 & 3	Electricity	Standardising and lowering voltage infrastructure on campus	M	Y	L	M	H	L	H	H
2 & 3	Electricity	Energy efficiency upgrades to buildings	H	Y	L	M	H	M	H	H
2 & 3	Electricity	Offset of electricity emissions	H	Y	H	H	H	H	L	H
2 & 3	Electricity	Revisit existing power purchase contracts and opportunity for green PPA	H	Y	L	H	M	H	H	M
3	Employee commute	Increase promotion and support for alternative travel options to campus	H	N	M	H	H	H	L	H
3	Employee commute	Support electric vehicle uptake, installing charging facilities across campus	H	Y	M	H	H	H	L	H
3	Air travel	Offset all travel related emissions	H	Y	M	H	H	H	H	H
3	Air travel	Encourage and incentivise low emissions business travel through current booking portal	M	N	M	H	H	H	L	M
3	Services	Review procurement process to identify supply chain opportunities and local markets	H	N	M	H	H	M	L	H
3	Waste	Consistency across campus regarding waste management	H	Y	L	H	H	M	M	M

Figure 28. Short-term opportunities for Curtin, assessed against scalability, capital required, co-benefit values, and partnership opportunities.

8.2.2 Curtin's journey: medium term (3–10 years)

In the medium term, once Curtin University has upgraded its network infrastructure, renewable energy should be increased on campus. Owing to the age of many buildings on campus and the concerns raised by PF&D on placing solar PV systems on some buildings, assessment should occur on the optimal placement of renewable energy generation. This may include car parks, shade structures around campus specifically built for that purpose, or use of surrounding land, such as land outside the Kalgoorlie or Midland campuses. Storage options to provide 24/7 renewable energy should also be investigated. Optimising energy consumption across campus to support both the use of the renewable energy and to provide grid stabilisation services to the SWIS can be undertaken. Continued retrofitting of existing buildings to improve energy efficiency can also occur. As the price of electric vehicles comes down and a greater range of vehicles is introduced, the electrification of all campus vehicles can occur. With two-way charging facilities, these vehicles could be used as batteries during the afternoon or evening when they are not being used by the maintenance team around campus. Salary packaging options for e-mobility solutions could also be employed to reduce Scope 3 emissions. Finally, as the current waste management contracts are renewed, consideration can be given to more targeted management of waste once it is removed from site.

Scope	Source of emissions	Opportunity	Opp. to scale (H/M/L)	Capital required (Y/N)	Values (H/M/L)					Partnership opp. (H/M/L)
					Social	Local	Curtin	Enviro	Other	
1	Diesel	Remove diesel use in buildings	L	Y	L	L	H	H	H	M
1	Diesel	Electrify fleet vehicles on campus	H	Y	L	H	H	H	H	H
2 & 3	Electricity	Increase onsite and offsite renewable energy generation and storage	H	Y	L	H	H	H	H	H
2 & 3	Electricity	Seek opportunities for more campus energy sharing and district cooling connections	H	N	L	H	H	H	H	H
2 & 3	Electricity	Optimise demand response across Curtin buildings to consume energy generated by renewable sources and based on occupancy	H	N	L	L	H	H	H	M
2 & 3	Electricity	Retrofitting of existing building stock to improve energy efficiency	H	Y	L	H	H	H	H	H
3	Employee commute	Salary packaging for e-mobility solutions	H	Y	M	H	H	M	L	H
3	Waste	Ensure proper management of waste once off-site	L	N	L	H	M	M	L	H

Figure 29. Medium-term opportunities for Curtin, assessed against scalability, capital required, co-benefit values, and partnership opportunities.

8.2.3 Curtin's journey: long term (10+ years)

While reducing emissions should occur as fast and as comprehensively as possible, some initiatives will require longer-term planning and decision making. Given development of campus buildings and sites is often planned 5–10 years in advance, consideration of opportunities needs to be integrated into decision making processes now. One of the largest opportunities Curtin has to reduce its emissions in the future is to ensure all new buildings and retrofits are built to high energy efficiency standards. Consideration of alternative materials in construction and renovations, both to reduce embodied carbon in the buildings and support the burgeoning local construction industry in this area, can be championed by the university. Research projects are already underway on how these can be undertaken in a broader WA and Australian context, while the Legacy Living Lab Curtin building shows that this is already possible. Future projects should leverage these initiatives.

As the gas infrastructure on campus comes to its end-of-life stage, replacement with electricity infrastructure should be undertaken. If this, and other initiatives, can be done sooner, this would contribute to reducing Curtin's emissions.

Scope	Source of emissions	Opportunity	Opp. to scale (H/M/L)	Capital required (Y/N)	Values (H/M/L)					Partnership opp. (H/M/L)
					Social	Local	Curtin	Enviro	Other	
1	Natural Gas	Electrify gas infrastructure	M	Y	L	H	H	H	H	H
2 & 3	Electricity	All new buildings built to be net zero emissions in construction and operation	H	Y	L	H	H	H	H	H

Figure 30. Long-term opportunities for Curtin, assessed against scalability, capital required, co-benefit values, and partnership opportunities.

8.2.4 Organisational culture recommendations

At an organisational level, a stronger commitment by Curtin University to emission reductions through a net zero target and plan will provide clear leadership and guidance towards which all levels of the organisation can work. This may be a standalone target or incorporated into existing sustainability-related policies and the ATN university targets. Working consideration of carbon emissions into business cases and everyday operational activities of the university will normalise and standardise activities. While the university is siloed into its faculties and operations, ensuring collaboration and knowledge sharing across these areas is crucial to visualising and implementing net zero activities. This is already underway, with the SDGs being incorporated into research and teaching activities; however, they can also be used as a framework for educating and communicating to staff and students actions they can take to decarbonisation their activities, in the space of broader sustainability actions. This could be supported through training modules for all staff and student that allow them to calculate their individual carbon footprint, develop an action plan based on recommendations for improvement, and provide reminders and social network support, as is being tested at Monash University. The use of the existing Explore Curtin program to deliver sustainability-related events and programs to the Curtin staff and student community is also recommended. Previous programs run by this group include the Park(ing) day, which transforms empty parking lots into liveable and creative spaces, workshops on everyday actions individuals can take to live more sustainably, and e-waste recycling collection days. Greater marketing of sustainability and decarbonisation initiatives that are being undertaken at Curtin within the internal and external community will support organisational cultural changes to consider decarbonisation activities as business-as-usual.

8.2.5 Teaching and learning

In the teaching and learning space, incorporating the SDGs across all units is currently being implemented. This will first strengthen understanding of how sustainability is connected across all areas and also provide opportunities to engage with practical projects in assignments. Some of these projects could be related to decarbonisation activities and tested by the university either in practical applications on campus or employed as pilots in undertaking operational changes such as procurement, waste management, employee education programs or energy retrofits. This would enable students to undertake practical projects and learn skills in project management and stakeholder engagement, improving their employability. Developing a Graduate Attribute for all courses based on the UN SDGs may also be undertaken to highlight the understanding students have after completing Curtin courses. Supporting students to undertake internships with industry partners on decarbonisation projects would also strengthen graduate skills and industry relationships with the university.

Diverse decarbonisation-related research activities are occurring across Curtin, many of which are being fed back into unit curricula. Efforts should be made to increase such activities while supporting cross-faculty teaching on decarbonisation initiatives, particularly between the Faculties of Science and Engineering, Business and Law, and Humanities, where much of the current net zero research or units are being undertaken.

8.2.6 Research

There are diverse research activities being undertaken across the university; however, many of these are isolated and there is limited cross-faculty discussion occurring. Curtin University is actively examining how it can better support and visualise climate-related research across the university, such as this project, and a current project of funding towards net zero related activities within the Faculty of Humanities. Directing funds towards net zero research projects will assist in innovation and dispersing of net zero technology, while using the campus as a living laboratory to test these should continue. Specific areas of research related to initiatives that could be undertaken by Curtin as proposed could be focused on including energy generation and storage systems, EVs, decarbonisation of business services including procurement and travel, and decarbonisation of buildings through retrofitting or load shifting and building optimisation. There is a desire within many existing research institutes or groups on campus to undertake smaller, practical testing of solutions on the campuses in network and renewable energy options, building renovations and retrofits, and building management systems and automation, which have been specifically identified during this project. Funding organisations including RACE for 2030 and FBI CRC are well placed to support these efforts.

Outside of using the campus as a living laboratory, visualising and cataloguing current research outputs related to net zero is being captured in a wider cataloguing of SDG-related research. The use of net zero and decarbonisation terms in research keywords in outputs and internal tracking systems may assist this. Future options for this include developing common repositories of knowledge on particular topics, making it easier to access practical projects that could be used for marketing of net zero research, and encouraging cross-faculty research collaboration. Emissions generated during research work are a small amount of Curtin's total emissions, but could be visualised by developing guidelines on understanding, reducing and offsetting the emissions generated or incorporating a section on environmental impacts to all ethics proposals for research projects.

8.2.7 Industry partnerships

Curtin University has existing partnerships with many organisations that could be leveraged to engage on net zero strategies. Building on existing strengths and opportunities in the research space through using funding and partnerships with existing industry partners will contribute to knowledge transfer, building organisational cultures of net zero in all partners and moving Curtin further towards an anchor institution role in society. Many of Curtin's existing partner organisations already have net zero targets or plans in place. Aligning Curtin to these partner targets will help strengthen wider community linkages, illustrating the leadership role the university is taking in this space. Some of the net zero commitments of Curtin's industry partners are shown in Table 6.

RACE for 2030 has over 70 partners across a wide range of industry sectors, which can also be engaged for decarbonisation projects. Listed in Table 7 is a selection of partners that may be interested in projects suggested as key opportunities above. As RACE for 2030 is funded until 2030, there is ample opportunity for Curtin researchers and PF&D to engage with these partners on practical projects in the decarbonisation space.

Table 6. Existing industry partners of Curtin that have net zero or related commitments compiled on publicly available information.

Curtin industry partner	Net zero target
Alcoa	Scope 1 and 2 emissions reduction by 30% by 2025 and 50% by 2030
BHP	Net zero Scope 1 and 2 by 2050
Chevron	Net zero Scope 1 and 2 by 2050
Cisco Systems	Net zero by 2040 across all Scopes
Fortescue Metals Group	Net zero Scope 1 and 2 by 2030, net zero Scope 3 by 2040
Lendlease	Net zero Scope 1 and 2 by 2025, net zero Scope 3 by 2040 with no offsets
Optus	Net zero emissions by 2050
Rio Tinto	Net zero Scope 1 and 2 by 2050
Stockland	Net zero Scope 1 and 2 by 2028
Water Corporation	WA State Government aligned net zero by 2050
Wesfarmers (retail)	Net zero Scope 1 and 2 by 2030
Western Power	WA State Government aligned net zero by 2050
Woodside	Scope 1 and 2 15% emissions reduction by 2025, 30% by 2030, net zero by 2050

Table 7. RACE for 2030 industry partners that may align with Curtin project initiatives in the net zero space.

AGL	Ausgrid	Australian Alliance for Energy Productivity (A2EP)
Climate-KIC Australia	DPIE (NSW)	Planet Ark Power
PowerPal	RedGrid	Starling Energy Group
Sunovate	Selectronic	SwitchDin
DELWP (Victoria)	WePower	Western Power

9 Case studies

9.1 Climate Impact Lab: Glebe Energy Transitions (UTS)

9.1.1 Context

UTS's net zero strategy outlines how UTS will eliminate direct and indirect carbon emissions from its operations. However, educational institutions such as UTS can and must do more than simply find their own path beyond net zero carbon emissions; they must harness their teaching, learning and research to seed the foundations of a climate positive economy that works for all citizens. Universities can play a critical role as anchor institutions for socially-focused value creation within a defined region (McNeill *et al*., 2020). They are also an ideal location for 'living laboratories' that can test, accelerate and scale solutions to contribute not only to reducing carbon emissions but to achieving the UN SDGs (Verhoef & Bossert, 2019).

While UTS has several sustainability-focussed centres and departments, there is currently limited institutional architecture for applying its deep teaching, learning and transdisciplinary research resources to tackling these climate challenges.

9.1.2 A vehicle for climate positive impact

The Climate Impact Lab (CIL) will create a vehicle that connects UTS research, teaching and learning with community, industry and local social and environmental entrepreneurship partners, by applying collaborative innovation processes to climate challenges. Delivered as a partnership between the **Centre for Social Justice and Inclusion** (CSJI), the **Institute for Sustainable Futures** (ISF) and **UTS-Sustainability**, the goals of the CIL are to:

- apply transdisciplinary thinking to solve real climate challenges by harnessing the breadth of UTS expertise beyond just those disciplines explicitly focussed on sustainability
- deploy UTS researchers and students as resources to:
  - identify and support climate innovation projects with local community partners
  - develop climate-focussed social impact or industry partner supply chains
  - examine tricky longer-term UTS goals for decarbonising its supply chains, and
- create opportunities to use UTS's campuses and broader precincts as testing grounds for new ideas and technologies from UTS research or external partners.

The CIL will provide applied problem-solving experience and capabilities for UTS graduates, and create a platform to extend the impact of UTS's net zero plan beyond campus boundaries into local precincts and communities via industry supply chains and community engagement.

A host of impact lab challenges have been identified to support UTS's net zero plan to both help UTS eliminate its own emissions, and to extend UTS's impact to staff, students, industry and community partners. To demonstrate the viability of the CIL and delivery structure, a pilot project has commenced, as detailed below.

9.1.3 Pilot project concept

The founding pilot project of the CIL, known as Glebe Energy Transitions (GET) will focus on assisting the Glebe community—a large proportion of whom are vulnerable low-income households—to rapidly decarbonise their housing stock through deep energy efficiency retrofits and rooftop solar. This initiative builds on UTS's existing work over several years with the local Glebe community, exploring opportunities to apply its expertise to generate social value in the local area, while creating new opportunities for teaching, learning and research.

There are barriers to rapidly transforming our building stock, such as upfront costs with extended payback periods, misaligned incentives between landlords and tenants, and the transaction costs associated with implementing multiple small measures by a range of different tradespeople. Climate-KIC Australia and RACE for 2030, through the initial One Million Homes Fast Track project and its likely successors, are exploring options for delivering energy for deep retrofits at scale across Australia, and within this, different deployment models to achieve high uptake. The GET project will explore how UTS, with its existing research and teaching strengths in smart, sustainable and healthy built environments, and its strong staff, student and local area links and social networks, could be an effective facilitating agent to catalyse and deliver uptake of deep energy efficiency, solar and smart home retrofits.

For example, with the assistance of software tools, such as the Ecologic assessment and retrofit platform (see Section 8.1.8), distributed energy audits could be undertaken by lightly-trained community members, UTS students or residents, with guidance from UTS experts, to help identify the most cost-effective and consequential opportunities for energy savings. Glebe stakeholders would then be brought together to co-design the opportunities for fulfillment by local businesses or social enterprises.

9.1.4 Key partners and potential roles

Potential project partner	Potential role
UTS faculties (DAB, Business School, ISF, TDI)	Project design and coordination
UTS students	Energy auditing, research data collection & community support
UTS researchers	Monitoring and evaluation of resident outcomes
EnergyLab and UTS Startups	Linking commercialisation of entrepreneurial opportunities
Climate-KIC Australia	Finance design and delivery logistics structure
Local businesses	Trades and supply chain delivery
Financial institutions/Super funds	Project finance
NSW government agencies	Social housing landlord
Glebe Community representatives	Local community representation, communication, coordination
Glebe services (e.g. Tranby, Glebe Youth Service)	Exploration of supply chain skill development
RACE for 2030	Research funding

9.1.5 Pilot project development

The chosen path for further developing the GET project concept is illustrated in Figure 31.

Stage 1: Problem scoping—The initial problem scoping phase was conducted as part of this Green Wave project. It consisted of a series of meetings between ISF and CSJI staff to further explore the viability of the pilot from UTS's perspective, seeking to:

- identify what questions need to be answered before the pilot lab process can proceed
- conduct initial scoping of carbon emissions reduction opportunities in Glebe
- determine mechanisms for assessing emissions reduction and social benefits
- identify suitable customer segments (e.g. social housing, private housing, staff and students) and associated implications for deployment business models
- map stakeholders and begin conversations with key stakeholders.

Stage 2: Stakeholder workshop (0.5–1 day)—A stakeholder workshop is scheduled for 9 December 2021. This preliminary work is being supported by funding and substantial in-kind contributions from CSJI and ISF. An application has also been lodged by the project team for substantial additional UTS strategic funding to support further development of the pilot beyond the workshop and establish the minimum infrastructure required for ongoing operation of the Climate Impact Lab model. The workshop will be used to explore project viability from a stakeholder perspective, testing the assumptions developed in the pilot scoping. A short briefing paper and video have been developed and will be distributed prior to the workshop. The briefing materials are accessible to both the community and experts, and outline a series of propositions to explore. Stakeholders for a social housing focus in Glebe include the NSW Department of Communities and Justice (DCJ), NSW Department of Planning, Industry and Environment (DPIE), and local community representatives and services. A number of potential financial partners have also been invited (e.g. City of Sydney). Following the workshop, the project partners are expected to convene to confirm the viability of progressing and use information from the workshop to begin planning the next stage.

Stage 3: Intensive lab investigation (about two days)—Following the workshop, an intensive lab investigation is expected to be held involving UTS stakeholders, including academics (e.g. DAB, Business, TD School and other faculties), researchers, experts (e.g. UTS Startups and UTS Rapido), the community and industry stakeholders as guests. This investigation would explore issues and opportunities identified through the stakeholder workshop. Through rapid exploration and ideation, the investigation could identify viable project areas that would benefit from further investigation through universities assets (e.g. teaching and learning, research). The investigation could also include community site visits and an immersion into lived experience, and may break into different focus areas (e.g. technology, community, teaching and learning) based on outcomes. It is proposed that, after the initial lab intensive, there be two half days at intervals of two weeks each. These intervals allow for work to be done on ideas, such as identification of further stakeholders, stakeholder engagement to test project ideas, initial community engagement to gauge support, and identification of possible funding sources.

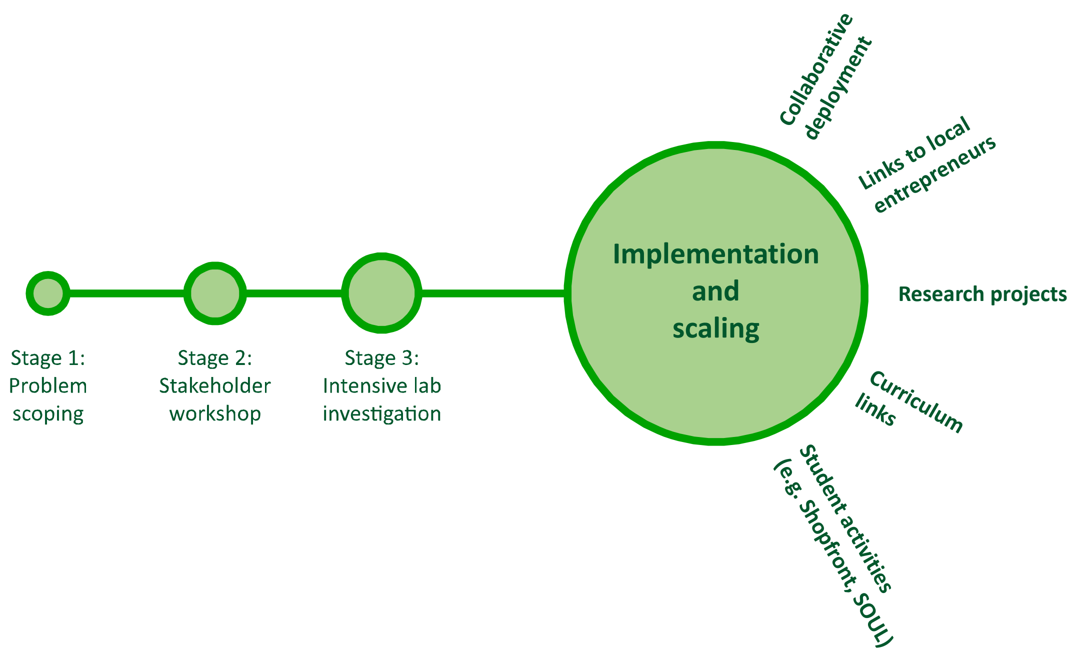
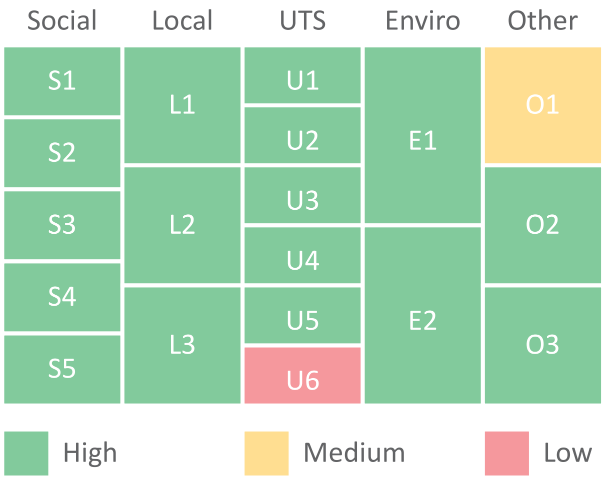


Figure 31. Process for scoping, workshopping, investigating, implementing and scaling solutions as part of the living lab approach.

9.1.6 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other value.



S1: Targets social disadvantage and inclusion
S2: High proportion of capital tied to social purpose outcomes or impact
S3: Systemic support of new businesses (social enterprise, non-profits, investment, incubation, research services and technical assistance)
S4: High proportion of expenditure covered by supply chain standards
S5: Potential to support indigenous empowerment

L1: Supports local area employment
L2: High proportion of spending invested within local area
L3: Contributes to socially just use of land and property

U1: Student marketing and branding benefits
U2: Creates long-term community and industry partnerships
U3: Enhances teaching and learning experience (including internships, career pathways, etc.)
U4: Provides a test bed for UTS research
U5: Enhances transdisciplinarity
U6: Better outcomes for campus building users

E1: Scale of potential catalytic benefit (reductions beyond UTS)
E2: Improves circularity of supply chain materials

O1: Energy system reliability
O2: Lower energy bills
O3: Other financial benefit

9.2 Best practice PPAs (UTS)

9.2.1 Context

In 2015, UTS developed Australian-first innovations in contracting mechanisms to purchase power from a Singleton solar farm. UTS is looking to decarbonise the rest of its emissions from electricity consumption (58% of total emissions), through signing one or more PPAs. Over the last four years, such corporate PPAs, spurred by increasing public renewable energy commitments and favourable market conditions, have underpinned more than $5 billion of investment (BRC-A, 2021) in over 3 GW of new wind and solar projects across Australia (BRC-A, 2020).

As demand has grown for corporate PPAs, the market has responded with a proliferation of different PPA models. This diversity of models provides choice for buyers and opens up corporate PPAs to a wide range of organisations. Some PPAs go further than others in requiring additional commitments such as local employment, biodiversity or energy storage as part of the deal. Clearly, not all PPAs are created equal in terms of their impact on energy system transformation or additional outcomes.

In its recent discussion paper (BRC-A, 2021), the Business Renewables Centre-Australia (BRC-A) suggests a three-tier rating system for PPAs, namely:

1. **Gold**—Directly supports new renewable investment and includes additional commitments that deliver on social, environmental and economic outcomes.
2. **Silver**—Directly supports new renewable investment but does not include any additional commitments.
3. **Bronze**—Contract with operating wind or solar farm.

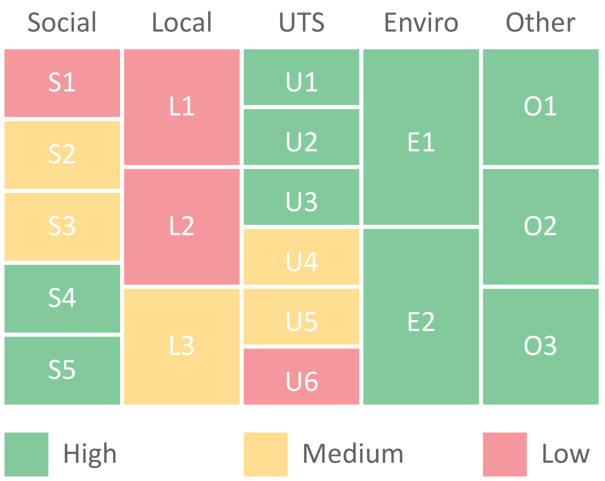
9.2.2 Project concept

By adopting a Gold standard PPA, UTS can maximise impact from its investment. Such a PPA would:

- involve a contract with a pre-finance project either directly or via a retailer
- include storage and/or load matching to reduce or eliminate requirement for firmed 'black' electricity
- enable a multiple of more new generation capacity than the buyer organisation has the capacity to contract
- include commitments aligned to environmental, social and economic outcomes, such as:
  - Local employment and training
  - Local education
  - Energy storage
  - Biodiversity objectives
  - Community energy component
- full LGC retirement.

9.2.3 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other.



S1: Targets social disadvantage and inclusion
S2: High proportion of capital tied to social purpose outcomes or impact
S3: Systemic support of new businesses (social enterprise, non-profits, investment, incubation, research services and technical assistance)
S4: High proportion of expenditure covered by supply chain standards
S5: Potential to support indigenous empowerment

L1: Supports local area employment
L2: High proportion of spending invested within local area
L3: Contributes to socially just use of land and property

U1: Student marketing and branding benefits
U2: Creates long-term community and industry partnerships
U3: Enhances teaching and learning experience (including internships, career pathways, etc.)
U4: Provides a test bed for UTS research
U5: Enhances transdisciplinarity
U6: Better outcomes for campus building users

E1: Scale of potential catalytic benefit (reductions beyond UTS)
E2: Improves circularity of supply chain materials

O1: Energy system reliability
O2: Lower energy bills
O3: Other financial benefit

9.3 24/7 renewables (UTS)

9.3.1 Context

UTS's draft net zero strategy includes sourcing 100% of its electricity needs from renewables, predominantly through off-site generation via direct PPAs, as outlined above. Across Australia, investments in renewable energy sources such as solar and wind are driving down wholesale prices for electricity and rapidly transforming the electricity sector.

One of the main barriers slowing uptake of renewables is their intermittency. Without adequate storage, renewable generators can only provide grid electricity when the sun is shining or the wind blowing. Our current grid electricity supply therefore still relies heavily on fossil fuel generators. However, a completely decarbonised electricity sector can be achieved using a combination of renewable generators, storage and flexible demand—i.e. shifting some loads to times when renewable energy is abundant. Electricity users such as UTS can support the transition to carbon-free energy by moving towards 24/7 renewables. This strategy has now been adopted by several global companies, including Google, Microsoft and PwC, as outlined in Section 2.6.

9.3.2 Project concept

UTS can begin moving towards 24/7 renewables through a combination of:

- flexible demand
- on-site energy storage (see Section 9.4)
- purchasing of renewable energy backed by grid storage or other forms of renewable firming.

Flexible demand largely involves moving electricity consumption to a different time of day, as illustrated in Figure 32.

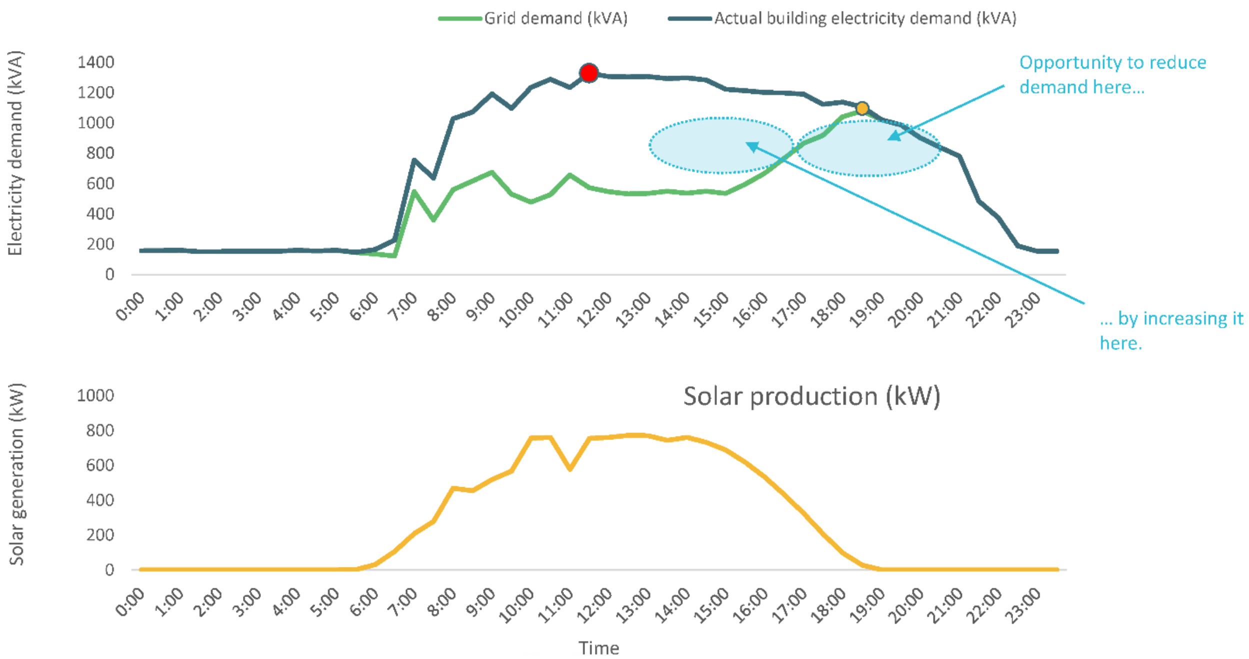


Figure 32. Shifting electricity demand from one time of day to another can support both on-site and off-site renewables, moving us closer to a decarbonised electricity system running on 24/7 renewables. (Source: Buildings Alive)

Much of UTS's energy use is driven by HVAC loads on its buildings. Commercial buildings such as those operated by UTS are a good fit for renewables, particularly solar, as they tend to use more electricity during the day than at night. Traditional building energy management focusses on reducing overall energy use and reducing overall peak demand, will little regard for timing other than to minimise overall peak consumption.

For an organisation such as UTS, there are several internal and external advantages to shifting energy use, including:

- **Reduced energy costs**—Renewables are now the cheapest source of energy across much of Australia's electricity networks. While wholesale electricity prices fluctuate at half-hourly intervals, they tend to be lowest during times of peak renewable energy generation, such as during the middle of the day, and highest in the early morning and early evening, when solar generation is less available. This is demonstrated in Figure 33 and Figure 34. Using energy at times when renewables are abundant could therefore reduce energy costs. UTS could take advantage of this by either (1) switching its electricity contract to a tariff structure that reflects wholesale electricity prices, rather than its current tiered pricing, or (2) collecting data to show that the time-of-use profile for UTS's electricity demand matches times of low wholesale electricity prices, and use this to negotiate a lower tariff.
- **Reduced GHG emissions**—Shifting energy use to maximise use of renewables would clearly decrease carbon intensity. As shown in Figure 35, using a single carbon intensity factor derived from the National Greenhouse Accounts (NGA) can grossly overestimate carbon emissions. A more rigorous approach is to use a time-varying carbon intensity factor. Use of such a factor in UTS's carbon accounting provides an incentive to shift energy use and minimise its emissions.
- **Supporting electricity system transformation**—Shifting energy to support renewables supports greater grid-penetration of clean energy sources and moves us close to an electricity system powered by 24/7 renewables.

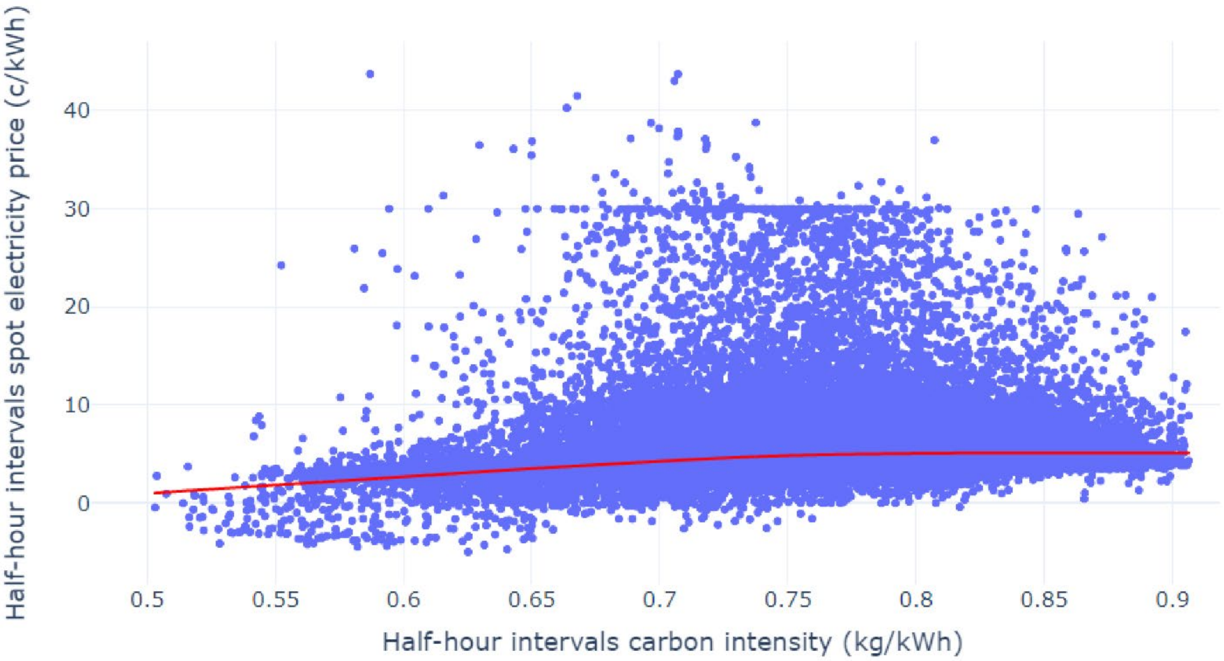


Figure 33. Across Australia's electricity networks, there is a growing correlation between the price of electricity and its carbon intensity. Hence shifting energy use to maximise use of renewables can both decrease carbon intensity while reducing energy costs. (Source: Buildings Alive)

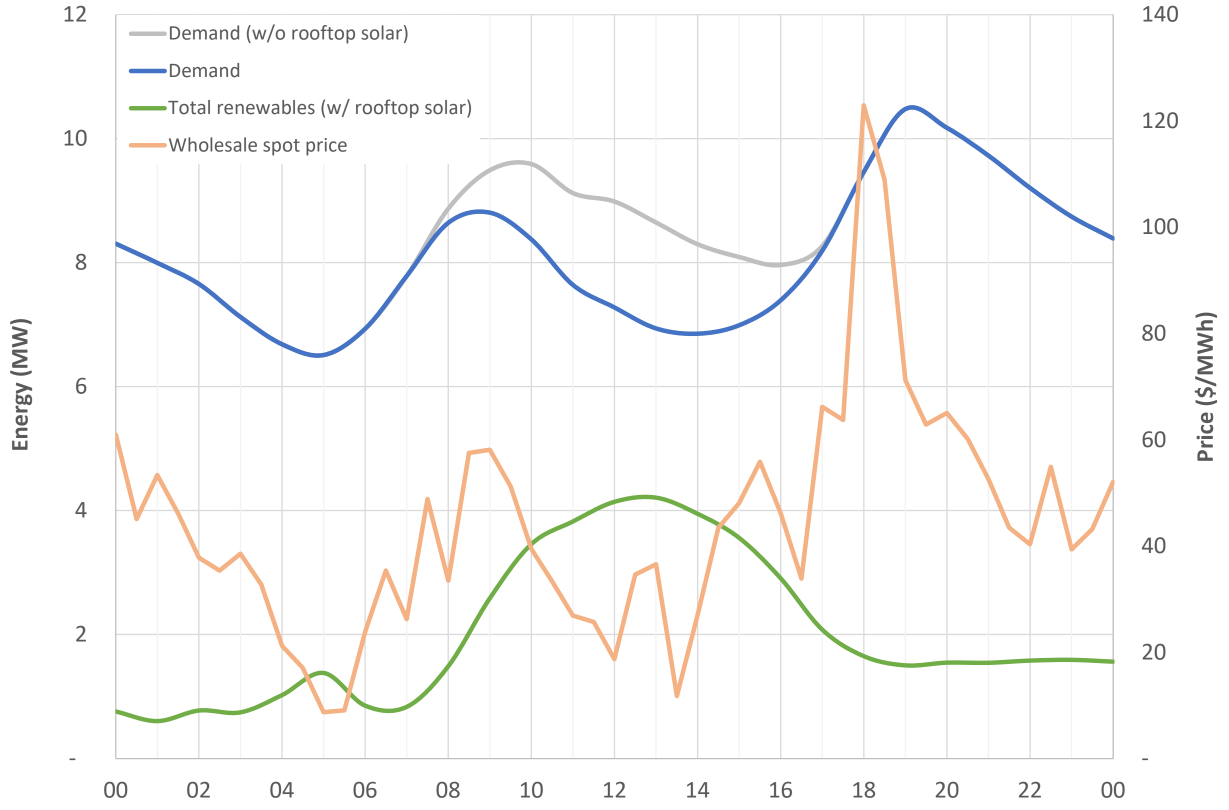


Figure 34. Demand and price profiles for NSW grid, 3 August 2021. Wholesale electricity prices tend to peak at times of high demand, such as early morning and evening. Conversely, prices are typically low in the middle of the day with renewable supply is abundant. Source AEMO and APVI.

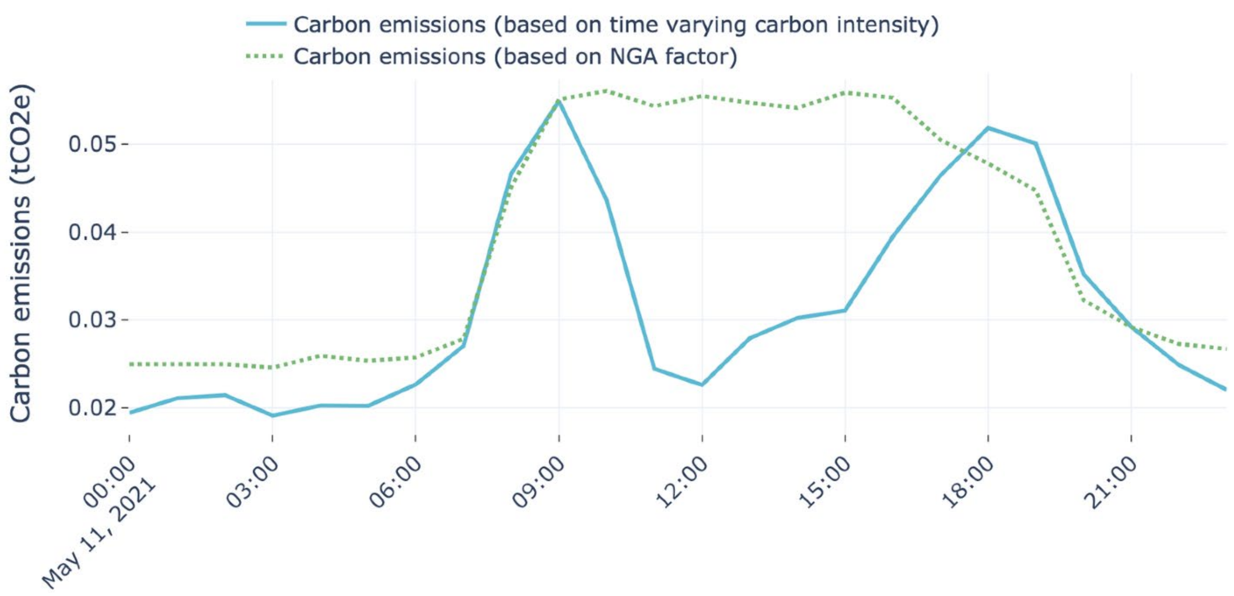


Figure 35. Calculating carbon emissions based on a single NGA factor can be misleading. (Source: Buildings Alive)

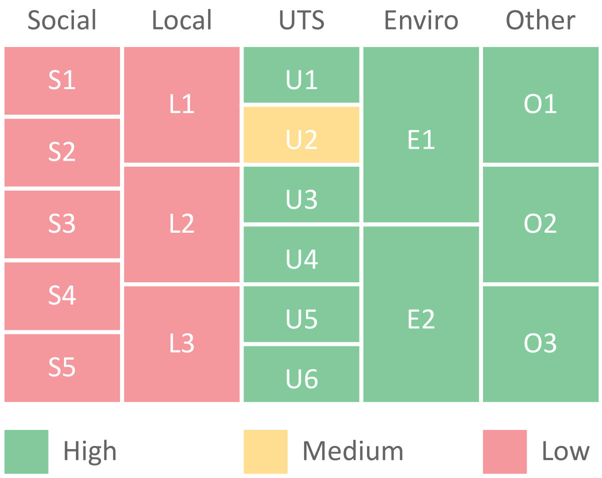
On-site energy storage can be achieved through installation of lithium-ion batteries, as described in Section 9.4. This would allow additional options for managing building energy flows to further reduce electricity costs and support increased grid penetration of renewables. Given the modularity of battery storage technology, there are few scale advantages of installing larger batteries closer to generation sources, but significant advantages to locating smaller batteries near the end of the distribution network, where the value of electricity is greatest.

Improved demand response through building energy management can be achieved through the following initiatives:

- continued and expanded monitoring of building energy use through partners such as Buildings Alive.
- adoption of suitable building energy management policies to minimise costs and/or carbon intensity
- ongoing research into the capacity and strategies for shifting building energy use
- training of building managers to under a new paradigm of minimising total carbon intensity and/or cost based on varying emission intensity factors and/or electricity prices
- shifting towards tariffs that reflect wholesale electricity pricing, beginning with a one-year pilot on Building CB10, to incentivise real-time flexible demand
- installing batteries for on-site energy storage, beginning with a pilot program described in Section 9.4.

9.3.3 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other.



S1: Targets social disadvantage and inclusion
S2: High proportion of capital tied to social purpose outcomes or impact
S3: Systemic support of new businesses (social enterprise, non-profits, investment, incubation, research services and technical assistance)
S4: High proportion of expenditure covered by supply chain standards
S5: Potential to support indigenous empowerment

L1: Supports local area employment
L2: High proportion of spending invested within local area
L3: Contributes to socially just use of land and property

U1: Student marketing and branding benefits
U2: Creates long-term community and industry partnerships
U3: Enhances teaching and learning experience (including internships, career pathways, etc.)
U4: Provides a test bed for UTS research
U5: Enhances transdisciplinarity
U6: Better outcomes for campus building users

E1: Scale of potential catalytic benefit (reductions beyond UTS)
E2: Improves circularity of supply chain materials

O1: Energy system reliability
O2: Lower energy bills
O3: Other financial benefit

9.4 PPA + battery + retail offering (UTS)

9.4.1 Context

A majority of UTS's emissions (55.7% in 2020–21) are a result of using electricity. As outlined in Sections 9.2–9.3, to reduce and eventually eliminate these emissions, UTS is looking to source all of its electricity from 100% real-time renewables through a combination of PPAs, storage and flexible demand.

Retail energy consumers are able to source their electricity from 100% renewables through various retail offerings. While an increased demand for renewable energy generally supports increased grid penetration of renewables and a corresponding reduction in burning of fossil fuels, these various green electricity retail offerings are of varying quality in terms of their impact and ability to fund new renewable generation capacity, fuelling consumer uncertainty and mistrust. And unlike large energy consumers, individual retail customers are too small to directly fund new centralised renewable energy generators through a PPA. These are among the factors driving uptake of rooftop photovoltaic solar systems for home owners with suitable roof space, and community-owned solar gardens for those without.

9.4.2 Project concept

In the first instance, the project would involve UTS signing a direct PPA to fund construction of new renewable generation capacity, as outlined in Section 9.2. If the size of this PPA were to exceed UTS's immediate requirements, it would provide an excess that could be used in a retail offering. The PPA could also be extended to include pumped hydro or other centralised energy storage to facilitate the move towards 24/7 renewable energy, as outlined in Section 9.3.

As part of a proposed pilot, UTS would install an 'over-sized' battery in Building CB10. The capacity of the battery would exceed the requirements for Building 10 to meet 24/7 targets, and the excess capacity would be used to firm the excess capacity from the PPA. UTS would then partner with a suitable energy retailer to create a special 'UTS Tariff', with a competitive tariff of no more than $0.15/kWh. This tariff would then form part of a retail offering to local businesses, staff, students and others within UTS's sphere of influence, effectively paying for the expand size of the PPA and battery. By lending its credibility to the retail offering and expanding the PPA, UTS would facilitate greater investment in renewables for greater impact on reducing carbon emissions.

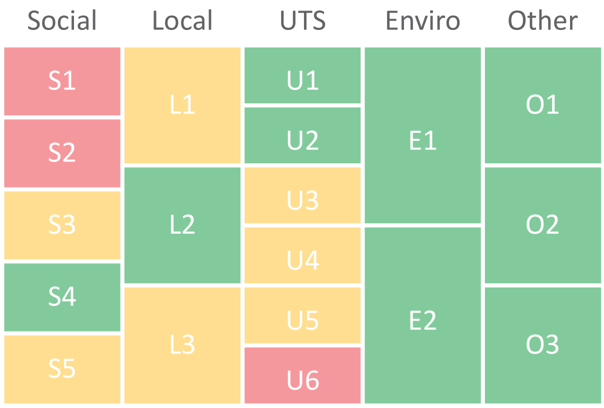
An expanded PPA provides greater economies of scale, potentially reducing UTS's electricity costs. The project would also provide UTS with a number of co-benefits, particularly in terms of marketing and branding, and creating long-term community and industry partnerships. For those who take up the retail offer, advantages would include a competitive electricity price, underwritten by UTS's purchasing power, and a guaranteed supply of 100% renewable energy from a trusted source.

9.4.3 Partners and logistics

Further details of the opportunity are currently being developed with CleanPeak. While this may proceed directly as a pilot project, any expansion would likely require a tender process.

9.4.4 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other.



S1: Targets social disadvantage and inclusion
S2: High proportion of capital tied to social purpose outcomes or impact
S3: Systemic support of new businesses (social enterprise, non-profits, investment, incubation, research services and technical assistance)
S4: High proportion of expenditure covered by supply chain standards
S5: Potential to support indigenous empowerment

L1: Supports local area employment
L2: High proportion of spending invested within local area
L3: Contributes to socially just use of land and property

U1: Student marketing and branding benefits
U2: Creates long-term community and industry partnerships
U3: Enhances teaching and learning experience (including internships, career pathways, etc.)
U4: Provides a test bed for UTS research
U5: Enhances transdisciplinarity
U6: Better outcomes for campus building users

E1: Scale of potential catalytic benefit (reductions beyond UTS)
E2: Improves circularity of supply chain materials

O1: Energy system reliability
O2: Lower energy bills
O3: Other financial benefit

9.5 Electrification (UTS)

9.5.1 Context

Burning of natural gas results in direct emission of carbon dioxide into the atmosphere. Natural gas is also rich in methane, a potent greenhouse gas (GHG), leakage of which from natural gas production, processing and distribution contributes significantly to Australia's overall GHG emissions (CSIRO, 2017). California has recently passed new energy codes that incentivise electric appliances and efficient heating and cooling systems, at the expense of gas heating (Kahn, 2021). In July 2019, Berkeley became the first city in the USA to ban natural gas in most new buildings (Morris, 2021). In its recently released roadmap report, the International Energy Agency (IEA) recommends that a ban on new fossil fuel boilers in buildings be introduced globally in 2025 (IEA, 2021).

In 2020/21, 9.7% of UTS's overall and 94% of its Scope 1 GHG emissions (5600 t CO_2-e) resulted from on-site burning of natural gas, predominantly for heating water, which is then used for space heating and domestic hot water.

To reduce and eventually eliminate its Scope 1 emissions, UTS must move away from on-site burning of natural gas. The available alternatives are:

1. **Biogas**—Replacing natural gas with biogas sourced from anaerobic digestion (see Section 8.1.11).
2. **Synthetic fuels**—Replacing natural gas with synthetic methane or hydrogen produced using renewable energy.
3. **Electrification**—Replace natural gas boilers with efficient heat-pump water heaters (HPWH), powered by 100% renewables.

Unfortunately, none of these options provides an easy solution. Biogas is relatively expensive to produce and is not currently readily available in the quantities required. Synthetic methane or hydrogen are not yet commercially available, but may become commonplace by 2030. HPWHs are among the more immediate and promising options. They operate much like a reverse-cycle air conditioner, with a typical coefficient of performance (COP) of around 4.0, meaning that each kilowatt of electrical input power is converted into four kilowatts of heat. Waste heat can also be utilised to improve efficiency.

While HPWHs are available for domestic applications, the industry for commercial-scale heat pumps is relatively immature, with very few example projects. Furthermore, there is currently little knowledge or experience at UTS with implementation or use of heat pumps for space or water heating.

9.5.2 Project concept

The project involves a series of investigations to identify the most viable and least complex opportunities for installation of heat pumps at UTS, and establish pathways to reducing and eventually eliminating on-site burning of natural gas across all UTS operations. Examples of similar projects, both domestic and international, can be investigated and analysed provide guidance. Monash University, for example, currently relies heavily on gas heating and is planning a re-build of its campus hot water loop to facilitate electrification, as part of its Net Zero Initiative.

While electrification of gas infrastructure will increase UTS's demand for electricity, this electricity can be sourced from 100% renewables (see Section 9.2) to reduce overall emissions. HPWHs can also include water storage tanks, allowing them to flex demand to operate when electricity prices are low and switch off when prices are high, much like a battery, to reduce running costs and support grid integration of more renewables (see Section 9.3).

As summarised in Table 8, UTS owns a range of gas infrastructure, including a number of large gas-fired boilers used for space heating, and some smaller systems used for hot water. The central plant located in CB01 has three gas-fired boilers with a total capacity of 7.3 MW, from which it supplies heating water and domestic hot water to a number of UTS buildings. Within each building, heating water is piped to individual air handling plants, where heat transfer takes place and heated air is distributed by ductwork systems. There are several other stand-alone gas-fired boilers in other UTS buildings.

The smaller systems domestic water heating systems represent lower-hanging fruit for achieving early gains and developing pathways for addressing the more challenging larger systems. Nearby cafes and commercial kitchens, though relatively small, may also offer meaningful targets for electrification in terms of impact, narrative and demonstration.

Table 8. Summary of gas plant at UTS.

Category	Building	Size (MW)	Notes
Space heating	CB01	7.3	Central plant, three gas-fired boilers, which supply several buildings
	CB10	1.8	
	CB05	0.8	
	CB08	1.4	
	CB15	0.4	
Domestic hot water	CB01 CB10		
	Yura Mudang		Previous investigation demonstrated heat pump replacement is feasible, supplementary to current boiler
Other	Café 10 (CB10) Tower Café Haberfield Rowing Club		

9.5.3 Benefits

Switching from natural gas to heat pump water heating, powered by 100% renewables, would (1) cut UTS's GHG emissions by 5600 t/a CO_2-e, and (2) reduce operating costs.

UTS currently purchases about 46 PJ/a of natural gas at an annual cost of about $786,600 (at $0.0171/MJ).[25] Assuming an existing thermal efficiency of 78.8%, as per AS/NZS 4234:2008 (DELWP, 2021) and replacement of all gas-fired boilers with equivalent heat-pump water heaters with thermal efficiencies of 85% and COPs of 4.0, the equivalent electrical load would be:

$$\frac{46{,}000 \times 78.8}{3.6 \times 85 \times 4} = 2961 \text{ MWh}$$

At an average electricity price of $0.17/kWh, the annual operating cost would be $503,444, an annual saving of $283,156 (36%).

9.5.4 Next steps

Given the size of the UTS central plant and the lack of available space, fully electrifying this plant *in situ* is not technically feasible. An alternative is to decentralise the central plant by adding water heating capacity to other buildings, beginning with a pilot project to add 200 kW of heating capacity to neighbouring buildings. Another pilot project involves installing three HPWHs to satisfy the domestic hot water requirements for the following UTS buildings. Such pilot projects are of much smaller scale than full replacement of the central plant boilers. They therefore involve less risk and lend themselves to research to inform the larger electrification work.

Table 9. Estimated costs of early stage electrification projects.[26]

Buildings	Estimated cost ($)
CB01 and CB02	400,000
CB04 gymnasium	250,000
CB06A housing	250,000
Total	**900,000**

UTS has recently engaged a consultant to conduct a feasibility study on the above options. This feasibility study will investigate likely capital costs and payback periods. Next steps can be planned once this study has been completed.

9.5.5 Links with UTS research

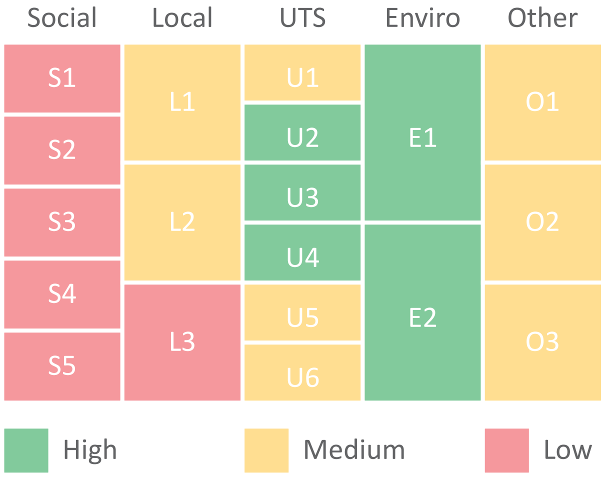
The pilot projects outlined above can be linked to research projects conducted in collaboration with UTS faculty and students, with funding potentially available through partners such as the RACE for 2030 and its industry partners such as the Australian Alliance for Energy Productivity (A2EP). A2EP is an independent, not-for-profit coalition of research, business and government leaders helping Australian businesses pursue a cleaner and more successful future by producing more with less energy.

25 UTS internal communication to Sustainability Steering Committee.

26 *Ibid.*

9.5.6 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other.



S1: Targets social disadvantage and inclusion
S2: High proportion of capital tied to social purpose outcomes or impact
S3: Systemic support of new businesses (social enterprise, non-profits, investment, incubation, research services and technical assistance)
S4: High proportion of expenditure covered by supply chain standards
S5: Potential to support indigenous empowerment

L1: Supports local area employment
L2: High proportion of spending invested within local area
L3: Contributes to socially just use of land and property

U1: Student marketing and branding benefits
U2: Creates long-term community and industry partnerships
U3: Enhances teaching and learning experience (including internships, career pathways, etc.)
U4: Provides a test bed for UTS research
U5: Enhances transdisciplinarity
U6: Better outcomes for campus building users

E1: Scale of potential catalytic benefit (reductions beyond UTS)
E2: Improves circularity of supply chain materials

O1: Energy system reliability
O2: Lower energy bills
O3: Other financial benefit

9.6 Algal carbon capture and use (UTS)

9.6.1 Context

To become climate positive, organisations such as UTS must reduce existing emission using a range of measures such as renewable energy and energy efficiency, before offsetting residual emissions using some form of carbon sequestration. While UTS can directly purchase carbon offsets from commercial providers such as South Pole, there are substantial advantages to UTS directly investing in projects to create its own carbon offsets, such as:

- **Reduced price risk**—Increasing demand for offsets, as corporations seek to meet Net Zero targets, is likely to drive future prices for offsets higher. Current investments can reduce this price uncertainty to reduce price risk.
- **Links to research**—Offsets projects can create significant opportunities for UTS research with both local and global impacts.
- **Links to teaching and learning**—Offsets projects can create significant teaching and learning opportunities for UTS students.
- **Addressing other SDGs**—Many offsets projects can have a wide range of additional social, environment and economic benefits, through addressing United Nations Sustainable Development Goals.

Carbon dioxide can be removed from the atmosphere using nature-based sinks, such as forests, soils and marine ecosystems ('blue carbon'). These options are technically viable and relatively cost-effective at less than $20 per tonne of CO_2 removed. However, they can be slow, vulnerable to ecosystem degradation, and are not deployable at an industrial scale.

An alternative sequestration method is capture of carbon dioxide using microalgae from waste gases or air (direct air capture—DAC). Algae produce half of the world's oxygen, via photosynthesis. They can also grow up to 10 times faster than land plants and are up to five times more efficient than trees at absorbing carbon. While the technology for microalgal carbon capture is still being developed and currently exists mostly at a pilot scale, it has enormous potential.

Two of UTS' leading research groups, the Climate Change Cluster (C3) and the Centre for Technology in Water and Wastewater (CTWW), are collaborating to solve the challenge of removing atmospheric carbon dioxide using microalgae. The Green Genie is a modular CO_2 capture unit (shipping container) using microalgae to sequester CO_2 in the form of algal biomass. This biomass can be transformed into any number of carbon-based products, including bioplastics, biofuels, animal feed and food. Each Green Genie unit has a current capacity to capture approximately 7 tonnes/year of CO_2.[27] Both yield and operating costs are expected to improve substantially over coming years as the technology is further developed and scaled, in the same way that renewable energy technologies such as photovoltaic cells have increased in efficiency and decreased in cost by several orders of magnitude in recent years.

9.6.2 Project concept

The project would begin with UTS piloting one Green Genie unit on its Ultimo campus. This pilot would be used to:

- demonstrate the utility of the system to potential users, including property managers and developers, government agencies, SMEs and other organisations
- engage students in teaching and learning
- demonstrate practical leadership in climate change solutions, and
- further research, development and commercialisation of the technology.

Once the Green Genie technology is fully developed, UTS could deploy multiple units on its Ultimo campus to directly capture carbon dioxide from the atmosphere. This could lead to further applications of the technology, both on campus and in the Ultimo precinct, such as:

- expansion to increase removal of atmospheric CO_2
- removing CO_2 from exhaust gases of on-site gas-fired boilers
- removing CO_2 from exhaust gases of tri-gen gas turbines (CHP) at Central Park
- removing CO_2 from biogas food waste or sewage anaerobic digestors, and
- scrubbing CO_2 from building air.

There are also opportunities to pair this last option with smart building management to reduce air exchange within buildings, reduce overall energy use and better match time of energy use to support renewables.

9.6.3 Pilot project

UTS is expected to have its first full-scale prototype unit ready by September 2022.[28] The pilot project would involve showcasing this unit and integrating it into the UTS building operations plan, for the purposes of demonstrate its potential. The project would proceed in four stages:

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[27] UTS internal communication.

[28] This assumes success in attracting support from a philanthropic funding round that is due to be announced in September 2021. That project was budgeted at $800,000.

Stage 1: Scoping, feasibility analysis and costing—A desktop analysis would be performed to determine pilot location, source of carbon dioxide (e.g. exhaust gas from boiler, biogas, building air or atmospheric CO_2), feasibility and estimated cost. *Deliverables:* Detailed feasibility report. *Duration:* Three months. *Estimated cost:* $25,000.

Stage 2: Adaptation of Green Genie to carbon source—The chosen carbon source will define the system biology (algal species and nutrient media) and chemistry of the gas delivery system. If the source gas contains pollutants that are toxic to the algae, a scrubber system will need to be developed. This will require one FTE research assistant and consumables to test algal strains against the carbon source. *Deliverables:* Final system design. *Duration:* Six months. *Estimated cost:* $55,000.

Stage 3: Installation—Once the final design system design is complete, the system can be installed and commissioned. Installation costs will be estimated as part of the feasibility study.

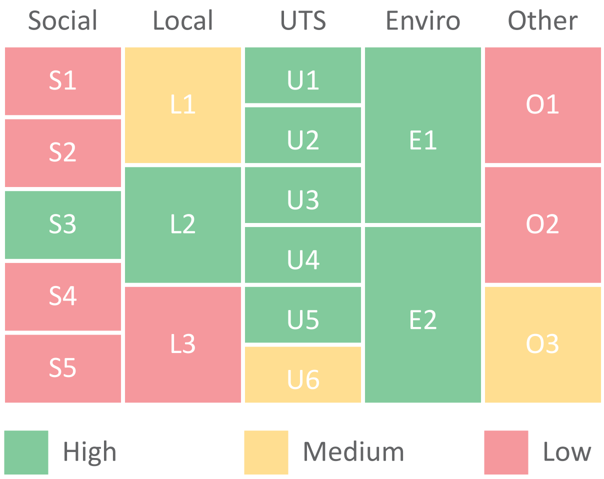
Stage 4: Validation and monitoring—The Green Genie includes a full suite of CO_2 sensors to assess the mass balance of CO_2 capture. Algal biomass will be monitored for production estimates with seasonal variation. A web interface will be developed to enable data capture, analysis and online presentation, and to facilitate teaching and learning. The data will also be used to inform a technoeconomic analysis (TEA) and life cycle analysis (LCA) of the Green Genie, and to help plan next steps beyond the pilot. *Deliverables:* Online data portal. *Duration:* Two months. *Estimated cost:* $20,000.

9.6.4 Links to research, teaching and learning

The Green Genie pilot can be integrated into ongoing research, teaching and learning activities. Research would be conducted on the impact and effectiveness of the prototype, and to develop subsequent versions with increased capacity to sequester carbon and improved cost-effectiveness. The pilot is also expected to attract new partners, including other researchers, government funding such as through the Australian Research Council and the RACE for 2030 CRC, and venture capital to fully develop and commercialise the technology.

9.6.5 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other.



S1: Targets social disadvantage and inclusion
S2: High proportion of capital tied to social purpose outcomes or impact
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S4: High proportion of expenditure covered by supply chain standards
S5: Potential to support indigenous empowerment

L1: Supports local area employment
L2: High proportion of spending invested within local area
L3: Contributes to socially just use of land and property

U1: Student marketing and branding benefits
U2: Creates long-term community and industry partnerships
U3: Enhances teaching and learning experience (including internships, career pathways, etc.)
U4: Provides a test bed for UTS research
U5: Enhances transdisciplinarity
U6: Better outcomes for campus building users

E1: Scale of potential catalytic benefit (reductions beyond UTS)
E2: Improves circularity of supply chain materials

O1: Energy system reliability
O2: Lower energy bills
O3: Other financial benefit

9.7 Accounting for renewable energy (Curtin)

9.7.1 Context

In the suburbs around Curtin's campus in Bentley (and the broader metropolitan area), there is a growing number of homes with solar panels (estimated to be 40% of households). While the growth in domestic solar penetration has positive benefits, it is also creating problems for overall power grid stability because of the amount of electricity being put into the gird during day when demand is not at its highest. This is particularly relevant for the South West Interconnect System (SWIS) to which Curtin is connected, as it is an islanded grid with high penetration of domestic solar panels, 7800 km of transmission lines and more than 1 million customers.

The Curtin Perth campus, in contrast, uses most of its electrical demand during the day when the university is at the peak of its operations. Effectively the campus is and could be drawing this 'green' power fed back into the grid from domestic solar systems into its accounting of green energy. Currently, there is no way of accounting for this green energy, which is effectively carbon neutral. Finding a way to measure off-site renewables is becoming increasingly important for companies and organisations who are seeking ways to account for their net zero credential as they reach the limits of their on-site emissions reduction potential.

9.7.2 Proposed project and key partners

RACE for 2030 is currently considering a project titled: Towards True Zero: Solutions for Matching, Tracking and Enhancing Corporate Renewables Purchasing. This project aims to help put in place traceability mechanisms using systems such as Enosi Australia's Powertracer / EnergyTag platform for tracing and visualisation of the coincidence of renewable energy generation and matching it with consumption. This could include providing a system of carbon accounting attached to a many-to-one transaction for a commercial consumer (like a university) to purchase solar generation from a residential solar, in the form of virtual power plants. This will help overcome the challenge that as the deployment of renewables grows (in this case domestic solar systems), so too does the challenge of successfully integrating them, requiring better matching of renewable energy to demand, and a change in focus from accounting for just the total megawatt-hours of renewables to megawatt-hours of renewables where and when they are of most value.

Curtin researchers are joining with researchers from UNSW to prepare a research proposal which will test the efficacy of the accountability systems in a range of situations. The Curtin Perth campus could be used as a test study for this project.

9.7.3 Impact assessment

The following impact assessment gauges the potential of this project to create additional value across five keys areas: social, local area, university, environmental and other value. This project addresses local, Curtin, environmental and other values through its implementation.

<table>
<tr><th>Social</th><th>Local</th><th>Curtin</th><th>Enviro</th><th>Other</th></tr>
<tr><td rowspan="2">S1</td><td rowspan="2">L1</td><td>U1</td><td rowspan="2">E1</td><td rowspan="2">O1</td></tr>
<tr><td>U2</td></tr>
<tr><td rowspan="3">S2</td><td rowspan="3">L2</td><td>U3</td><td rowspan="3">E2</td><td>O2</td></tr>
<tr><td>U4</td><td rowspan="2">O3</td></tr>
<tr><td>U5</td></tr>
<tr><td>High</td><td></td><td>Medium</td><td></td><td>Low</td></tr>
</table>

S1: Contributes to social equity, equality
S2: Direct links to Indigenous empowerment and the Curtin RAP

L1: Contributes to local area employment or use of materials
L2: Contributes to socially just use of land and property

U1: Enhances teaching and learning experience including transdisciplinary activities
U2: Test bed for Curtin research including transdisciplinary activities
U3: Better outcomes for campus building users
U4: Creates long-term community and industry partnerships
U5: Engages with the student population

E1: Scale of potential catalytic benefit across other environmental areas and potential to reduce emissions beyond Curtin
E2: Improves circularity or visibility of supply chain materials

O1: Improves energy system reliability
O2: Lowers energy bills
O3: Provides other financial benefit

9.8 Carbon offsets (Curtin)

9.8.1 Context

Carbon offsets are part of most organisations and universities' net zero strategies (see Section 2.4). For Curtin, they are beneficial for decarbonising existing electricity emissions from the SWIS that is primarily sourced (66%) from non-renewable sources. In Australia, Climate Active is an accreditation mechanism that involves a partnership between the Australian Government and Australian businesses to drive voluntary climate action. Climate Active is an Australian government accredited carbon neutral certification scheme. Climate Active has defined a set of eligibility requirements for offset units that align with the framework for Australian Carbon Credit Units (ACCUs).

The two main categories of offsets are:

1. nature-based offsets, such as
   - avoiding deforestation
   - reforestation and afforestation
   - soil and wetland management
   - savannah and fire management
   - coastal carbon sequestration (blue carbon), and
2. technology-based offsets, such as:

- renewable energy technologies, such as solar PV, wind farms, biogas and hydro power
- energy efficiency measures
- low-tech items in developing countries such as improved cooking stoves, and
- methane collection and combustion for use as an energy source.

9.8.2 Proposed project and key partners

As the majority of Curtin's carbon emissions are associated with purchased electricity, and delays in installing more renewable energy on campus while the voltage infrastructure is updated, offsetting current carbon emissions is a viable option for the university to immediately decarbonise.

If Curtin University chose nature-based offsets, there is an opportunity to align these initiatives with the Curtin Reconciliation Action Plan. For example, this could be achieved through establishing offsets in partnership with Gondwana Link and the Nowanup Bush University campus, where partnerships currently exist. The Nowanup Bush Campus is a 750-hectare space located on Nyungar bushland that hosts on-country education programs delivered by Aboriginal Elders and educators. It is located in the Great Southern Bushland region, north-east of Albany, which is part of the Gondwana link (Figure 36). The Gondwana Link is a 1000 km continuous bushland link that is dedicated to establishing: "Reconnected country across south-western Australia, from the wet forests in the south west corner to the dry woodlands and Mallee bordering the Nullarbor Plain, in which ecosystem function and biodiversity are restored and maintained."

Gondwana Link provides better than industry standard credits with a range of industry partners that are enabling carbon offsets with the general approach of achieving 'Carbon, Habitats, Communities and Culture' where it facilitates voluntary and/or accredited offsets that deliver effective change across those four key elements, and are part of achieving the much bigger Gondwana Link:

1. **Carbon**—restoration plantings where carbon sequestration is achieved in an enduring manner (i.e. not fragile plantations subject to loss over 50-plus years)
2. **Habitats**—restoration plantings established in line with the SERA restoration standards and strategically placed to maximise wildlife benefit for the long term
3. **Communities**—restoration plantings undertaken with the LOCAL groups we work with, and managed so as to support their ongoing viability
4. **Culture**—restoration plantings undertaken with involvement of First Nations communities.

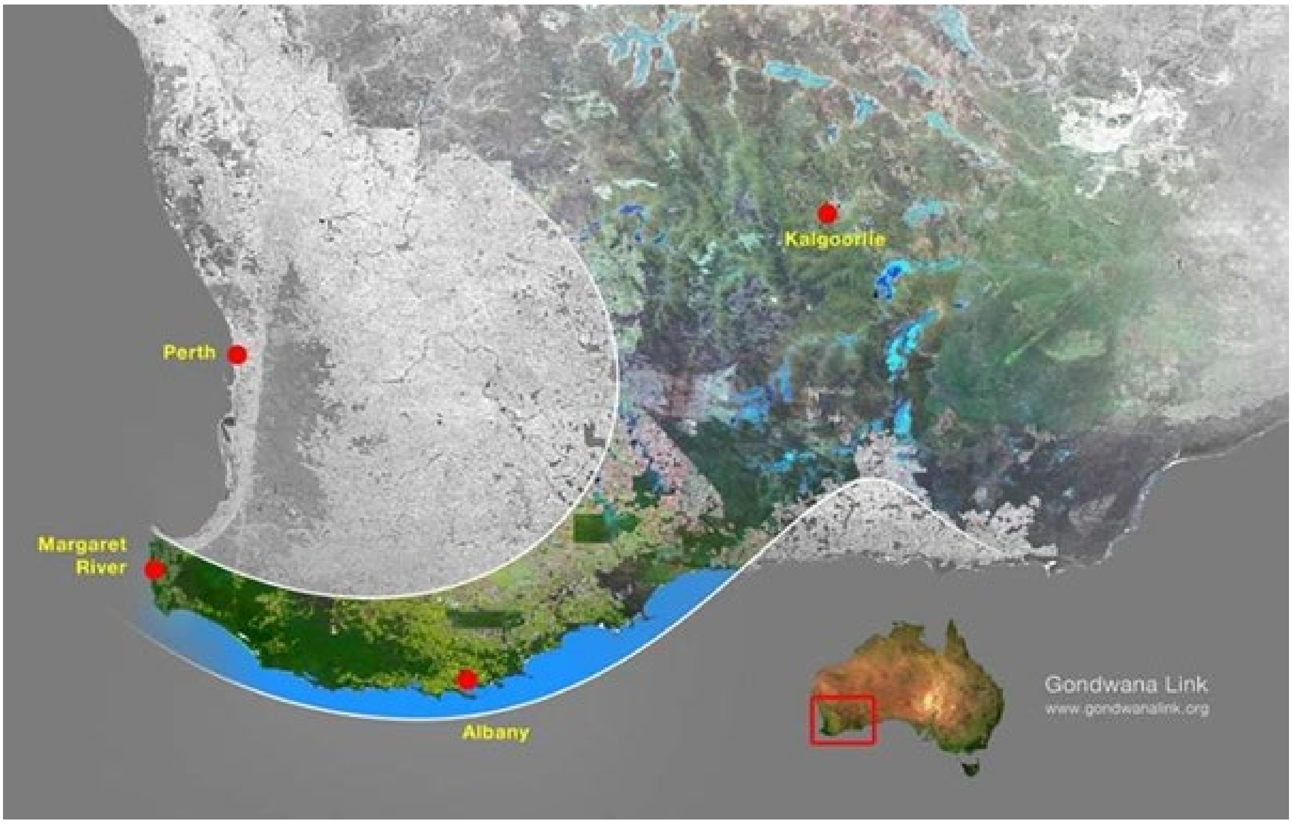

Figure 36. Gondwana Link. The Nowanup Bush University Campus is located northeast of Albany (gondwanalink.org).

Further exploration of this case study opportunity needs to be undertaken to consult with both the Nowanup and Gondwana Link organisations and the elders and communities in the region. The Centre for Aboriginal Studies and Curtin's Office of the Elder in Residence should be integral in these discussions and any project undertakings. The exact carbon offset amounts and initiatives could then be considered.

9.8.3 Impact assessment

Social	Local	Curtin	Enviro	Other
S1	L1	U1	E1	O1
		U2		
		U3		O2
S2	L2	U4	E2	O3
		U5		
High		Medium		Low

S1: Contributes to social equity, equality
S2: Direct links to Indigenous empowerment and the Curtin RAP

L1: Contributes to local area employment or use of materials
L2: Contributes to socially just use of land and property

U1: Enhances teaching and learning experience including transdisciplinary activities
U2: Test bed for Curtin research including transdisciplinary activities
U3: Better outcomes for campus building users
U4: Creates long-term community and industry partnerships
U5: Engages with the student population

E1: Scale of potential catalytic benefit across other environmental areas and potential to reduce emissions beyond Curtin
E2: Improves circularity or visibility of supply chain materials

O1: Improves energy system reliability
O2: Lowers energy bills
O3: Provides other financial benefit

9.9 Solar panels on carparks (Curtin)

9.9.1 Context

Several Australian universities have installed solar panels above open-air carparks to provide both shading and electricity generation. The advantage of these systems for Curtin is high, owing to the small number of suitable buildings having been identified for solar panel systems and the multiple car parks located on the Perth campus. The systems provide shading and protection from weather as well as electricity generation for the campus, along with providing a visible initiative of renewable energy.

9.9.2 Proposed project and key partners

General estimates by Infinite Energy indicate that each car spot can potentially have around 3 kW of solar panels over it, which would produce 4.8 MWh of electricity per year, equating to approximately $1000/year in savings per car bay (Infinite Energy, 2021). With 196,130 m² of open-air parking spaces at the Perth campus, totalling approximately 5800 open air car bays, there is the possibility of up to 17.4 MW (about 27.8 GWh/year) of solar power being generated from the car parks on campus. Further analysis is required to determine which car parks meet the criteria set by the university for consideration and are suitable for installation, regarding existing vegetation and shading. Additional LED lighting is provided for visibility assistance underneath the structures, which range from 2.7 to 3 m in height.

Other Australian universities that have installed solar panels over carparks include:

- La Trobe University's Bendigo campus, which has two car parks totalling almost 200 parking spaces that are covered with almost 1500 solar panels. La Trobe University's Albury-Wodonga campus has one car park already featuring solar panels and is increasing this to cover an adjacent parking space with another 270 panels to produce a total of 110 kW. The existing car park generates 11% of the total energy consumption for the campus (Figure 37a).
- University of Southern Queensland's Toowoomba campus has 449 parking spaces covered with 3,800 solar panels, providing 1.1 MW of power.
- Monash University's Clayton campus has 180 parking spaces covered with a 741-kW solar panel system.
- Flinders University's Bedford Park campus has 4136 solar panels installed over car parks, which contribute the majority of the 1.8 MW of solar installed across campus. The car park where they are located is now known as the solar car park on campus and contributes approximately 20% of the campus' electricity needs. An existing tree has been retained in the middle of the system (Figure 37b).
- RACE for 2030 industry partner Planet Ark Power has installed solar panel shade structures at other Australian projects, including at a primary school, and it will install sustainably-sourced timber PV shade structures across the IKEA Adelaide car park in the near future (Arreza, 2020).

(a) **(b)**

Figure 37. University solar car parks. (a) La Trobe University Albury-Wodonga campus current and future solar car park locations (latrobe.edu.au/mylatrobe/solar-carports-coming-to-the-regions). (b) The solar car park at Flinders University, including the mature tree that was retained (news.flinders.edu.au/blog/2018/08/23/almost-6000-solar-panels-power-campus).

9.9.3 Impact assessment

Social	Local	Curtin	Enviro	Other
S1	L1	U1	E1	O1
		U2		
S2	L2	U3	E2	O2
		U4		O3
		U5		
High		Medium		Low

S1: Contributes to social equity, equality
S2: Direct links to Indigenous empowerment and the Curtin RAP

L1: Contributes to local area employment or use of materials
L2: Contributes to socially just use of land and property

U1: Enhances teaching and learning experience including transdisciplinary activities
U2: Test bed for Curtin research including transdisciplinary activities
U3: Better outcomes for campus building users
U4: Creates long-term community and industry partnerships
U5: Engages with the student population

E1: Scale of potential catalytic benefit across other environmental areas and potential to reduce emissions beyond Curtin
E2: Improves circularity or visibility of supply chain materials

O1: Improves energy system reliability
O2: Lowers energy bills
O3: Provides other financial benefit

10 Conclusions, recommendations and future research

10.1 Overview

Over the course of the project, we applied and refined a process for developing an institutional net zero plan in the context of net zero strategies for the University of Technology Sydney and Curtin University. This process, summarised in the Executive Summary on page 1, includes:

- conducting deep stakeholder engagement, including community and business partnerships
- developing a thorough understanding of the organisation's history, identity, goals, values and purpose—and using these to define success metrics
- devising an impact assessment tool based on the success metrics to help evaluate and refine project concepts
- developing a net zero narrative alongside the refined set of project business cases such that each supports the other in the final net zero plan.

10.2 Monash NZI

The Monash Net Zero Initiative provides a valuable case study on strategising the net zero challenge in the context of a university campus. Our work found several critical elements were required for the implementation of this strategy to succeed, including having the right champions and leaders in place, and using smaller projects to showcase concepts, develop ideas and build partnerships.

The Monash NZI provides a strong knowledge sharing opportunity. Further work could involve deeply engaging with Monash University to build case studies and business case templates for sharing with others looking to

10.3 Key net zero opportunities

The project identified a number of key net zero opportunities across both UTS and Curtin University, including:

- establishing a Climate Impact Lab (UTS) to address complex climate challenges requiring multidisciplinary problem solving
- signing new best-practice power purchasing agreements that maintain high standards for achieving SDGs and other co-benefits
- expanding spheres of influence to help decarbonise upstream and downstream supply chains, including from staff and students
- moving towards 24/7 renewables through load shifting and storage
- replacing gas with electric alternatives
- linking the net zero challenge to research, teaching and learning
- improving emissions accounting practices
- leveraging existing land resources to create nature-based carbon credits
- increasing on-site renewables
- strengthening the energy start-ups ecosystem to better support talented founders with innovative and creative solutions to climate challenges.

10.4 Challenges and future research opportunities

10.4.1 Implementing opportunities

For some of the opportunities identified by the project, their pathway for further development and implementation is relatively straightforward. However, many face significant technical, economic and other challenges. This complexity presents opportunities for further research, including research funded by RACE for 2030, to create new knowledge and innovations, and to demonstrate additional pathways to decarbonisation. Examples include:

- Electrification at UTS (as well as Curtin, Monash or other universities). This requires a step-wise approach involving decentralisation, smaller trial projects, establishment of partnerships, and further development of suitable technologies and products. Research activities may involve installing monitoring equipment as part of equipment trials to collect and analyse data.
- Investigating the role of Curtin University in stabilising the SWIS in the context of substantial local residential rooftop PV capacity. This could involve a trial of Enosi's Powertracer platform.
- Establishment of one or more living labs at partner universities, similar to UTS's nascent Climate Impact Lab, to address complex climate challenges requiring multidisciplinary problem solving, and funding specific projects run through these labs. Examples of questions that could be addressed by such living labs include:
  - How can cost-effective energy retrofits be delivered to social housing to provide both energy savings and social value?
  - How can we decarbonise university supply chains?
  - How can we further encourage and incentivise active and low emissions travel?
- Development of innovative methods for creating nature-based carbon credits, though this likely extends beyond the energy focus of RACE for 2030's research scope.
- Engaging with start-ups, such as the EnergyLab alumni listed in Section 8.1.8, to fund specific decarbonisation-related research and commercialisation activities currently being pursued by these energy system innovators.

10.4.2 Incentives

A key finding of this project is that innovations to add complementary 'impact' value for other stakeholders are difficult to incorporate into any net zero claims. It is difficult to build incentives to follow the 'impact pathway' approach, illustrated in Figure 8 on page 27, given the limitations of the existing regime of LGCs, certified carbon credits and carbon accounting rules. Future research is recommended to explore ways of providing suitable incentives.

Related to the above, we found that for larger institutions, there is a growing shift away from GreenPower towards direct and other forms of PPA, and towards 24/7 renewables. Again, the current regime does not provide all the necessary incentives for this to happen smoothly and along the most effective and least-cost pathways. Future research is recommended to explore ways of providing suitable incentives, such as streamlining processes for negotiating and signing PPAs, methods for aggregating smaller energy users that allow them to benefit from larger PPA deals, and time-stamped LGCs using EnergyTag or similar technologies.

10.4.3 Co-benefit limitations

As illustrated in the impact assessment matrices shown in Section 9, not all types of additional value can be delivered through all projects. For example, a PPA can account for much of an organisation's emissions reductions, but is limited in its ability to enhance local area values or outcomes for building users. Other decarbonisation opportunities similarly offer significant emissions reductions with minimal co-benefit value. These limitations can be partially overcome through a portfolio approach to emissions reductions, where benefits are incorporated across a range of diverse projects, as per the UTS strategy.

10.4.4 Resources

Project development and implementation often require extensive internal resources, which limits the speed at which projects can be developed and implemented, the number of projects that can be undertaken simultaneously, and the complexity of projects considered. These challenges have only been exacerbated by COVID-19 pandemic, particularly when multiple stakeholders are involved. A focus on building the required capacity and streamlining processes for opportunity evaluation and implementation is therefore required to assist organisations with meeting the net zero challenge. Recommendations around this theme are made in Section 10.4.6 below.

10.4.5 Net zero narrative

The process presented in this project includes development of a net zero narrative to articulate the benefits of the strategy, such as embracing non-financial values. An example draft narrative for UTS is presented in Section 7. While this project was conducted in the context of developing a comprehensive net zero strategy for UTS, full development of this strategy is outside the scope of this project and remains incomplete at the time of project completion. We were therefore unable to verify the effectiveness of the net zero narrative on persuading the UTS executive team. Further investigation is recommended to answer this question, and test the effectiveness of other net zero narratives across a range of organisations.

10.4.6 Net zero business

The methodology and case studies developed through this project are intended to be applicable beyond university campuses to businesses and precincts. There is an open question about the extent to which the presented methodology intersects with the net zero needs of businesses or precincts. Follow up research could involve applying the methodology in these contexts to determine its applicability and what modifications might be required.

More broadly, this project suggests many opportunities through which RACE for 2030 can support businesses in meeting their net zero objectives, particularly in the context of the CRC's Net Zero for Business strategic challenge. This might include:

- **Building capacity within businesses**—Internal resource limitations, as outlined above, constrain the ability of businesses to address the net zero challenge. Building capacity within businesses to address decarbonisation should be a high priority.
- **Streamlining net zero responses**—Many businesses are presented with similar challenges and similar opportunities for addressing climate change. There is a role for RACE for 2030 in building a database of knowledge, case studies and other guidance to help businesses more easily identify opportunities, streamline their implementation and reduce perceived risks. The work of the BRC-A in building a collective understanding of PPAs is a good example of this approach.

- **Scaling solutions**—Related to the above is the question of how best to scale each solution. Innovations developed both within and outside RACE for 2030 can be scaled through research partners, industry partners, and supply chains. Finding the right pathway to scale for each solution remains an ongoing challenge.
- **Innovating incentives**—As outlined above, current carbon accounting rules, largely based on a regime of LGCs and certified carbon credits, fail to adequately incentivise the actions required to drive deep decarbonisation of the energy system. There is an opportunity for innovation in this space through exploring regulatory, policy and market mechanisms for building these incentives. For example, new types of LGCs can be formulated and recommended to drive investment in energy storage and flexible demand.
- **Strategising net zero responses**—Climate change presents businesses with great risks but also great opportunities. Through development of knowledge sharing materials and practices, including workshops and seminars, there is a role for RACE for 2030 in helping businesses strategise their net zero response, to better understand the problem, to set, monitor and communicate clear decarbonisation targets, and to manage their climate and carbon risks through innovation to drive competitive advantage.

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