DEPARTMENT OF PLANNING, INDUSTRY AND ENVIRONMENT

ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT (ESD) PLAN

SPECIAL ACTIVATION PRECINCT, PARKES

JULY 2019

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Environmentally Sustainable Development (ESD) Plan
Special Activation Precinct, Parkes

Department of Planning, Industry and Environment

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1 EXECUTIVE SUMMARY

A Special Activation Precinct (SAP) is a dedicated area in a regional location identified by the NSW Government to become a thriving business hub. The Parkes SAP is the first SAP to be announced by the NSW Government taking advantage of the location, business development opportunities and employment growth offered by the east-west rail line and the Inland Rail project which places Parkes at the crossroads of Australia.

The NSW Government recognise the need for the Parkes SAP to be sustainable both in its development and operations. As such Environmentally Sustainability Design (ESD) has been identified as a key component to ensuring the success of the Parkes SAP as a hub of enterprise that will enhance the local and regional community and economy. There are two primary purposes for the Parkes SAP from which many other opportunities and beneficial outcomes will arise, the first is to be a national logistics hub and the second is to become a high value agricultural area and food export district. These will be underpinned by the international framework for delivering exemplary Eco Industrial Parks (EIP).

SUSTAINABILITY GOALS

Through a series of workshops, the key stakeholders have worked together to define the 'Preferred Future' for the Parkes SAP and this is now represented as a suite of **sustainability goals**, shown in Figure 1-1.

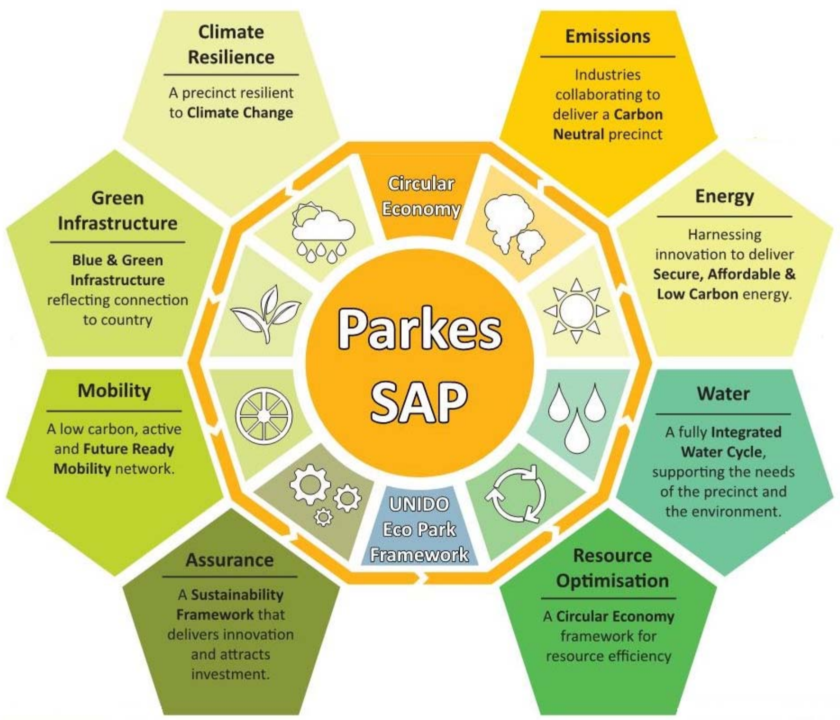


Figure 1-1 Sustainability Goals for the 'Preferred Future' for the SAP (Source: dsquared Consulting, Adelaide)

The foundation for the delivery of the 'Preferred Future' for the Parkes SAP is the United Nations Industrial Development Organisation's (UNIDO) Eco Industrial Parks Framework (hereafter referred to as the UNIDO Framework). To support this foundation is the concept of a 'Circular Economy'. The circular economy principle was identified as the keystone to the 'Preferred Future' for the Parkes SAP, fundamental to delivery and binding together the sustainability goals, as outlined in this ESD Plan.

The delivery of the initiatives outlined in this report will require collaborative governance. The Development Corporation will be key in the implementation of the Parkes SAP's governance structures working in collaboration with the Department of Planning Industry and Environment and and Parkes Shire Council.

The UNIDO Framework focuses of four categories:

1. Park management performance
2. Environmental performance
3. Social performance, and
4. Economic performance

This ESD Plan is primarily focused on the environmental performance of the Parkes SAP and how the aim to exceed compliance with local and national regulations can be represented in the Master Plan, Activation Precinct State Environmental Planning Policy (SEPP) and Design Guidelines.

Energy efficiency and pro-active energy performance requirements for buildings have the potential to minimise the energy demand in the Parkes SAP, however, alternative district infrastructure will be required to deliver the performance required to make substantial improvements on a business as usual trajectory. In order to effectively manage distributed generation from on-site and renewable sources, smart grid infrastructure is essential to manage energy demand and regulate generation systems.

The opportunities for **water** efficiency mirror those for energy. Efficiency for new buildings can, and must, play a role, but district infrastructure systems are required to achieve long-term water efficiency performance for the Parkes SAP.

With a specific focus on logistics, **mobility** within the precinct has a high profile. Safety and efficiency in the movement network are needed in equal measure with understanding the way mobility is evolving with the introduction of new technologies.

Industry recognises that there needs to be a shift from the traditional linear economy, which has a 'take, make, dispose' model of production. Instead **resource optimisation** should be at the heart of our processes. The implementation of the principles of a **circular economy** to all aspects of the Parkes SAP will aim to minimise waste and make the most of all resources.

Furthermore, a **green infrastructure** strategy is necessary to provide an attractive destination; **climate resilience** against heat waves and storms, and to manage the impact of the SAP on broader ecological systems.

Each of the goals mentioned above will contribute to reaching the overarching goal for the Parkes SAP to be a **carbon neutral** precinct through the implementation of the Zero Carbon Hierarchy including energy efficiency, on-site low/zero carbon heat and power, and investment in allowable offsite solutions for the remaining emissions.

Developing the Parkes SAP in a sustainable way is also considered to be critical to the success of the industries that decide to become resident businesses in the Parkes SAP and for the overarching goals for the locality and the region.

The aim of this ESD Plan is to provide a framework as to how the Parkes SAP can meet its sustainability goals.

2 INTRODUCTION

2.1 PARKES SPECIAL ACTIVATION PRECINCT

The Parkes Special Activation Precinct (the Parkes SAP) is a joint Government Agency initiative, intended to catalyse the development of a major transport and logistics hub, taking advantage of the inland rail corridor to enable faster and easier access to global freight markets for local businesses and agricultural producers. The project was announced by the Deputy Premier, the Hon John Barilaro MP, to create a 20-year vision for job creation and regional development. The Department of Premier and Cabinet and the Department of Planning and Environment are leading the creation of the Parkes SAP.

Parkes is a location of state and regional significance and the Parkes SAP is an economic enabler that will address market failures and leverage catalyst opportunities. The SAPs are a place-based approach to 'activate' this strategic location.

The Parkes SAP was selected because of its geographic location in relation to, and the economic opportunities associated with the construction of the Inland Rail from Brisbane to Melbourne and the existing east-west Sydney to Perth/Adelaide Rail corridor which cross at Parkes creating an opportunity for an Inland Port.

The Parkes SAP will lead to investment in a suite of supporting infrastructure, including roads infrastructure, water, electricity, telecommunication, gas systems and services, high speed internet and data connections and facilities, and other possible infrastructure or services.

The Parkes SAP covers an area of approximately 3,600 hectares and is located to the west of the Parkes township (see Figure 2-1). The Parkes SAP is strategically located at the intersection of:

- the Brisbane to Melbourne Inland Rail;
- the Sydney to Perth/Adelaide Rail corridor; and
- is in close proximity to the junction of the Henry Parkes Way and Newell Highway.

The Inland Rail project has received $9.3 billion in funding from the Commonwealth Government to support the upgrade to the freight network from Brisbane the Melbourne. It is projected that the first train will run between the two capital cities in 2025. Parkes is an important connection for the Inland Rail project, as it is the epicentre of inland freight.

Figure 2-1 Indicative location of Parkes SAP

The Parkes SAP area is predominantly occupied by agricultural land, with a solar energy facility located in the north-western corner and an existing quarry operation located in the south-eastern area of the Parkes SAP.

The existing primary industries in Parkes are focused around freight and logistics, agribusiness and mining. Parkes strategic location within Regional NSW provides the opportunity to capitalise on these industries, along with the potential to expand into warehousing, advanced food manufacturing and renewable energy uses.

A SAP contains five core components and this plan (along with government led studies) will inform fast track planning for the Parkes SAP and potential future infrastructure investment and government led development:

2.1.1 REGIONAL AND LOCAL CONTEXT

Parkes local government area (LGA) is located approximately 350 kilometres west of Sydney, in the Central West and Orana Region. The main townships and settlements in the LGA include Alectown, Bogan Gate, Cookamidgera, Parkes, Peak Hill, Trundle and Tullamore. Other major centres in the region include Condobolin, Cowra, Dubbo, Forbes and Orange.

The Parkes township has a stable population of approximately 11,500 people (ABS, 2016), with around 5,000 dwellings. An industrial estate (zoned IN1 - General Industrial) is located south of the town, adjoining the Newell Highway. The town is serviced by an existing local centre, mixed use areas that contain both commercial, business and retail use. A new hospital and associated health Precinct is located towards the southern end of the town. The Parkes Regional Airport is located east of town, with the Parkes National Logistics Hub located to the west.

The Central West and Orana Regional Plan 2036 identifies the following key features about Parkes:

- Development and settlement is clustered around key corridors, including the twin centres of Parkes and Forbes;
- Parkes, along with Dubbo, is a major freight hub particularly in the selling, processing, manufacturing and transporting of livestock and agricultural produce;
- TransGrid's NSW Connection Opportunities identifies Parkes as having capacity for renewable energy generation; and
- Existing regional mining operations (North Parkes Mines and Tomingley) near Parkes.

The establishment of a Parkes SAP is consistent with Parkes Shire Council's vision and strategic planning for the locality.

2.1.2 PLANNING FRAMEWORK

Currently under Parkes Shire Council's *Parkes Local Environmental Plan (LEP) 2013*, the Parkes SAP area is zoned:

- RU1 – Primary Production;
- SP1 – Special Activities; and
- SP2 – Infrastructure.

The land zoned SP1 – Special Activities has been identified as the Parkes National Logistics Hub. The Logistics Hub covers approximately 600 hectares. The land includes the Pacific National and SCT Logistics sites among other landholdings. The locality provides the opportunity to create an intermodal site serviced by rail and road connections.

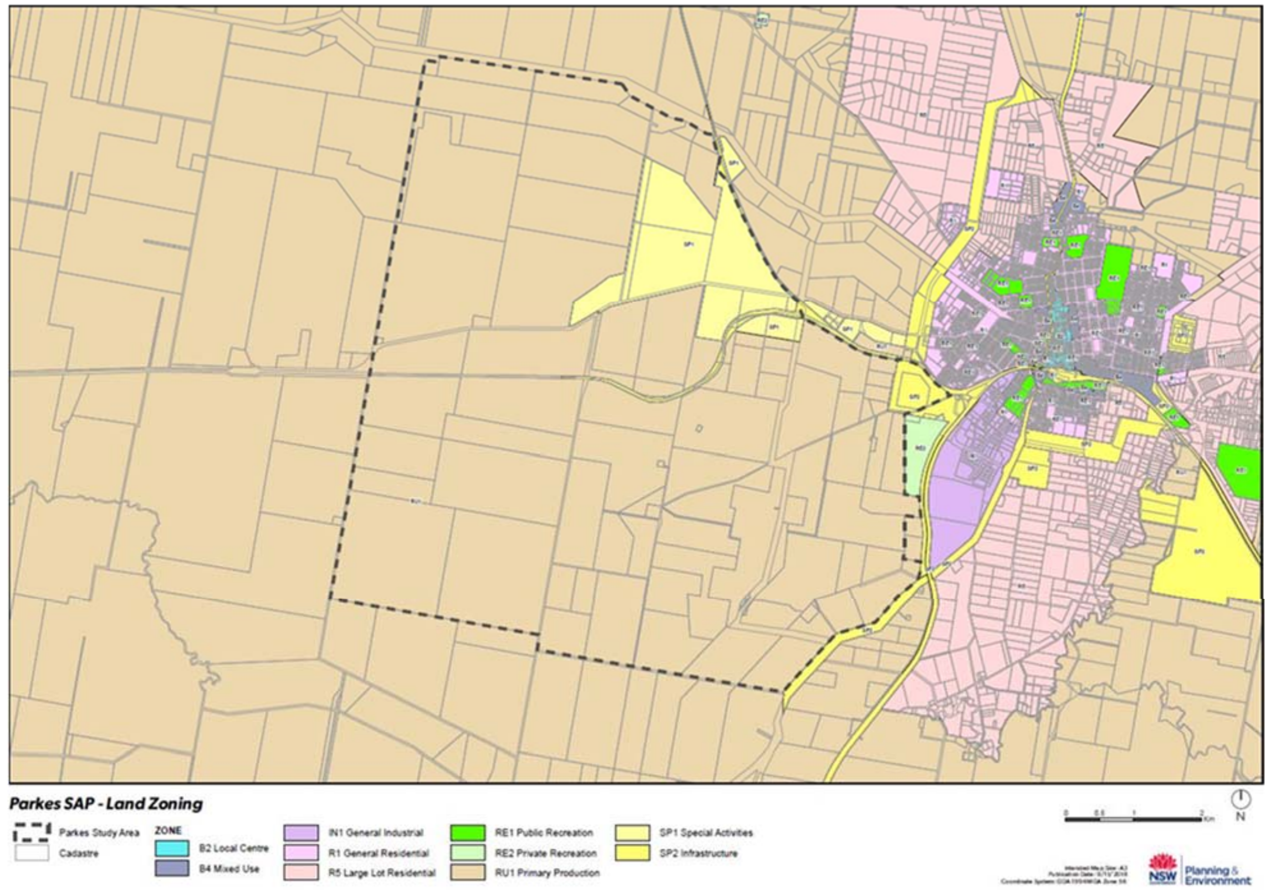


Figure 2-2 Zoning map

2.2 KEY STAKEHOLDERS

The key stakeholders are everyone with an interest in the Parkes SAP:

— Department of Premier and Cabinet
— Department of Planning and Environment
— Parkes Shire Council
— Federal Government – The Government of Australia
— Office of Environment and Heritage
— Transport for New South Wales
— Roads and Maritime Services
— Australian Rail Track Corporation
— Environmental Protection Agency

As the Master Plan for the Parkes SAP develops it will be important to continue to engage emerging stakeholders.

2.3 PURPOSE OF THIS REPORT

The purpose of this report is to make recommendations for inclusion in the Master Plan for the Parkes SAP. The report will specifically address carbon, energy, water, waste and sustainable transport and examine opportunities to leverage planned land uses to deliver a SAP with internationally recognised green credentials. This report provides a framework for the inclusion of sustainability goals and principles for the Parkes SAP as an integral part of that design and delivery of the vision through the Master Plan, the Activation Precinct State Environment Planning Policies (SEPP) and to inform the development of future design standards. The report will:

— Articulate the global, Federal, State and Local government policy framework that will inform the sustainability framework for the Parkes SAP; and
— Clearly communicate the ambition for the Parkes SAP in its response to climate change and achieving best practice sustainability outcomes, to reflect its desired vision as a SAP with internationally recognised green credentials;
— Provide recommendations for infrastructure development to be included in the Master Plan to support the sustainability goals and insure sustainability measures can be implemented within the Master Plan and future design standards.

2.4 EXISTING CLIMATE CHANGE AND SUSTAINABILITY FRAMEWORK

This ESD plan seeks to be aligned at the highest level, to the **United Nations Sustainable Development Goals** and more locally, to both the **NSW Climate Change Policy Framework,** and the **NSW EPA Circular Economy Policy Statement**. These are considered below with some additional state and local policy framework documents that are relevant in the development of goals and targets for environmental indicators for inclusion in the Master Plan.

2.4.1 GLOBAL

UN Sustainable Development Goals

The United Nations prioritises 17 Sustainable Development Goals as part of a Sustainable Development Agenda with the purpose of transforming our world by ending poverty, protecting the planet and ensuring prosperity for all. Each goal has specific targets to be achieved by 2030, with six of these seventeen goals advocating for climate change response and resource demand reduction initiatives. To achieve these goals change is sought from governments, the private sector and civil society. The goals listed below are most relevant to the Parkes SAP and the outcomes that are anticipated from the implementation of an ESD plan.

United Nations SDG Goal	Relevance/Opportunity for the Parkes SAP
Goal 6: Clean water and sanitation	Goal 6 focuses on clean, accessible water for all. The Parkes SAP approach to water infrastructure is to implement a fully **integrated water cycle** supporting the needs of the precinct and environment. This approach supports the targets for Goal 6 to implement integrated water resources management at all levels and protect and restore water-related ecosystems.
Goal 7: Affordable and clean energy	Goal 7 focuses on universal access to energy, increased energy efficiency and the increased use of renewable energy through new economic and job opportunities. It is considered crucial to creating more sustainable and inclusive communities and resilience to environmental issues like climate change. The Parkes SAP aims to harness innovation to deliver **secure, affordable & low carbon** energy. This can include energy from waste plants, solar, wind turbines, air and ground source heat pumps across building and precinct scale.
Goal 8: Decent work and economic growth	Goal 8 focuses on **sustainable economic growth** through the creation of conditions that allow people to have quality jobs that stimulate the economy while not harming the environment. The SAP program directly supports this goal's target to promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services. As a new development identified through the SAP program, the Parkes SAP will provide new economic opportunities and decent work through both the construction and operation phases. As the SAP is established and continues to grow the opportunities both direct and indirect at the local and regional scale will increase.
Goal 9: Industry, innovation and infrastructure	Goal 9 recognises that technological progress is the foundation of efforts to achieve environmental objectives, such as increased resource and energy-efficiency. The vision for the Parkes SAP as a place which will stimulate economic development as a hub of sustainability and enterprise enhancing the local and regional community directly reflects the focus of this goal. The Parkes SAP has a clear focus on **resilience across energy, water and infrastructure** and this is embedded throughout the ESD Strategy.
Goal 11: Sustainable cities and communities	Goal 11 seeks to increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters. The Parkes SAP is planned to **be inclusive, safe, resilient and sustainable**. From the design of safe transport options, clean energy options to ensure climate safety, resilient water and energy strategies and inclusive sustainable design guidelines. The overall strategy promotes inclusivity for the community and focuses on sustainability.
Goal 12: Responsible consumption and production	Goal 12 states that sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. The principle of a **circular economy** is the keystone of the ESD Strategy for the Parkes SAP. This will support the delivery of responsible consumption and production through the implementation of a framework for resource efficiency within the precinct.

United Nations SDG Goal		Relevance/Opportunity for the Parkes SAP
13 CLIMATE ACTION	Goal 13: Climate action	Goal 13 notes that affordable, scalable solutions are now available to enable countries to leapfrog to cleaner, more resilient economies. By for example turning to renewable energy and a range of other measures that will reduce emissions and increase adaptation efforts. Noting climate change impacts already affecting the Parkes region, with rising temperatures and increased drought conditions, the ESD plan for the Parkes SAP focuses on being a place where industries collaborate to deliver a **carbon neutral** precinct that is climate safe. This directly responds to the Goal 13 target to integrate climate change measures into national policies, strategies and planning as the ESD Plan has been developed to inform the master plan for the Parkes SAP and the Active Precincts State Environment Planning Policy (SEPP).
15 LIFE ON LAND	Goal 15: Life on land	Goal 15 has specific targets for the integration of ecosystem and biodiversity values into national and local planning, and development processes; and action to reduce the degradation of natural habitats, halt the loss of biodiversity and, protect and prevent the extinction of threatened species. The approach to **green infrastructure** in the Parkes SAP is informed by technical biodiversity studies and seeks to deliver a precinct which retains and enhances the ecological and biodiversity values of the site.

2.4.2 NATIONAL

Australia's COP21 Paris agreement Commitments

Australia is committed to taking strong domestic and international action on climate change. An historic global climate agreement was agreed under the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties (COP21) in Paris (30 November to 12 December 2015).

The Paris Agreement is an international agreement with a central aim to:

"Strengthen the global response to the threat of climate change by keeping global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue other efforts to limit the temperature increase even further to 1.5 degrees Celsius." (United Nations, 2017)

Australia became a signatory to the Paris Agreement on 22 April 2016, and the Paris Agreement came into force on 9 November 2016, ratification occurred thirty days after the date parties, which make up an estimated 55% of the total global Greenhouse Gas (GHG) emissions, chose to become signatories. Under the Paris Agreement, Australia has committed to reducing emissions to 26-28% on 2005 levels by 2030.

The Australian government aims to meet these commitments by 'Direct Action Policies' created with the objective of reducing emissions, increasing energy productivity and improving environmental health. These reduction targets have set the benchmark in which each state has developed their own climate positive strategies with an emphasis on either meeting or exceeding this target.

National Climate Resilience and Adaptation Strategy, Department of Environment and Energy

On 2 December 2015, the Australian Government released a *National Climate Resilience and Adaptation Strategy*. The Strategy articulates how Australia is managing the risks of a variable and changing climate. It identifies a set of principles to guide effective adaptation practice and resilience building and outlines the Government's vision for a climate-resilient future.

2.4.3 STATE

The State policy framework for considering sustainability outcomes in the Parkes SAP includes the following:

1. *NSW Climate Change Policy Framework,* which seeks to achieve net zero emissions by 2050 and for NSW to be more resilient to a changing climate;
2. *NSW EPA Circular Economy Policy Statement: Too Good to Waste*, which seeks to change the way we produce, assemble, sell and use products to minimise waste and to reduce our environmental impact;
3. *NSW Office of Environment and Heritage (Adapt NSW) Central West and Orana Climate Change Snapshot, November 2014*;
4. *Smart Cities Plan* call for us to become smarter investors in out cities' infrastructure through the coordination and driving of smarter city policy and smart technology to improve the sustainability of our cities and to drive innovation; and

5. *Future Transport Strategy* which sets the framework to working towards environmental sustainability, securing energy reliability and affordability and managing a resilient transport system.

The ***NSW Climate Change Policy Framework*** identifies an aspirational emissions reduction objective of net-zero emissions by 2050 as well as making NSW more resilient to a changing climate. The ***NSW Climate Change Plan (draft)*** identifies several strategies aligned with the policy framework and relevant to Parkes:

- Accelerating investment under the Renewable Energy Target (RET);
- Accelerating advanced energy technologies;
- Accelerating the transition to a 21st century transport fleet;
- Drive innovation and build confidence about energy efficiency;
- Managing the risks of climate change to public assets and services;
- Strengthen natural eco-systems to respond to a changing climate.

2.4.4 LOCAL

Sustainability outcomes in the Parkes Shire local government area are influenced by the following local plans, policies and papers:

- *Central West and Orana Regional Plans* – with "The vision is to make the region the most diverse regional economy in NSW"
- *Parkes Shire 2030+ Community Strategic Plan* – with the goal Parkes Shire becoming a "progressive and smart regional community embracing a national logistics hub with a vibrant healthy community"
- *Parkes Local Environmental Plan (LEP) 2012* and *Parkes Development Control Plan (DCP)*
- *Parkes National Logistics Hub Prospectus*

2.5 PARKES SAP MASTER PLAN, SEPP AND ESD PLAN

There is a comprehensive policy framework and development precedent at global, national, state and local government levels for embedding drivers for sustainability into the Parkes SAP.

A new **Activation Precinct State Environmental Planning Policy (SEPP)** will provide the planning policy framework. This new Activation Precinct SEPP is intended to facilitate more streamlined environmental approvals of exempt and complying developments, encouraging the rapid design and development of the Parkes SAP while maintaining the overall precinct environmental performance attributes. The Parkes SAP Master Plan will form a schedule to the Activation Precinct SEPP.

A suite of reference documents will be developed to support the Master Plan for the Parkes SAP, the ESD Plan sustainability goals and principles will be incorporated into the Master Plan and the suite of reference documents for consistency and to support the design, development and construction of a SAP with internationally recognised green credentials. The focus of the Parkes SAP is a 20-year vision for job creation and regional development. The ESD Plan considers a 20-year planning horizon with a long-term view to 40 years.

Figure 2-3 Sustainability Goals for the 'Preferred Future' for the SAP (Source: dsquared Consulting, Adelaide)

This ESD Plan is founded on a 'Preferred Future' for the Parkes SAP, which is based on a set of sustainability goals and key considerations developed through the Enquiry by Design (EBD) process, that describe it as a successful SAP in the future.

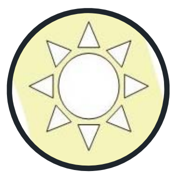
Table 2.1 is a summary of the key considerations, actions and outcomes that underpin the sustainability goals and will inform the policy framework and strategy to deliver the 'Preferred Future' for the Parkes SAP. It is recognised that the ESD Plan for the Parkes SAP needs to coexist, interact with and help deliver on other relevant and complimentary strategies, it is considered that these goals can do this supporting its design and delivery as a SAP with internationally recognised green credentials.

The foundation for the delivery of the 'Preferred Future' for the Parkes SAP is the UNIDO Eco Industrial Parkes Framework (further discussed in Section 12). The concept of a circular economy (further discussed in Section 3) was identified as the keystone to the 'Preferred Future' for the Parkes SAP, fundamental to its delivery and binding the ESD Plan together. An Eco–Industrial Park is a defined as a community of businesses located on a common property in which businesses seek to achieve enhanced environmental, economic and social performance through collaboration in managing environmental and resource issues. The Eco-Industrial Parks concept has also increasingly been recognised as an effective tool to overcoming challenges related to inclusive and sustainable industrial development within the scope of the UN's Sustainable Development Goals.

The following chapters expand on the sustainability goals and the key considerations outlined in this chapter. The key considerations have been applied to the context of each sustainability goal and have informed the recommendations for infrastructure options and policy approaches that can be included in the Master Plan. The key considerations reflect the main topics of discussion for each goal raised during the Enquiry by Design (EBD) workshop. A summary of the EBD workshop discussions can be found in Appendix A.

The key considerations for each goal led to actions that will be taken by the by the Development Corporation to encourage businesses to locate in the Parkes SAP, which will in turn enable desired outcomes to be delivered through the wider precinct as businesses seek to locate there. The ESD 'Strategy on a Page' developed at the EBD workshop can be found in Appendix B.

Table 2.1 Sustainability Goals and Key Considerations

GOALS		KEY CONSIDERATIONS	ACTIONS AND OUTCOMES
	Climate Resilience: A precinct resilient to **Climate Change**	— Green and blue infrastructure will contribute to the SAP's resilience as more extreme weather events are experienced. — A Climate Adaptation Plan (CAP) is essential to categorize risks and implement resilience strategies. — The implementation of an Integrated Water Cycle model which is informed by the CAP. — Renewable energy serving individual sites as part of an embedded network/microgrid.	**Actions:** The SAP Masterplan will provide a secure water supply; a secure energy supply; climate resilient infrastructure; and blue & green infrastructure to reduce heat island effect.
	Green Infrastructure: **Blue & Green Infrastructure** reflecting connection to country	— A focus on blue and green infrastructure to increase resilience to climate change. — An environment that supports natural balance, expanding on existing natural areas. — A focus on reducing the heat island effect in human centric areas. — Flood water retention and reuse on an individual site scale and precinct scale. Restoration of local natural habitat and connection with country.	**Actions:** The SAP Masterplan will provide green corridors, natural waterways, native green reserves and recreation spaces. **Outcomes Enabled:** Flora & fauna habitat continuity, biodiversity, stormwater conveyance.
	Mobility: A low carbon, active and **Future Ready Mobility** network.	— Efficiencies in the logistics network to reduce movement, handling and emissions. — A highway hub for truck servicing including provision for EV and Hydrogen charging. — Planning for the future use of autonomous vehicles and drones. — Connectivity to neighbouring towns – on demand transport, shuttle buses, and public transport. — The use of recycled materials in the construction of transport infrastructure. — Cycle and walking paths within the precinct's green infrastructure.	**Actions:** The SAP Masterplan will provide efficient transport and logistics networks; a gateway transport hub; and a precinct shuttle bus service. **Outcomes Enabled:** Smart-tech communications for transport logistics; autonomous vehicle use; and next generation vehicle fuelling (electric/hydrogen/biofuel)
	Assurance Rating Tools: A **Sustainability Framework** that delivers innovation and attracts investment.	— Standards above the National Construction Code — Sustainability Governance including the Eco Industrial Park framework to guide the implementation of world class industries and systems, and Carbon Neutral certification. — The Development Corporation or a private operator in charge of the embedded energy network, integrated water cycle, and resource circular economy.	**Actions:** The SAP Masterplan will provide UNIDO Eco Industrial Park Framework recognition; sustainability governance; and NCOS - Precincts Carbon Neutral Certification. **Outcomes Enabled:** Infrastructure rated with the Infrastructure Sustainability Council of Australia (ISCA) and Buildings rated with the Green Building Council of Australia (GBCA).
	Emissions: Industries collaborating to deliver a **Carbon Neutral** precinct.	— Individual business emission reporting and carbon offsetting — Potential for a carbon market with business to business trading of emissions. — Alignment of carbon neutral target with NSW policy (2050), National Policy and Paris commitment agreement.	**Actions**: The SAP Masterplan will provide a framework for carbon management and NCOS certification; and an industry support programme for carbon reduction. **Outcomes Enabled:** NCOS precinct carbon neutral certification; carbon offset project and investment creation; and carbon neutral industries.
	Energy: Harnessing innovation to deliver **Secure, Affordable & Low Carbon** energy.	— On-site renewable requirements for individual sites and buildings. — Governance to coordinate Energy focused research and development and to facilitate a circular economy approach. — The Development Corporation or a private operator in charge of the embedded energy network/microgrid. Energy storage within the precinct for use across the embedded network/ microgrid. — Ongoing energy performance measurement through a smart grid.	**Actions:** The SAP Masterplan will provide electricity via a shared embedded network; piped natural gas; solar renewable energy; and smart delivery and management of systems. **Outcomes Enabled:** Renewable energy system deployment; energy generation and supply; hydrogen & alternative fuel use; and energy sharing.

GOALS		KEY CONSIDERATIONS	ACTIONS AND OUTCOMES
	Water: A fully **Integrated Water Cycle**, supporting the needs of the precinct and the environment.	— An integrated water cycle with rainwater capture, storm water harvesting, wastewater and greywater treatment and reuse. — A system to provide for the needs of the precinct whilst minimising negative impacts to the precinct or the environment. — Water modelling to include predicted climate change impacts.	**Actions:** The SAP Masterplan will provide a reliable water supply; alternative water sources for non-potable uses; sub-precinct rainwater storage and re-supply; precinct stormwater treatment; and a developed framework for water management.
	Resource Optimisation: A **Circular Economy** framework for resource efficiency.	— A centralised resource recovery facility – including hazardous waste, compost and recycling. — An energy from waste facility to dispose of waste that is not otherwise recoverable — An understanding of individual industry waste outputs within the precinct to facilitate the implementation of circular economy streams. — Continuous innovation to reduce the creation of waste within the precinct.	**Actions:** The SAP Masterplan will provide a circular economy business to business concierge; and waste/resource recovery services. **Outcomes Enabled:** Resource sharing; advanced re-manufacturing; co-located complimentary industries; energy from waste; and on-site resource extraction.

3 CIRCULAR ECONOMY

The implementation of the principles of a circular economy is the keystone in the ESD Plan for the Parkes SAP. The approach is relevant to all aspects of the ESD Plan and has the potential to reduce industrial carbon dioxide, landfilling of materials, hazardous waste streams and industrial use of water. It would also reduce the demand on natural virgin resources. The system diagram shown in Figure 3-1 below illustrates the continuous flow of technical and biological materials through the 'value circle'.

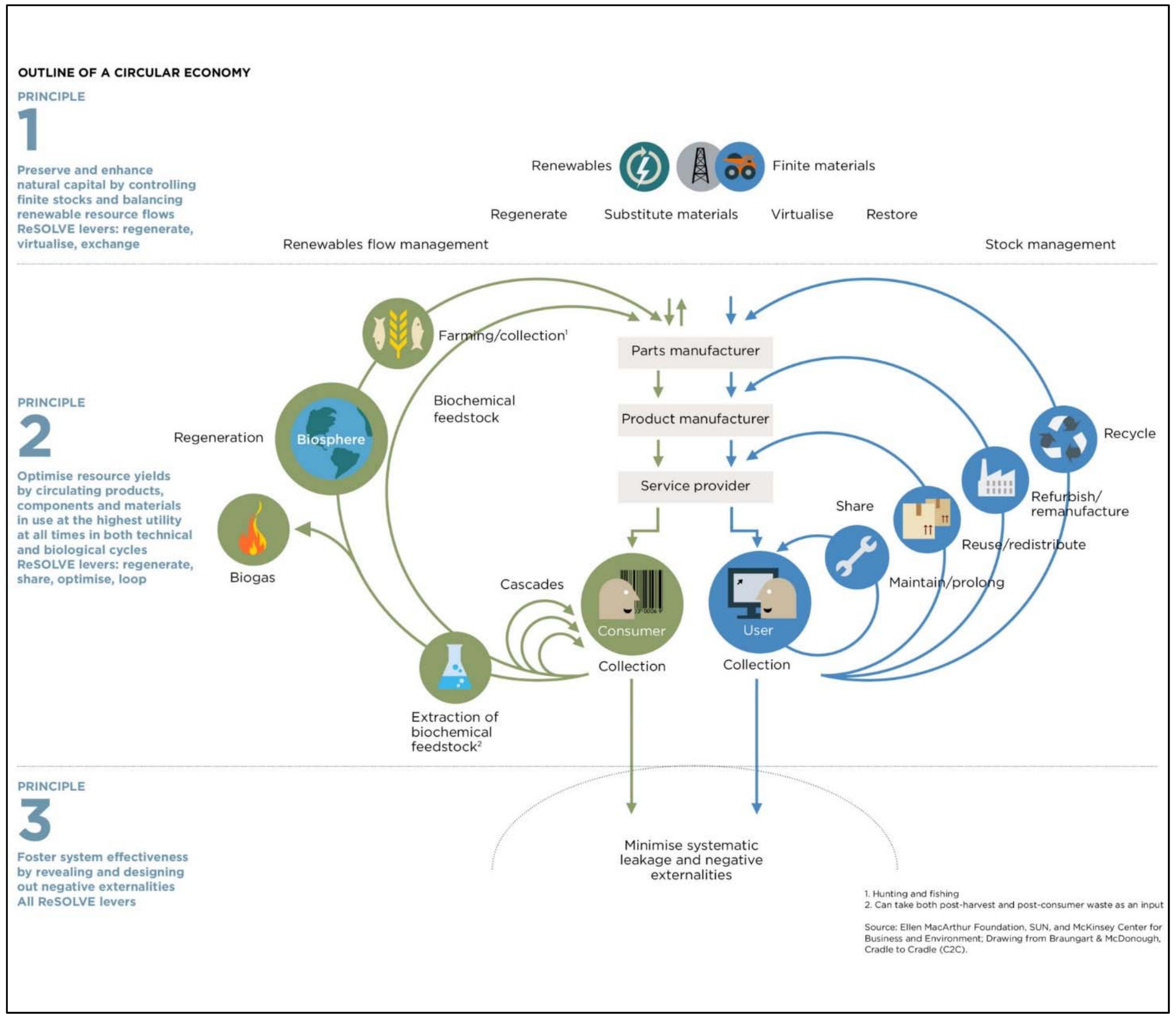


Figure 3-1 Circular Economy System 'Butterfly' Diagram (Source: Ellen MacArthur Foundation)

A circular economy supports the delivery of several of the international Sustainable Development Goals by committing to sustainable consumption and production patterns. Sustainable development goals that are identified as linking to the objectives of the NSW Circular Economy Policy Statement include:

Goal 9 – Industry, Innovation and Infrastructure Thinking of innovative new ways to repurpose old materials

Goal 12 – Responsible production and consumption Promoting resource and energy efficiency, reducing resource use and pollution along the whole life cycle.

3.1 IMPLEMENTING A CIRCULAR ECONOMY

The implementation of a circular economy is about finding a balance between efficiency, and the resilience in the diversity and interconnectivity of participants. Understanding the mix of land uses expected to develop first in the Parkes SAP has allowed a high level of initial circular analysis to be completed. The success of the circular economy will rely on review of the entire system as operation, upgrades, development and redevelopment take place.

Each proposed land use will have different input intensities for energy, water and materials, as well as different waste outputs. The first exercise is to estimate these inputs and outputs and make connections in the system where one land use's output can serve as an input for another land use, reducing waste. The exercise will also bring colocation opportunities to light. Table 3.1 shows an outline of this exercise.

Table 3.1 Simple Draft Symbiosis Exercise

Category	Land Use	INPUTS	Intensity	OUTPUTS
Freight & Logistics	Rail Terminals	Energy Water Materials	Low Medium Low	General waste
High and Low Amenity	Agribusiness (Processing Plants, Green houses)	Water Energy Materials	High High High	Biomass
Low Amenity	Abattoir	Water Energy Materials	High High High	Effluent Scraps Waste
Low Amenity	Energy from waste	Water Energy Materials	Low Low Low	Energy Anaerobic Digestion – Biogas and Digestate Advanced Gasification – Syngas and Slag & Recovered Materials
Low Amenity	Water and biohazard treatment	Water Energy Materials	Low High Low	Water sludge and sand

The outputs in this simple analysis can already be linked to be inputs within the circular economy:

- The general waste from the Rail Terminals and the effluent, scraps and waste from the Abattoir can be sent to the energy from waste plant.
- The biomass from the agribusiness can be recycled into fertiliser for the agribusiness.
- The water and biohazard treatment plant will create a by-product of sludge and sand which can be used as fertiliser for agribusiness.

As land uses provide greater detail on their inputs and outputs more synergies can be made amongst the intended operations of the Parkes SAP.

There are many different possibilities that can be explored in industry by-products:

- **Water** - waste water, cleaned waste water, surface water, used cooling water, deionized water, cleaned surface water
- **Energy** – steam, power to grid, warm condensate, district heating, natural gas
- **Materials** – waste, gypsum, fly ash, sulphur, slurry, sand, sludge, ethanol, biomass, fertiliser

For example, there is an application called SYNERGie developed by International Synergies a company which devises and manages industrial symbiosis programmes. The application can provide amongst other things integrated mapping of resources to prioritise local sourcing and reuse opportunities to close as many loops in a development as possible. For further information please see https://www.international-synergies.com/projects/.

CONCLUSION
There is an opportunity for the Parkes SAP to implement a process and mechanisms to manage the symbiosis that will exist between each of the Parkes SAP occupants. This will ensure that opportunities of site selection for each industry seeking to locate within the Parkes SAP can be optimised.

3.2 CIRCULAR ECONOMIES AND EIPS

The NSW Circular Economy Policy states, "The circular economy is about changing the way we produce, assemble, sell and use products to minimise waste and to reduce our environmental impact. The circular economy can also be great for business; by maximising the use of our valuable resources, and by contributing to innovation, growth and job creation." The advantages of the circular economy as highlighted by the NSW Office of Environment and Heritage are in line with the concerns of local communities, becoming self-sufficient and resilient. It is very important that the principles of a circular economy are incorporated into the development of the Parkes SAP, and to understand that it involves stakeholder buy-in from early stage, as well as continuous evaluation and innovation throughout development and operation.

The United Nations Industrial Development Organisation, The World Bank Group and GIZ (Deutsche Gesellschaft fur Internationale Zusammenarbeit) created an international framework for Eco-Industrial Parks (EIPs), to be used as a tool for overcoming challenges related to inclusive and sustainable industrial development within the scope of Sustainable Development Goals (SDGs). The goal of the UNIDO Framework is that EIP would be designed to use resources more efficiently and improve productivity. A well-designed EIP will consider the most efficient use of resources such as land, water, and/or energy by creating synergies (for example, using waste heat), or by achieving better economies of scale (for example, through joint usage of infrastructure).

The UNIDO Framework has been identified as the preferred framework to use as the foundation for the delivery of the 'Preferred Future' for the Parkes SAP. The most famous example of the circular economy/ industrial symbiosis approach is in Denmark. The Kalundborg Symbiosis is a partnership between nine public and private companies in Kalundborg. Since 1972 they have developed the world's first industrial symbiosis with a circular approach to production.

The main principle is, that a residue from one company becomes a resource at another, benefiting both the environment and the economy.

The symbiosis creates growth in the local area and supports the company's Corporate Social Responsibility (CSR) and climate change mitigation.

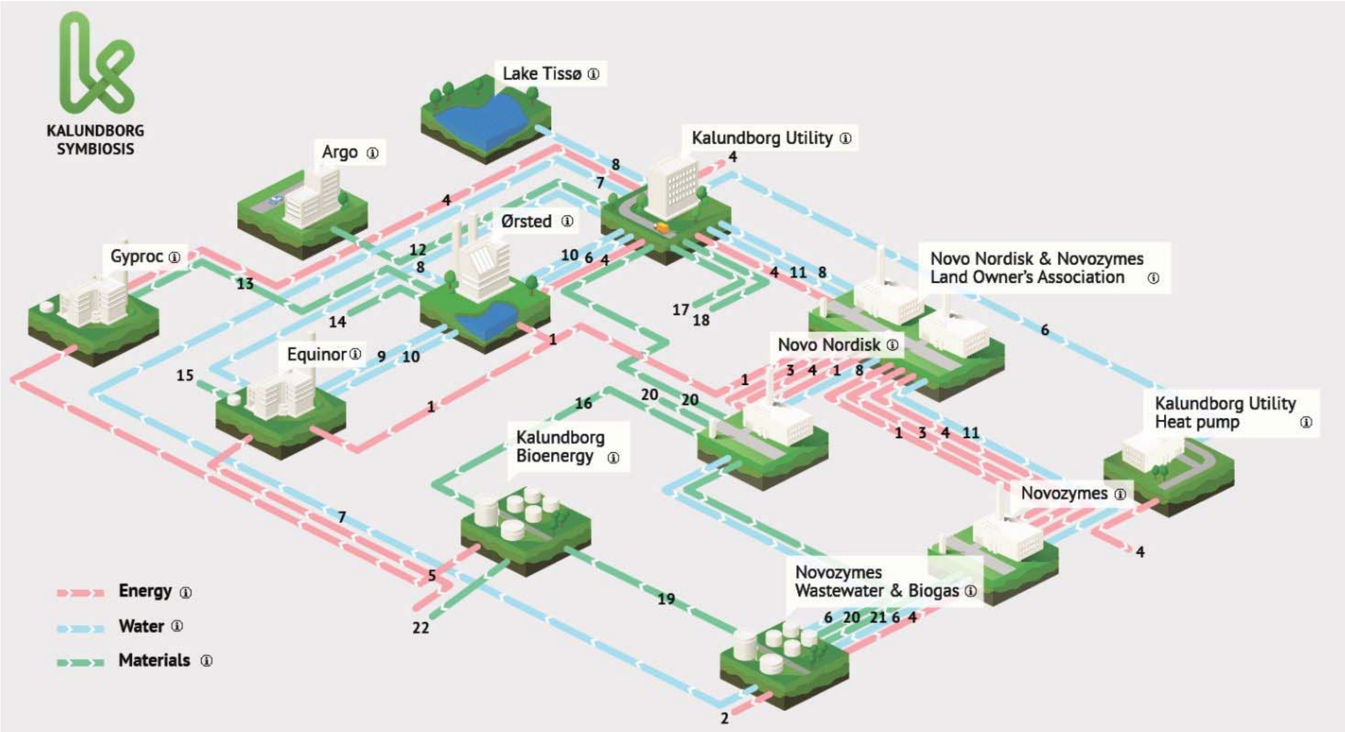


Figure 3-2 Kalundborg's Symbiosis Network source: http://www.symbiosis.dk/en/

Kalundborg with their principle of 'provide, share and reuse resources' has identified the following shared networks illustrated in Figure 3-2 above and listed in the table below. Further detail on each of these shared networks can be found in Appendix E.

Steam	Wastewater	Fly Ash
Power to the Grid	Cleaned Wastewater	Sulphur
Warm Condensate	Cleaned Wastewater	Yeast Slurry
District Heating	Cleaned Surface Water	Sand
Natural Gas	Waste	Sludge

Table 3.2 Shared networks in Kalundborg

4 CARBON NEUTRAL

The carbon goal for the Parkes SAP is to be **carbon neutral**. This goal is underpinned by each of the goals identified for the Parkes SAP as discussed throughout this report.

The NSW Government is committed to achieving net zero by 2050 and this is outlined in the ***NSW Climate Change Policy Framework***. For the Parkes SAP to be carbon neutral it is vital that all opportunities to reduce the Parkes SAP's carbon intensity are identified and implemented. Carbon neutrality refers to achieving net zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset or buying enough carbon credits to make up the difference. Before offsetting is undertaken, first principles require that all viable energy efficiency and on-site measures are implemented, as depicted in the image below.

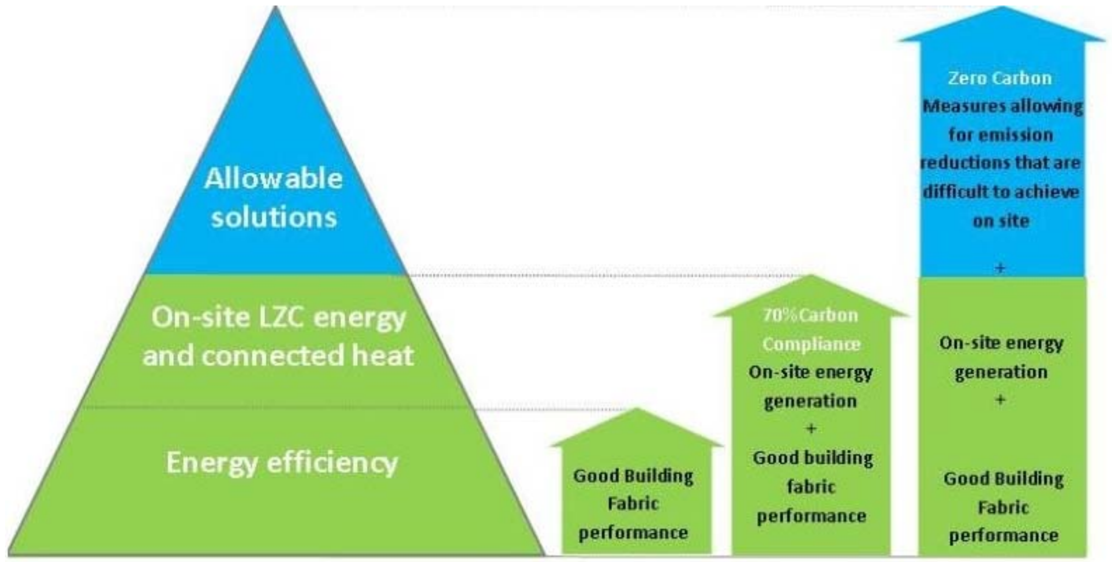


Figure 4-1 The Zero Carbon Hierarchy (Source Zero Carbon Hub)

4.1.1 *CARBON NEUTRAL PRECINCT*

4.1.1.1 NATIONAL CARBON OFFSET STANDARD (NCOS) FOR PRECINCTS

The Australian Government, Department of the Environment and Energy developed The National Carbon Offset Standard (NCOS) which is a voluntary standard to manage greenhouse gas emissions and to achieve carbon neutrality. It provides best-practice guidance on how to measure, reduce, offset, report and audit emissions for organisations, products and services, events, precincts and buildings.

The NCOS for Precincts can be used to develop a framework by which to achieve carbon neutrality and showcase climate leadership. The NCOS provides best-practice guidance on how to measure, reduce, offset, report and audit emissions that occur as a result of the **operations of a precinct**.

Operational emissions are those generated from the day-to-day running of the Parkes SAP and therefore includes scope 1 (direct) and scope 2 (indirect) emissions, but also upstream and downstream emissions (scope 3) from resource consumption and waste generation necessary for a precinct's day-to-day operations.[1]

The following emissions sources are deemed to be relevant to all precincts:

- All scope 1 emissions (direct emissions within the geographic boundary of the precinct) from precinct operations.
- All scope 2 emissions (emissions from the generation of purchased electricity, heat, cooling and steam; i.e. energy produced outside the geographic boundary of the precinct but used within the precinct) from precinct operations.
- Scope 3 emissions from electricity consumption and fuel use (indirect emissions from the extraction, production and transport of fuel burned at generation, and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network) from precinct operations.
- Scope 3 emissions from waste, water supply and wastewater treatment from precinct operations.
- All other emissions identified, such as precinct-induced and transboundary transport, must be assessed for relevance in accordance with the relevance test.

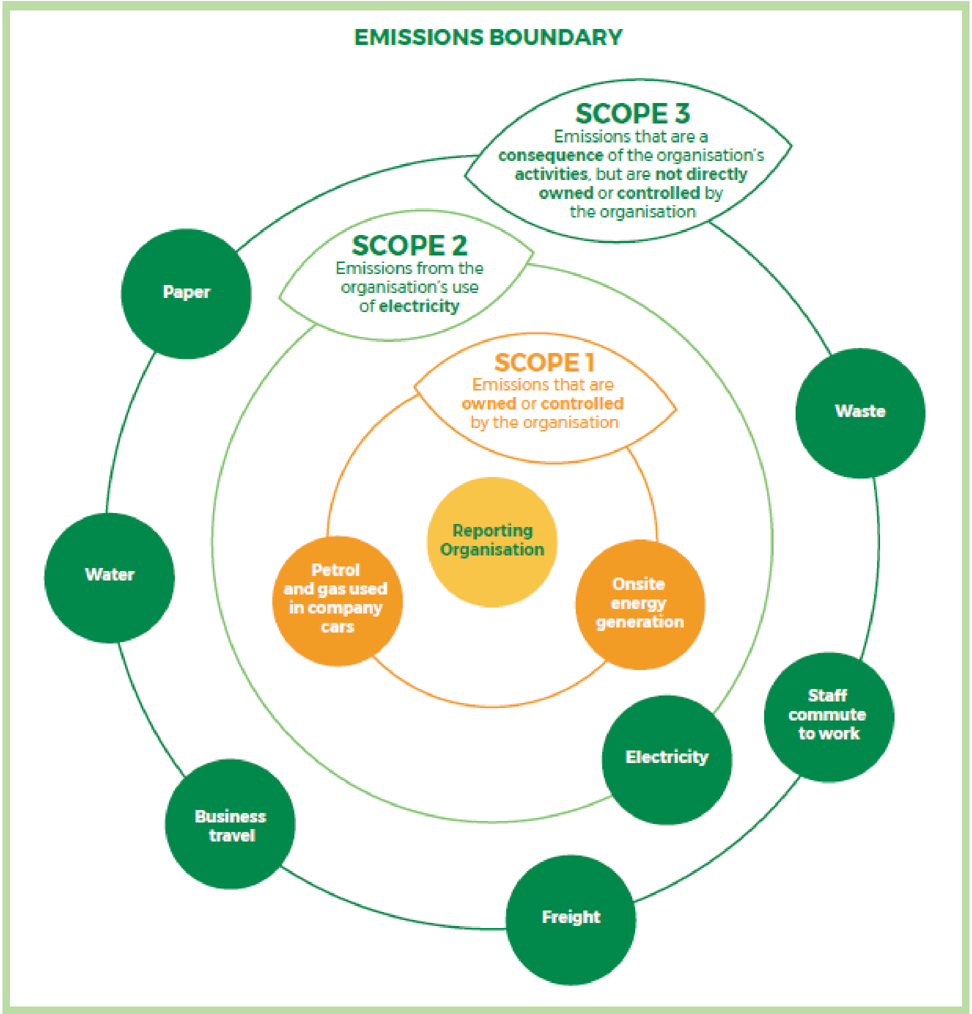


Figure 4-2 Typical examples of scope 1, Scope 2 and Scope 3 inclusions in an emissions boundary (Source: NCOS for Precincts).

[1] Scope 1 greenhouse gas emissions are the emissions released to the atmosphere as a direct result of an activity, or series of activities at a facility level. Scope 2 greenhouse gas emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity. For example, 'indirect emissions' come from the use of electricity produced by the burning of coal in another facility. Scope 3 emissions are indirect greenhouse gas emissions other than scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business. (National Greenhouse and Energy Reporting Scheme)

To make a valid and credible carbon neutral claim against the NCOS standard, and to maintain carbon neutral status, the responsible entity must:

- Measure: Prepare a carbon account.
- Reduce: Reduce emissions where possible.
- Offset: Cancel eligible offset units to compensate for remaining emissions.
- Report: Prepare a public report.
- Audit: Arrange for an independent audit of the carbon account and public report.

Offsetting can be achieved through the cancelling out of greenhouse gases (carbon emissions), through a combination of sustainable infrastructure solutions (such as renewable power generation) and the creation of certified carbon offset credits (for example, by creating high impact natural environments, replanting etc.).

Certification through the Australian Government's Carbon Neutral Program must be renewed every 3 years.

CONCLUSION

NCOS for Precincts could be used by the Parkes SAP to certify its operation. To enable this, a carbon strategy for the Parkes SAP should be implemented following the carbon reduction hierarchy of energy efficiency, onsite renewable energy generation and offsite renewable energy generation before undertaking carbon offsetting. This should ensure that when the Parkes SAP seeks to achieve certification, the amount of carbon offsetting required to achieve carbon neutrality will be minimised.

Some of the following emissions reduction initiatives proposed for the Parkes SAP are discussed in more detail in the following sections of this report:

- increasing energy efficiency (e.g. by installing energy efficient street lighting and guidelines for energy efficiency in buildings) through design standards
- substituting products or inputs with those that are less emissions intensive (e.g. the implementation of circular economy principles (See Chapter 3), reusing greywater to reduce potable water use (see Chapter 7) or the adaptation of industrial processes that are not yet electrified, which could be powered by renewable energy to support a carbon neutral goal (see Chapter 4)
- changing practices to replace emissions intensive activities with those that generate fewer emissions (e.g. ensuring the green infrastructure for the Parkes SAP are low-maintenance rather than landscape comprising water and fertiliser intensive gardens)
- encouraging and optimising the responsible treatment of waste (e.g. through source separation and procurement of waste treatment services with biogas capture (see Chapter 8).

4.1.2 CARBON NEUTRAL BUILDINGS/ORGANISATIONS

4.1.2.1 GBCA'S CARBON POSITIVE ROADMAP

The GBCA has worked closely with industry to develop a draft roadmap outlining high-level outcomes, actions, targets, advocacy positions and proposed changes to Green Star over the next decade to achieve net zero. It is noted that the roadmap is limited to commercial, institutional and government buildings and fit outs, and that the next release of the roadmap to be released in 2019 will also address the residential sector and precinct scale development. As such this will not be applicable to all developments in the Parkes SAP but should be applied to all those that it can.

With the implementation of the actions identified in the GBCA's Carbon Positive Roadmap for the built environment, the Master Plan for the Parkes SAP presents the opportunity for the key stakeholders to commit to delivering a built environment that is energy efficient, powered by renewables, and supports decarbonising the grid. These actions can be outlined in the planning policy framework that will influence the design, construction and operations of the built environment within the Parkes SAP.

The Road map provides the following:

- Established targets by which the built environment and its supply chain must decarbonise.
- The chance to create incentives to drive the Parkes SAP to meet the target for a zero-emissions built environment.
- Opportunities to remove barriers to renewable energy installations, purchasing and distribution.

	Cities	Buildings	People	Governments
1. Climate change and environment	• Resilient to heat waves • Reduced urban heat island effect	• Resilient to heat waves and infrastructure failures	• Reduced impact from climate change	• Disaster resilience • COP21 targets met • SDG met
2. Health and wellbeing	• Reduction in pollution • Reduced obesity and health costs due to better active transport infrastructure.	• Better air quality • Reduced noise	• Increased comfort • Reduced heat stress • Reduced asthma and allergies • Reduced noise	• Reduced spending on health systems
3. Value and economic impact	• Reduced energy use and energy infrastructure • Increased energy access • Attraction of investment • Resilience to heat waves • Reduced water infrastructure	• Enhanced value to buildings • Energy savings • Management of own infrastructure • Better service to occupants • Diversified business opportunities (through energy generation, embedded networks, and reliability solutions)	• Increased productivity • Increased energy security • Guarantee of amenity and service	• Increased investment and employment • Energy security and reduction in total energy demand • Increase in competitive advantage

Figure 4-3 Benefits of using the GBCA's Carbon Positive Road Map

The benefits of following the Carbon Positive Roadmap are not only relevant at a building level but would have an impact at the Parkes SAP level. See Figure 4-3 above for further detail on the expected benefits.

4.1.2.2 NATIONAL CARBON OFFSET STANDARD (NCOS) FOR BUILDINGS AND ORGANISATIONS

The NCOS for Buildings provides best-practice guidance on how to measure, reduce, offset, report and audit emissions that occur as a result of the operations of a building. It has been designed to accommodate a wide variety of building types in Australia. From large office buildings to smaller apartment complexes, the NCOS for Buildings is a framework to achieve carbon neutrality and showcase climate leadership.

In the same way, the NCOS for Organisations provides best-practice guidance on emissions that occur as a result of the operations of an organisation. It accommodates a wide variety of organisations with operations in Australia, regardless of scale and type. From large-scale organisations with thousands of employees to local businesses, the NCOS for Organisations can be used as a framework to achieve carbon neutrality and showcase climate leadership.

CONCLUSION
Industries seeking to be occupants in the Parkes SAP should be encouraged to implement their own carbon strategy using the GBCA's Carbon Positive Roadmap and certification for their building (if it is eligible to be certified) or organisation. The NCOS Precinct Standard is for precinct operations and decisions made about buildings and infrastructure will have a direct impact on the operational carbon account for the Parkes SAP, individual building or organisation NCOS ratings will simplify the certification process for the Parkes SAP as a whole. The outcomes of individual certifications will also complement and feed into any reporting that would be required under the UNIDO Framework.

4.1.3 ELECTRIFYING INDUSTRY

Beyond Zero Emissions is an Australian climate change think tank. Their research is focused on demonstrating that zero emissions is both achievable and affordable now. Of particular interest for the Parkes SAP is their recent publication *Zero Carbon Industry Plan; Electrifying Industry, September 2018.* The report focuses on the adaptation of industrial process that are not yet electrified, which could support a zero-carbon economy powered by renewable electricity. Figure 4-4 (right) is extracted from the report and outlines the key messages underpinning the opportunities that are presented by adopting the recommendations for electrifying industry from the report.

Key Messages

How things stand:

1. Manufacturers' use of fossil fuels causes **8% of Australia's greenhouse gas emissions** – as much as our entire car fleet and more than the state of South Australia.
2. Australian manufacturers are struggling to remain competitive due to **rising energy costs.** Many businesses' gas and electricity bills have doubled in the last two years, and the days of cheap gas in Australia are over for good.
3. Australian manufacturing is inefficient, consuming **more energy per dollar of output** than any other developed country.
4. Australia's manufacturing sector is in long-term decline, with nearly **one in five manufacturing jobs disappearing** in the last 10 years.
5. Businesses wedded to **high-carbon strategies are at risk** from the global transition to a low-carbon economy.

Australia's opportunity:

1. Renewable energy is affordable and reliable now. Many businesses are already paying **20 to 50% less** for electricity by switching to renewables.
2. Renewable energy could be **30 to 50% cheaper** in just 10 years. In some places this could make electricity cheaper than gas.
3. With Australia's unparalleled resources in solar and wind energy, we could electrify all industrial processes. This would eliminate **6 to 8% of national greenhouse gas emissions,** and relieve industry of its dependence on gas.
4. Electricity is a versatile form of energy that can be used to **power any industrial heat process.** By switching to electrical heating we can **halve the energy required** to produce many goods, while reducing costs and increasing production speed.
5. The next wave of industrial revolution is coming – **the zero-carbon economy.** Electrifying industry would **increase the competitiveness of Australian manufacturing** by reducing costs and producing zero-carbon goods.
6. Electrifying industry would enable Australia to **become a world leader** in energy-intensive, zero-carbon manufacturing, such as:
   - becoming the first country to produce emissions-free steel without coal
   - exporting renewable ammonia – a zero-carbon fuel
   - zero-carbon production of energy-intensive materials such as carbon fibre.
7. Renewable electricity could power a vibrant industry in r**ecycling materials including plastic, glass and paper.**
8. Thousands of factories across Australia could save money on energy today, by **replacing their gas-fired boilers with industrial heat pumps.**
9. The manufacturing sector drives innovation, exports and creates high-quality jobs. Governments should help Australian manufacturers capitalise on the zero-carbon opportunity with **ambitious industrial policy.**

Figure 4-4 Key Messages - Zero Carbon Industry Plan: Electrifying Industry

The role that Federal and State governments can play in making the electrification of industry happen is significant and the Parkes SAP is an opportunity to set ambitious emissions reduction targets and provide the mechanisms to encourage the industries that are seeking to locate in the Parkes SAP to invest and make the transition to electrical heating technologies powered by renewables. Table 4.1 below details the recommended actions from the report to develop Zero Carbon Industry in Australia. The action area for the Parkes SAP is item 2 - Zero Carbon Industry Strategy and the opportunity to "implement an industrial strategy to rapidly reduce industrial emissions to zero and promote growth in Australian low-carbon manufacturing."

Table 4.1 Recommended actions to develop zero carbon industry in Australia

Action area	Recommended action	Responsible
1 Manufacturers' opportunity	Where possible, manufacturers to set ambitious emissions reduction targets and invest in electrical heating technologies powered by renewables.	Large businesses
2 Zero carbon industry strategy	Implement an industrial strategy to rapidly reduce industrial emissions to zero and promote growth in Australian low-carbon manufacturing.	Federal and state governments
3 Sustainable procurement	Support low-carbon goods through procurement standards and targets.	Federal and state governments Large corporations
4 Research and commercialisation	Substantially increase spending on research and commercialisation of renewable heating technologies.	Federal and state governments
5 Information provision	Set up information and advice service to help manufacturers move away from fossil fuels Help manufacturers understand business advantages of switching to renewable energy and decarbonising Increase study of low-carbon approaches to manufacturing and ensure knowledge transfer to industry. Build engineering capacity in use of electrical heating technologies and renewable energy	Federal/state governments Industry groups Universities and research bodies Engineers Australia
6 Financial incentives	Establish substantial financial incentives – grants, loans and tax credits – for manufacturers investing in new renewable heat processes and switching from fossil fuels	Federal and state governments
7 Carbon price	Impose a price on carbon which includes domestic and imported manufactured goods Call for coordinated international action on the embedded carbon in manufactured goods	Federal Government

CONCLUSION

There is an opportunity to have a clear strategy for business locating to the Parkes SAP to stimulate growth in low-carbon manufacturing, capitalising on the unique renewable energy resources that will be available. It should have a specific focus on high-carbon production processes used in industry. Industries seeking to be occupants in the Parkes SAP should be required to explore the potential for their industry to generate heat differently, through the smart use of renewable energy. There are many industrial heat processes that can be electrified saving energy and money as well as reducing emissions.

4.1.4 CARON DIOXIDE REMOVAL

Carbon dioxide removal, also known as negative emissions technologies, covers several technologies which reduce the levels of CO_2 in the atmosphere.
These include:

— Bioenergy in combination with carbon capture and storage (BECCS)

— Afforestation: large-scale tree plantations to increase carbon storage in biomass and soil

— Enhanced weathering: distribution of crushed silicate rocks on soil surfaces to absorb and bind CO2 chemically

— Direct air capture of CO_2 from ambient air through engineered chemical reactions

It is noted that when comparing these approaches, the direct air capture approach has some advantages over other carbon removal technologies: it does not require water or depend on arable land; has a small physical footprint; and is scalable.

Example

Climeworks is a Swiss company which has developed the world's first commercial carbon removal technology. Their direct air capture plants remove CO_2 from the atmosphere to supply to customers. It is considered to be of particular interest for the Parkes SAP as the customers they are working with are industries that are anticipated to form part of the future land use mix for the precinct.

- Food and Beverage Industry
- Greenhouses (Protected Cropping)
- Energy, Fuels and Materials

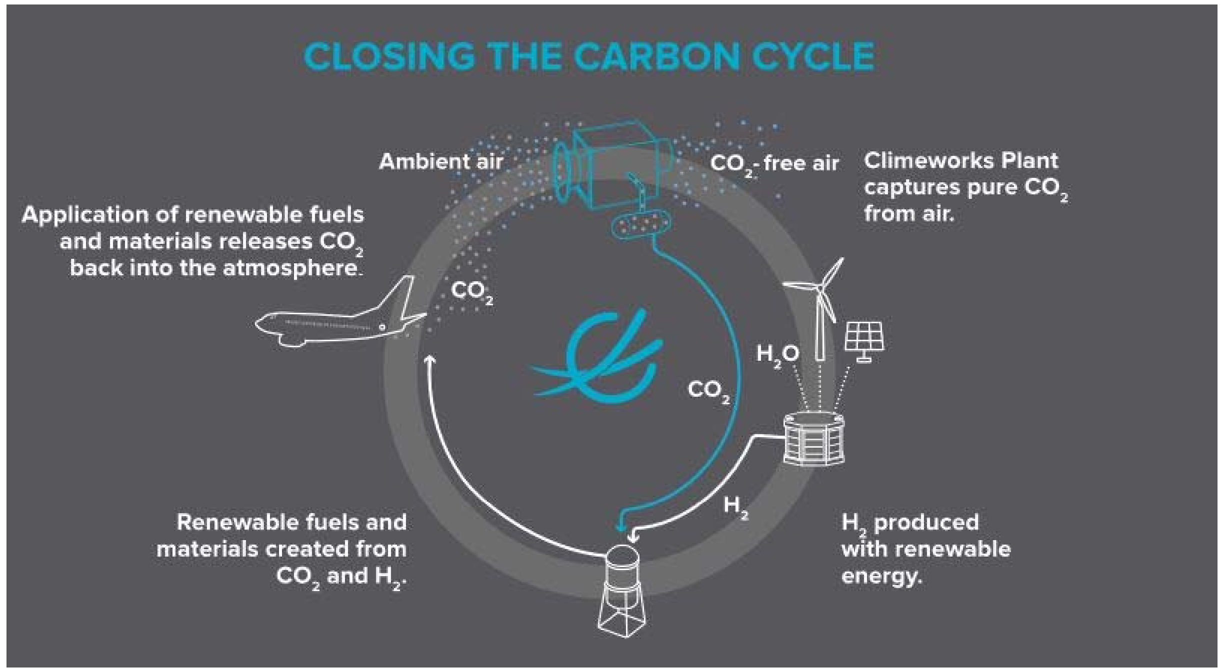


Figure 4-5 Closing the Carbon Cycle (Source: www.Climeworks.com)

If we look at greenhouses specifically, farmers use greenhouses to create finely tuned conditions to ensure optimum yield from their crops. Raising carbon dioxide (CO_2) levels within these greenhouses increases the rate of photosynthesis which can boost the crop yield by up to 20 per cent.

Climeworks has installed a direct air capture plant at the KEZO waste incineration facility in Hinwil, Canton of Zürich, Switzerland, which powers the direct air capture plant with heat. The high purity CO_2 is delivered to the neighbouring greenhouse operated by Gebrüder Meier. The gas is pumped into the greenhouse atmosphere, enhancing vegetable and lettuce growth by up to 20 per cent.

Figure 4-6 Climeworks Plant in Hinwil, Canton of Zurich, Switzerland (Source: www.climeworks.com)

Figure 4.7 provides a comparison of CO_2 removal approaches focusing on the area required, water required, expected cost and impact on the environment for each approach. When considering this information, this technology warrants serious consideration and investigation for its potential to offset residual carbon emissions from the Parkes SAP, and importantly, as part of the implementation of circular economy principles.

CONCLUSION
There is an opportunity for the Master Plan to have a clear strategy for the investigation and consideration of all options for carbon dioxide removal (negative emissions technologies), as part of the Precincts approach to achieving carbon neutrality.

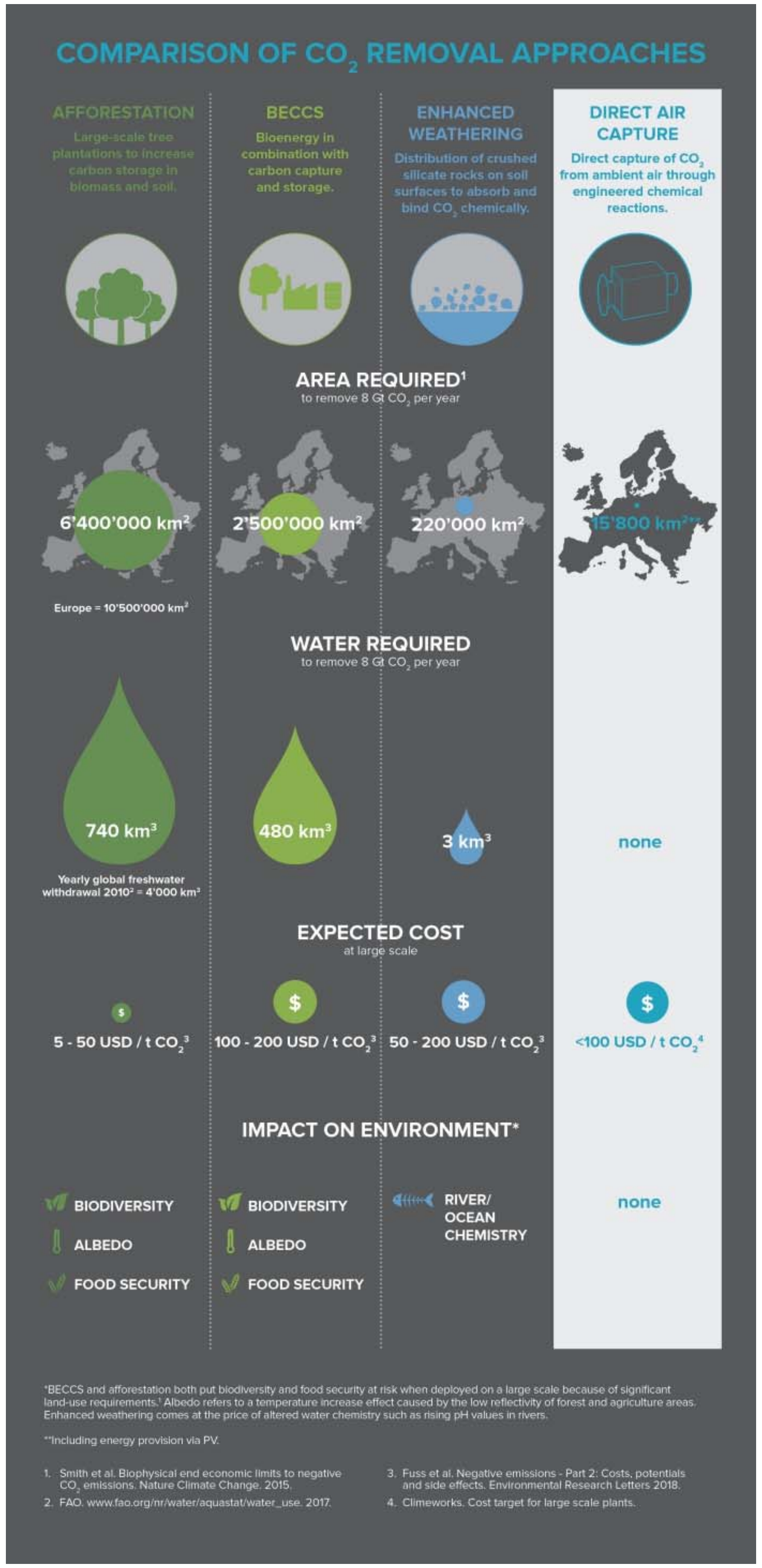


Figure 4-7 Comparison of CO2 Capture Methods (Source: www.climeworks.com)

5 CLIMATE RESILIENCE

The goal for the Parkes SAP is to be a precinct resilient to climate change. This goal will be used to set design principles for the Precinct to achieve a high degree of resilience in the face of changing climatic conditions under climate change scenarios.

The Office of Environment and Heritage (OEH) issued the Central West and Orana Climate Change Snapshot, which covers the region of Parkes, however as it is not an in-depth study of the Parkes SAP area, it is advised that a Parkes SAP specific climate adaptation plan is prepared for the Parkes SAP.

For the purposes of this ESD Plan we have used the detail available in the Central West and Orana Climate Change Snapshot. Regionally, both minimum and maximum temperatures are projected to increase. Rainfall is projected to decrease in the spring, and increase in the autumn, and fire weather is expected to increase in winter, spring and summer. Some of the greatest reductions in rainfall are projected to happen in areas including Parkes, so more detailed understanding the future climate will influence not only development locations, but also the water use and recycling within the Parkes SAP.

Design responses for the climatic changes that are likely to affect the Parkes SAP are considered throughout this report as appropriate for each sustainability goal.

5.1.1 CLIMATE ADAPTATION AND RESILIENCE

The NSW Climate Change Policy Framework identifies the critical risks faced by physical infrastructure and communities across the state as a result of climate change. The Parkes SAP should consider climate risk factors in its design and delivery with a climate risk assessment and climate adaptation plan.

Figure 5-1 NSW Climate Change Policy Framework

The aim of undertaking a Climate Risk Assessment (CRA) is to identify key climate variables that would pose a risk to the Parkes SAP's operation over its life and to ensure adaptation measures are integrated in to the project design to build resilience over time.

The approach of a CRA should include the five steps outlined below:

Step 1: Assessing risk exposure

Step 2: Develop risk statements

Step 3: Undertake risk assessment

Step 4: Identify adaptation initiatives

Step 5: Reassessing risk

The following provides a summary of the climatic changes that are likely to affect the Project:

— Increase in maximum temperatures

— Increase in minimum temperatures

— A greater number of extreme hot days (days over 35°C)

— A decrease in cold nights (nights less than 2°C)

— Change in rainfall patterns.

A Parkes SAP specific detailed climate risk and adaptation strategy would allow for the assessment and management of climate related risks for the Parkes SAP in the long term.

There are a range of potential design responses to the predicted impact of climate change. Some examples include:

— Emergency plant locations;

— Tree canopy cover of the public domain and heat wave management;

— Flood thresholds for floor levels;

— Public domain utility and water management infrastructure;

— Resilient systems (on-site generation + storage).

CONCLUSION
A Parkes SAP specific detailed climate risk and adaptation strategy would allow for the assessment and management of climate related risks for the Parkes SAP in the long term. This could become a living document which can be revised and updated in line with changes to climate data. Design responses for the climatic changes that are likely to affect the Parkes SAP, informed by the Central West and Orana Climate Change Snapshot, are considered throughout this report as appropriate for each of the sustainability goals.

6 ENERGY

The energy goal for the Parkes SAP is to harness innovation to deliver **secure, affordable & low carbon** energy using an energy strategy that is underpinned by **circular economy principles.** This also supports the goal to create a Parkes SAP that is **carbon neutral**.

To create a Parkes SAP of this scale with secure, affordable & low carbon energy, several energy strategies will need to work in synchronicity. We have considered the range of land uses in the Parkes SAP and their differing energy needs to inform our advice for the creation of an integrated and flexible energy strategy for the Parkes SAP.

While improving the energy efficiency of buildings is a critical consideration, there are also substantial opportunities to reduce the carbon intensity and environmental impact of energy consumption through innovation on the supply side, for example through renewable energy embedded generation opportunities, enabled by micro-grids.

The energy section of this report provides a summary of key technologies and associated infrastructure that are likely to be required within the Parkes SAP, or within specific land use areas, that would contribute to the Parkes SAP achieving carbon neutral status. This enabling infrastructure is also intended to signal to investors that the challenging energy and carbon standards within the Parkes SAP are achievable without being cost prohibitive to their business models.

Methodology

The process we have implemented to assess the most appropriate technologies, has been to firstly assess the energy characteristics associated with each land use area. This is to understand the differences in terms of demand for electricity, heating or cooling. Some land use areas rely predominately on electricity with little or no demand for heating, such as the freight terminals. Whereas others, such as the abattoir have very high demand for electricity, heating (predominately in the form of very hot water) and cooling for cold room or freezer storage. Cooling for this analysis, is assumed to be delivered via electrically powered equipment such as air source heat pumps (ASHP), variable refrigerant flow (VRF) systems or other refrigeration systems for cold/freezer storage such as vapour absorption systems (VAS) and vapour compression systems (VCS).

Next, we undertook research to establish benchmark energy demand data to further understand which land use areas are likely to require relatively more or less energy. We have used a combination of in-house data from relevant projects and research into existing facilities within NSW (as far as possible) and Australia.

It is important to note that at this stage of analysis, the data is very high level and provides an overview of relative, annual demand. The data does not reflect daily demand profiles, which provide a more complete picture of demand such as baseloads, peak demands and fluctuations over time periods. Nor does it provide a breakdown of the split between demand for electricity, heating or cooling. This level of detail will become available as the overall project progresses. Thus, the data is highly indicative and is useful to undertake a comparative analysis rather than an absolute analysis.

In the next stage of the assessment, we applied assumptions in terms of the ratio of building to land use area to draw insight into the relative energy intensity of different industries. For example, the freight terminal has a higher energy intensity per meter squared than the abattoir, even though the abattoir involves a far more energy intensive process. This reflects that the abattoir requires a large land area relative to the size of the actual building, compared to freight terminal buildings and operational areas, which take up a large proportion of the land available.

Another aspect of the energy strategy is to assess the range of low and zero carbon technology options available for the Parkes SAP, which land use areas they would best serve and to consider such factors as infrastructure requirements, business model complexity, initial capital costs, opportunities for co-location and contribution to the circular economy objective. Table 5.1 below provides a summary of this assessment.

The results of the analysis we have undertaken have been used draw conclusions in relation to the most suitable renewable energy technologies for the planned industrial land uses, to support a net zero energy strategy and reduce scope 1 and 2 emissions, for the Parkes SAP. The results of this assessment are referred to in the following sections of the report and are contained in Appendix C of this report.

6.1 TECHNOLOGY AND LAND USE APPRAISAL

This section of the report provides discussion on the high-level strategies that should be considered and investigated further in the more detailed stages of the project. Conclusions from the land use appraisal regarding renewable energy technologies that will support the Parkes SAP in achieving net zero energy and net zero carbon status are also provided.

6.1.1 BUILDING, COMMUNAL OR SAP SCALE STRATEGIES

A successful energy strategy will need to be flexible and respond to a variety of outcomes for the Parkes SAP such as the type and scale of industries that come forward, along with the speed and sequence of uptake of parcels of land. In some instances, the most appropriate energy solution will at the building level, whereas for other demand profiles a centralised system serving all, or part of a land use may be appropriate.

Precinct level solutions such as the electricity utility, present opportunities to deliver a best practice in embedded networks, which allows building users to be both electricity customers and suppliers to the network. Large-scale embedded generation can improve resilience and reliability, provide long-term energy cost certainty. Other opportunities exist for integrated micro-grids, which can provide for multiple end-use needs including heating, cooling and electricity. This system could be enhanced further through building in smart grid technology to improve operational performance further and ensure the Parkes SAP is ‘future ready’.

Where ideal conditions and business case parameters could be satisfied, this would present an excellent opportunity for an energy network operator to manage the site. There are a range of business models available which should be investigated to assess the business case for such a system and consider ownership options. Micro and smart grids are discussed in more detail in Section 5.1.1.

Furthermore, the location and climate of the Parkes SAP provides some initial benefits to the performance of certain technologies, such as solar PV. In addition, and unique to the Parkes SAP, is the potential for EFW processes to be incorporated in the Parkes SAP. This type of technology could provide the platform for demonstrating the Parkes SAP is a world-class industrial Precinct and a leader in delivering industrial processes that are highly sustainable through embedding circular economy systems.

Energy from Waste processes come in a variety of systems and vary significantly in their ability to process waste to produce renewable gases, which can be used to produce electricity and heat, and in terms of truly reducing operational greenhouse gas emissions. There are two distinct Energy from Waste systems that could operate successfully in this setting, they are - anaerobic digestion (AD), which processes organic waste, and advanced gasification (AG), which processes solid, municipal waste.

There are other forms of Energy from Waste, such as incineration/combustion processes, that have been widely used for many years globally and in recent years have made significant advances in environmental performance. Combustion has not been considered in detail within the ESD Plan, as it is generally not considered to be the optimum approach for Energy from Waste that meets with the proposed sustainability goals for the Parkes SAP. This process is suited to large scale systems that process in excess of >100,000tpa of waste, and research has shown that electricity production and efficiency is limited in comparison to other technologies such as advanced gasification.[2]

6.1.2 ENERGY FROM WASTE FOR RENEWABLE ENERGY GENERATION

Anaerobic Digestion

Anaerobic digestion (AD) is the bacterial breakdown of organic materials in the absence of oxygen. This biological process generates a gas, referred to as biogas. This gas is produced from feedstock such as biosolids, livestock manure, and wet organic materials. The anaerobic digestion process occurs in three steps:

- Decomposition of plant or animal matter by bacteria into molecules such as sugar;
- Conversion of decomposed matter to organic acids;
- Organic acid conversion to methane gas.

Anaerobic processes can occur naturally or in a controlled environment such as a biogas plant. In controlled environments, organic materials such as biosolids and other relatively wet organic materials, along with various types of bacteria, are put in an airtight container called a digester where the process occurs. In addition to the production of biogas, a by-product of the process is a high-grade organic fertiliser called a digestate.

The biogas can then be utilised to produce both heat and electricity through combustion in a co-generation plant. Co-generation, sometimes called combined heat and power, is the simultaneous production of electricity and heat using a heat engine. This process is a more efficient use of fuel than traditional systems, as the heat generated from the creation of electricity, which would otherwise be wasted, is recovered.

This process would make a significant positive contribution to the sustainable operations of the Parkes SAP. The proposed land uses generate the type of organic waste that is required for the AD processes through diverting this waste to a renewable fuel source and creating zero carbon electricity and heat that is required by the land uses producing the waste. This plant would therefore contribute significantly to the circular economy vision for the Parkes SAP.

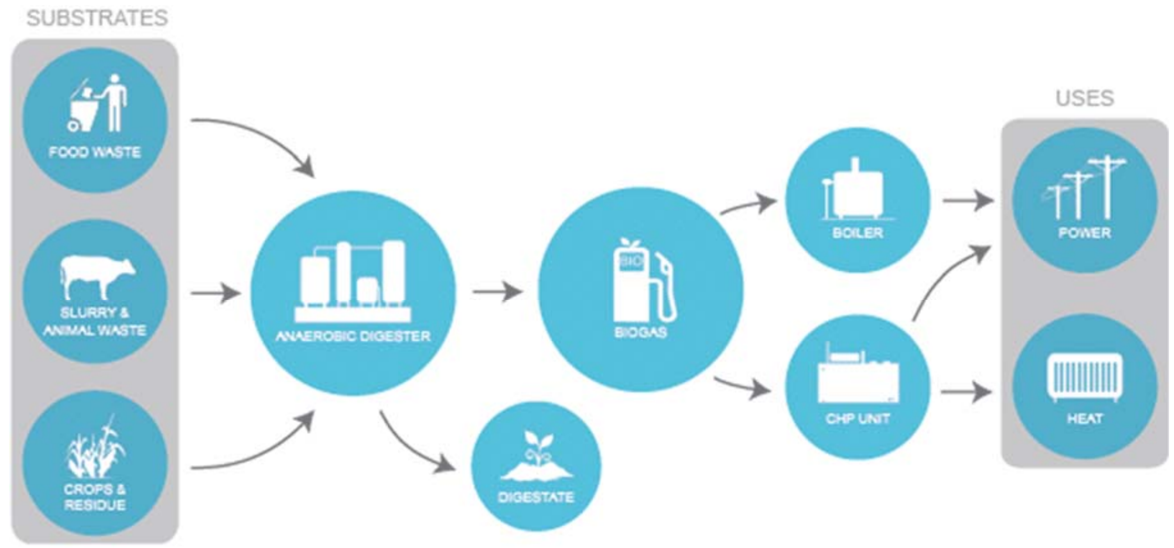


Figure 6-1 Anaerobic Digestion Process (Source: https://simonsgreenenergy.com.au/product-range/biogas-cogeneration)

Example: Yarra Valley Water, North Melbourne

Figure 6-2 Yarra Valley Water's to Energy Facility, North Melbourne

The site is an anaerobic digestion facility operated by Rewaste north of Melbourne. It has a capacity of 100T/d, 1MW and is a dedicated facility processing commercial organic waste and powering the adjacent to a Waste Water Treatment Plan with significant excess power generation.
Winner "Best international commercial plant" UK ADBA awards 2017

[2] Waste Technologies: Waste to Energy Facilities, A Report for the Strategic Waste Infrastructure Planning (SWIP) Working Group. WSP Environmental Ltd for the Government of Western Australia, Department of Environment and Conservation (May 2013). Page 45

The spatial (land take) of the AD facility is indicated below – estimated from areal images from Google maps.

	m^2	% Site Area
Site Area	11,763.07	
Buildings	4,088.66	35%
Roads + Parking	6,380.64	54%

Advanced Gasification

Advanced Gasification (AG) converts municipal solid waste (MSW) to a usable synthesis gas, or syngas. It is the production of this syngas which makes gasification so different from incineration. In the gasification process, the MSW is not a fuel, but a feedstock for a high temperature chemical conversion process.

Rather than producing just heat and electricity, as is done in a waste-to-energy plant using incineration, the syngas produced by gasification can be turned into higher value commercial products such as transportation fuels, chemicals, fertilizers, and even substitute natural gas for use in co-generation plant. Incineration cannot achieve this and of course represents a range of other undesirable environmental outcomes.

A comparable Energy from Waste facility has been granted permission in Pilbara, WA. The facility there will divert between 70,000 – 130,000 tonnes of waste per year from landfill, and through the advanced gasification process will generate enough energy to power 21,000 homes. The thermal capacity of the plant is 72MW and the electrical generation capacity is 18.5MW. It is interesting to note some of the determining factors for the facility in this location:

— Proximity to major road transport routes
— Access to major existing power infrastructure
— Proximity to major regional sources of waste
— Good separation from the nearest residential land (Approx. 6.4km)

Inclusion of this type of facility within the Parkes SAP also offers significant positive outcomes for both the site and for the region. To operate an Energy from Waste facility of this kind would require an integrated waste management facility to process thousands of tonnes of MSW per year. This could represent significant improvements to the current process of waste management in the region and is ideally suited to the industrial nature of the Parkes SAP.

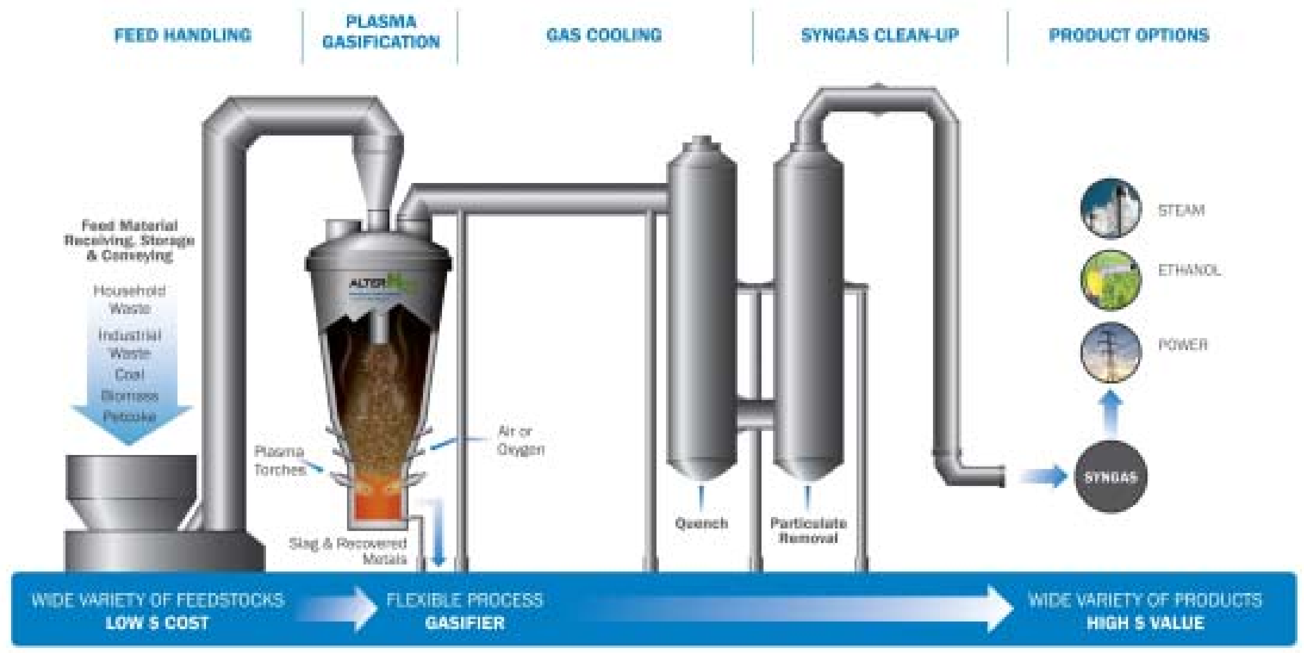


Figure 6-3 Advanced Gasification Process

Example: Pilbara, WA

Figure 6-4 New Energy. Energy from Waste Facility in the Pilbara Region, WA

Thermal Capacity 72MW

Waste Capacity from 70,000-130,000t/yr (the average Australian produces 1.5t/yr

Electrical Generation Capacity 18.5MW (enough to power 21,000 homes)

http://www.newenergycorp.com.au/assets/pilbara/New-Energy-PilbaraMarch-2016.pdf

6.1.3 GEOTHERMAL AND GROUND SOURCE HEAT PUMPS

A geothermal heat pump or ground source heat pump (GSHP) is a central heating and/or cooling system that transfers heat to or from the ground. There are a range of applications and examples of geothermal energy, however for the purpose of this analysis, we are considering a communal system consisting of a network of vertical boreholes coupled with a communal, high efficiency GSHP.

Such a system exchanges heat energy with the ground via boreholes, at depths of between one and 100 metres below the surface. The GSHP works like a refrigerator, which uses a circulating refrigerant and a compressor to move heat from inside the fridge out into the room, lowering the temperature inside the fridge. Exchanging heat energy with the ground, GSHPs move heat into, or out of, a building. All GSHPs consist of a loop field, a compressor and refrigerant. This system then connects to a heating, cooling and/or hot water system of choice.

GSHP systems differ mainly in the type of loop field they employ (the pipes and their configuration), and the liquid circulating through it. The loop field can be a vertical ground loop, or a horizontal loop field placed about 1.5 metres below the ground, or in a body of water. Standard vertical water loop geo exchange systems circulate water through high-density polyethylene pipes underground. These are the most prevalent systems around the world as they were the first GSHPs to be commercialised. In direct exchange systems, refrigerant circulates directly through copper pipes underground. Typically, these systems involve digging holes down to about 30 metres. Depending on the heat pump's design, both the standard and direct exchange systems can perform more than one function, such as heating, cooling, and/or hot water.

This technology within the Parkes SAP should be investigated in further detail as it may be a very efficient method of meeting the heating and cooling demands within particular land use areas such a Protected Cropping.

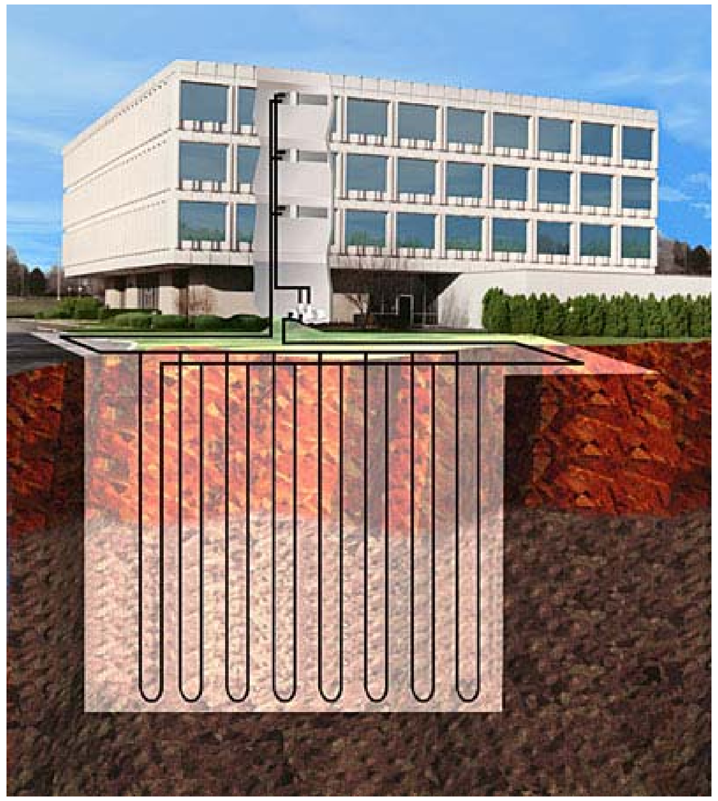


Figure 6-5 Commercial Geothermal Ground Loop, Winslow Pump & Well

6.1.4 HYDROGEN ENERGY

When hydrogen is burned for power, transport or heating purposes, it produces only water vapour. No particles, no greenhouse gases, no carbon monoxide or sulphur dioxide emissions – just water vapour.

The life-cycle emissions of hydrogen can be zero if it is produced using renewable energy; the determining factor is if it is sourced from natural gas or coal. In the latter case, the emissions could be reduced by including carbon capture and storage technologies in the hydrogen production facility.

Producing the hydrogen is the first step. Hydrogen provides opportunities as a chemical feedstock for power generation, but also creates potential solutions in transport and for heating and home cooking.

The generation of hydrogen from renewable energy systems represents a major opportunity for the Parkes SAP to be among the first in Australia to commercialise this type of technology and be part of the Australian led participation in the global hydrogen fuel and energy storage market.

Hydrogen provides an opportunity as a fuel source for multiple uses including the following:

- Storage of excess electrical energy to smooth out the supplies from wind and solar through both daily and seasonal fluctuation.
- Provision of liquid fuel for the transport sector locally.
- Provision of liquid fuel for export.
- Injection into the gas grid to supplement natural gas and reduce the carbon emissions associated with natural gas consumption.

The market for hydrogen is in its infancy however economies in Japan, Canada and China have already indicated strong targets for hydrogen powered vehicles (HPVs) for 2030 and out to 2050, for the purposes of reducing emissions associated with transport. HPVs offer some key advantages over electric vehicles for larger trucks and buses, the travel range is longer for smaller vehicles and the net environmental impact is much lower than batteries which often require mining of scarce resources such as lithium.

Technology description

Hydrogen is the most basic of all elements, the hydrogen atom is made up of a single proton and a single electron. It is the most common form of matter in the universe however on Earth it is more commonly bonded to other elements within molecules such as water, air and methane.

To separate hydrogen gas from its companion substances takes a lot of energy but when recombined with other elements such as oxygen it releases energy. As such, the creation of hydrogen is a form of energy storage where electrical energy may be stored as a liquid and released for later use. In this way hydrogen, can be used as an energy store to convert the electricity generated by renewables in to a fuel source for transportation.

Hydrogen may also be produced from natural gas reformation of methane (CH_4) using steam as the thermal driver to separate the elements. This is known as steam reformation. The outputs are hydrogen and carbon monoxide. Typically, the more common method of producing hydrogen from renewable electric sources is by electrolysis. This is where an electric current is passed through an electrolyser containing water (H_2O) to split it into its component elements oxygen and hydrogen.

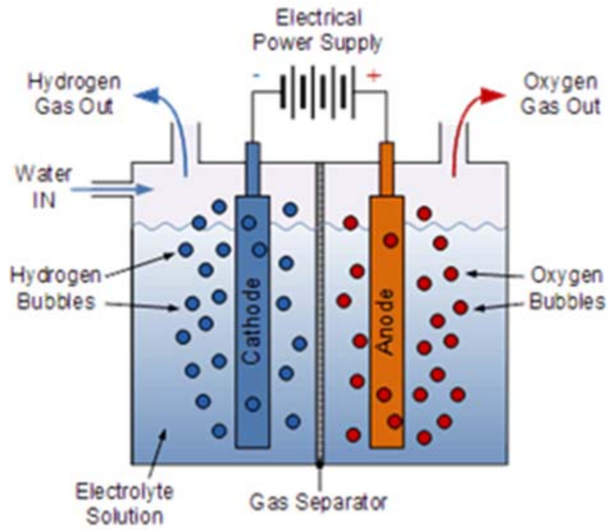


Figure 6-6 Hydrogen Electrolysis Generation Process

Hydrogen may also be used as a volatile natural gas and injected in to the natural gas network to provide clean renewable gas, or it can be used in a fuel cell to recombine hydrogen with oxygen to produce water and an electric current. When hydrogen is consumed in a fuel cell it produces only water.

Hydrogen can be produced from a variety of energy resources such as natural gas, coal-fired power, biomass, and renewable power (e.g. solar and wind). It can then be used in a range of applications including energy generation, transport fuel, heating, portable power and other applications.

Electricity generation from wind and solar present significant challenges to grid operators, including intermittent outputs and often a mismatch between peak output and peak demand, which can result in grid instability, negative power pricing (where renewable generators are paid to shut down), and wasteful curtailment of supply. Grid-scale energy storage in the form of hydrogen production combined with regenerative hydrogen fuel cells enables further growth of these renewable energy sources by levelling out the supply peaks, increasing the capacity factors of wind and solar installations, and transforming these intermittent generators into grid-dispatchable resources and base load power.

Relevant precedents

Australia is still in its infancy in terms of the development of effective policy and regulatory frameworks for the widespread, safe and efficient adoption of hydrogen and associated technologies.

While hydrogen fuel cell technology is not new - NASA has used them to power rockets for decades - car manufacturers are now able to make fuel cells small and mobile enough to fit inside passenger cars.

Energy storage in hydrogen is a technically feasible option for grid-scale storage and is already in pilot demonstrations. Because of its low overall efficiency from storage to recovery, it may be overlooked despite its potential advantages, such as high energy storage density and low rate of self-discharge when compared to existing battery technologies. Hydrogen is therefore much more viable as a seasonal energy store making it suitable for technologies such as solar to be generated in summer and used in winter.

The following section outlines hydrogen energy projects that are installed or undergoing feasibility studies.

AGIG's Hydrogen Park of South Australia

As a national gas network distributor, Australian Gas Infrastructure Group (AGIG) own 33,764 km of natural gas networks and over 3,500 km of transmission pipelines across South Australia, Queensland, New South Wales, Victoria, Western Australia and the Northern Territory.

AGIG's Hydrogen Park of South Australia (HyP SA) will deliver a 1.25-megawatt (MW) polymer electrolyte membrane (PEM) electrolyser at the Tonsley Innovation District in Adelaide's southern suburbs.

The produced hydrogen will then be injected (up to 15 per cent) into the local gas distribution network with future potential to provide low-carbon gas to homes and businesses.

Heywood Hydrogen Project

A business case and preliminary design for Victoria's first large scale hydrogen generation project powered by renewable energy in the form of an 80 MW solar farm is being developed. The solar farm will enable electrical energy to be used to produce hydrogen gas in a large-scale electrolyser. The intent is for the hydrogen gas to be exported for domestic or off-shore use or used on site to power gas turbine or hydrogen fuel cell electrical generators at times of peak grid demand or poor solar performance. A project consortium has been assembled to progress the Hydrogen Project which consists of Glenelg Shire Council, Countywide Renewable Energy, Deakin University, CSIRO, ITM Power, Port of Portland and Ausnet Services. The proposed project location is Homerton, approximately 17km east of Heywood.

Moreland City Council

Moreland Council instigated a hydrogen-powered garbage truck scheme. The $9.37 million project was intended to establish Australia's first commercial-scale hydrogen refuelling station, which would produce hydrogen from 100% renewable energy using a 1 MW on-site solar plant and grid-sourced wind power. The project was intended to enable the council's heavy vehicle fleet to begin transition to a zero-emission Fuel Cell Electric Vehicles. However due to failure to reach favourable commercial terms the project has not yet proceeded.

Japanese hydrogen fuel cell buses

In Japan, Toyota has released approximately 100 hydrogen fuel cell buses for use in Tokyo for the 2020 Olympic games.

Figure 6-7 Toyota Sora Hydrogen Fuel Cell Bus

Opportunities for the Parkes SAP

The intended use for hydrogen within the Parkes SAP is yet to be determined and would depend on the various economics of different end uses. The intent is that it may be used for a range of different uses depending on the international and local prices of each end use including:

- Liquid fuel for export
- Liquid fuel for domestic use
- Fuel for electrical energy generation
- Fuel to supplement the gas grid

In order to be considered a renewable energy resource, hydrogen fuel cell technology would have to be coupled with a renewable energy power source such as solar or wind to provide the energy required to power an electrolyser to split water into its component elements, oxygen and hydrogen.

Hydrogen storage will complement the highly intermittent energy generating capabilities associated with solar and wind generation and will ensure that there are minimal GHG emissions over a life cycle, as compared with conventional storage options such as lithium batteries. Hydrogen production has a small GHG impact associated with the fugitive loss of hydrogen from the plant into the atmosphere which can increase the content of methane and ozone in the atmosphere.

When comparing hydrogen fuel cells as a method of energy storage to the more conventional lithium ion battery technology, for the same quantity of manufacturing energy input, hydrogen storage provides more energy dispatched from storage than a typical lithium ion battery over the lifetime of the facility. On the other hand, energy storage in hydrogen has a much lower overall efficiency than batteries (30% vs 75-90%), resulting in significant energy losses during operation. The round-trip efficiency of hydrogen fuel cell energy storage must improve dramatically before it can offer the same overall energy efficiency as batteries.

The following table provides an overview of the technologies that have been considered within the analysis.

Table 6.1 Energy Profile Overview by Land Use

Technology	Building Scale	Communal System	Infrastructure Requirements	Business Model Complexity	Initial Capital Cost	Co-location Opportunities	Circular Economy
Roof Mounted Solar PV	Yes	Yes (through an embedded network)	Low	Low	Medium	Not Significant	Medium
Roof Mounted Solar Hot Water	Yes	Yes (proximity is very important)	Medium	Low	Low at Building Scale Medium at Communal Scale	Not Significant	Medium
Wind Turbines	No	Yes (through an embedded network)	High (plus, high spatial requirements)	Medium	High (plus complex planning and environmental regulation)	Not Significant	Low
Air Source Heat Pump	Yes	No	Low	Low	Medium	Not Significant	Low
Ground Source Heat Pump (ground or water source)	Yes	Yes	High (due to depth and number of boreholes required)	High	High	Important	Medium
Energy from Waste (AD) w Cogen	Very specific to land use i.e. Intensive Livestock Agriculture	Yes	High	Very High	High	Important	High
Energy from Waste (AG) w Cogen	No	Yes	Very High	High	High (plus complex planning and environmental regulation)	Not Significant	Medium/High
Hydrogen	Yes	Yes	High	High	High (unique challenges to pipeline materials and compressor design for pipeline network)	Important - Most hydrogen used is produced at or close to where it is used.	Medium/High
Solar PV Farm (Utility Scale)	NA	Yes	Medium	Low	Medium	Not Significant	Low

The analysis allows initial conclusions to be drawn across technologies, such as:

— Roof mounted solar PV can be implemented at building scale, can supply a communal network and is a relatively low cost, low complex technology solution.

— Roof mounted solar hot water is suitable at the building scale and works as a communal system, however is only efficient where customers are located very close together. The infrastructure requirements at the communal level are considered medium due to the necessity for large thermal storage tanks and distribution pipework. In addition, this technology would require additional 'top-up' to generate high temperature water which is likely to be required in industrial processes.

— Wind turbines will require large areas of land and are likely to be complex in terms of cost and business case due to planning and environmental regulation.

— Air source heat pumps are likely to be best suited to use at the building level rather than for communal systems.

— Ground source heat pumps utilising either geothermal or water loops could be implemented at either building or communal scale. Initial capital costs are likely to be high due to the number and depth of boreholes and potentially complex planning and environmental regulation (particularly around water source systems). However, where such barriers are removed, this technology can deliver a strong business case and long term, secure renewable energy.

Table 6.2 below provides an initial overview of the energy profile and intensity of the land uses proposed. It also considers the potential for solar PV to offset annual energy demand and to supply the embedded network with renewable electricity. The table has also been used to consider where a land use has the potential to be a customer, and the likely importance of their demand in creating a positive business case, for a communal co-generation system and as part of an EFW system.

Table 6.2 Land Use Energy Characteristics

Land Use Area	Energy Profile	Energy Intensity		Potential Technology		
		Building (kWh/m2/year)	Land Use (kWh/m2/year)	Roof Mounted PV	Energy from Waste (AD) w Cogen	Energy from Waste (AG) w Cogen
Freight Terminals	Electrical Demand: **High** Thermal Demand: **Limited/none** Cooling Demand: **Limited** (office spaces)	62.10	27.32	Annual Demand Offset: **> 140%** Network Supply: **Medium**	Potential Customer: **Electricity** Significance: **Low**	Potential Customer: **Electricity** Potential Supplier: Relatively low volumes of solid (municipal) waste Significance: **Low**
Regional Enterprise: Distribution Centres, Warehousing, Mining Services, Customs Facility, Small Enterprise/Office	Electrical Demand: **High** Thermal Demand: **Limited/none** Cooling Demand: **Medium** (refrigeration areas + office cooling)	41.01	10.57	Annual Demand Offset: **> 200%** Network Supply: **Very High**	Potential Customer: **Electricity** Significance: **Medium** (additional load for cooling)	
Regional Enterprise & Commercial Gateway: Advanced Manufacturing	Electrical Demand: **High** Thermal Demand: **Limited/none** Cooling Demand: **Limited**	80.00	25.71	Annual Demand Offset: **> 100%** Network Supply: **High**	Potential Customer: **Electricity & Heating** Significance: **Very High**	
Intensive Livestock Agriculture: Abattoir	Electrical Demand: **High** Thermal Demand: **High** Cooling Demand: **High** (refrigeration/freezing)	135.00	8.10	Annual Demand Offset: **> 40%** Network Supply: **Medium**	Potential Customer: **Electricity & Heating** Significance: **Very High** Potential Supplier: **Organic Waste** Significance: **Very High**	
Intensive Livestock Agriculture: Poultry Farm, Piggery, Intensive Livestock Growing/Processing	Electrical Demand: **High** Thermal Demand: **High** Cooling Demand: **Medium** (refrigeration/freezing)	80.00	13.83	Annual Demand Offset: **> 73%** Network Supply: **High**		
Mixed Enterprise & Protected Cropping: Commercial Greenhouses, Hydroponics, other value-added crops	Electrical Demand: **High** Thermal Demand: **High** Cooling Demand: **High** (refrigeration/freezing)	250.00	31.25	Not feasible due to building type		
Green Infrastructure: Protected vegetation, offset planting areas, storm water treatment, wetlands, biodiversity corridor	NA	N/A	N/A	N/A	Potential Supplier: **Organic Waste** Significance: **High**	Potential Customer: Electricity (Storm water Treatment)

Table 6.2 above shows that the freight terminal areas are likely to have high demand for electricity and limited to no demand for heating and cooling. This land use area therefore has excellent potential to offset carbon emissions and achieve net zero energy consumption through renewable electricity produced by solar PV. Our initial and high-level calculations predict solar PV could offset around 140% of electrical demand in this area and hence, these building types could potentially be carbon positive on an annual basis. As discussed previously, this level of analysis does not consider daily demand profiles and peaks in demand where the solar PV array may either over or under supply demand at any point in time. In addition, this area of the site is unlikely to be a customer for heat generated from a centralised, co-generation system.

In contrast, the regional enterprise, intensive livestock agriculture and protected cropping land use areas, all have diverse energy profiles with relatively high demands for electricity, heating and cooling. These loads are likely to be relatively steady and predictable across time periods, however there could be significant peaks in demand across the daily profile. These land uses would be ideal customers for a centralised, co-generation system and have a high potential for achieving better energy outcomes through co-location and energy sharing strategies.

The table also shows the predicted energy intensity across both building area and land use areas. It is interesting to note that protected cropping has the highest land use and building energy intensity, whereas and the abattoir has the highest building energy intensity and lowest land use energy intensity.

The analysis has demonstrated that there are a range of potential technologies and solutions available for the site and it is important that these options remain flexible. The final solution is likely to be a combination of technologies and systems, based on a complex set of decisions around infrastructure, plant, equipment, energy profiles and availability of customers, contractual opportunities and limitations, and future costs of energy.

CONCLUSION

The is an opportunity for the energy strategy for the Parkes SAP to include the following, discussed in more detail in section 4.1 Energy Infrastructure.

Future ready utilities through:

- Embedded energy networks or micro-grids that allow energy sharing (import and export) across the entirety of the Parkes SAP.
- Cogeneration energy networks in areas of the site where land uses have a diverse energy profile that require high and constant demand for heating (where this cannot be met through alternative electric equipment). This should be considered where biogas or syngas (renewable gas produced through EFW processes) is a readily available input fuel to the co-generation plant and hence is a renewable energy system.
- Large-scale roof mounted solar PV to take advantage of expansive roof areas across the Parkes SAP, including consideration of battery storage to improve performance and contribute to meeting peak electrical demand.
- Consideration of all electric infrastructure supported by ground, air or water source heat pumps.
- Monitoring and controls to enable real-time demand management to best integrate decentralised solar generation and battery storage.
- Circular Economy approach to Energy

6.2 ENERGY INFRASTRUCTURE

6.2.1 MICRO GRID

A microgrid is a discrete energy system consisting of distributed energy sources (including demand management, storage, and generation) and loads capable of operating in parallel with, or independently from, the main power grid.

Micro-grids can be embedded networks, privately owned networks or public networks with bespoke metering, controls and embedded generation/storage. Some benefits of a micro grid are:

- Provision of power quality, reliability, and security for end users and operators of the grid
- Enhances the integration of distributed and renewable energy sources
- Enables smart grid technology integration
- Minimize carbon footprint and greenhouse gas emissions by maximizing clean local energy generation
- Increased customer (end-use) participation

Microgrids

6.2.2 SOLAR PHOTOVOLTAICS

Infrastructure Requirements

Solar PV has a relatively low infrastructure impact as the technology requires only the roof mounting system, suitable for the roof type and an inverter to be housed nearby. The key infrastructure that would allow the solar PV to contribute positively to the Parkes SAP as a whole, relates to the electricity grid and the requirement for this to be an embedded network as discussed above in section 4.1.1.

Co-location Opportunities

This technology does not require certain land use areas to be co-located to achieve additional efficiencies or better business case outcomes.

6.2.3 SMART GRIDS TO ENABLE PRECINCT LOAD MANAGEMENT

The term smart grid is a generic label for the application of computer intelligence and networking abilities to a standard, traditional electricity distribution system.

Smart grid initiatives seek to improve operations, maintenance and planning by making sure that each component of the electric grid can both 'talk' and 'listen.' Another major component of smart grid technology is automation.

At a precinct scale, smart grids can be market-enablers as they allow for more flexible commercial arrangements than conventional public utility connections between suppliers and consumers and allow more sophisticated technology and operational strategies which allow each component of the electric grid to both ‘talk’ and ‘listen’.

A smart grid can act as a platform for advanced services and is the combination of operational, passive and energy generation devices e.g. smart appliances and meters, renewable energy generation technologies and battery storage systems.

Through the provision of these devices and a real time smart control system the electricity network can be configured, monitored and operated to provide increased efficiency, resilience, and flexibility to end users.

It is anticipated that the Parkes SAP will include renewable energy technologies (i.e. solar PV) in addition to the existing solar farm. Precinct load management strategies implemented via a smart grid will be critical in the management of demand side risk associated with this renewable energy supply.

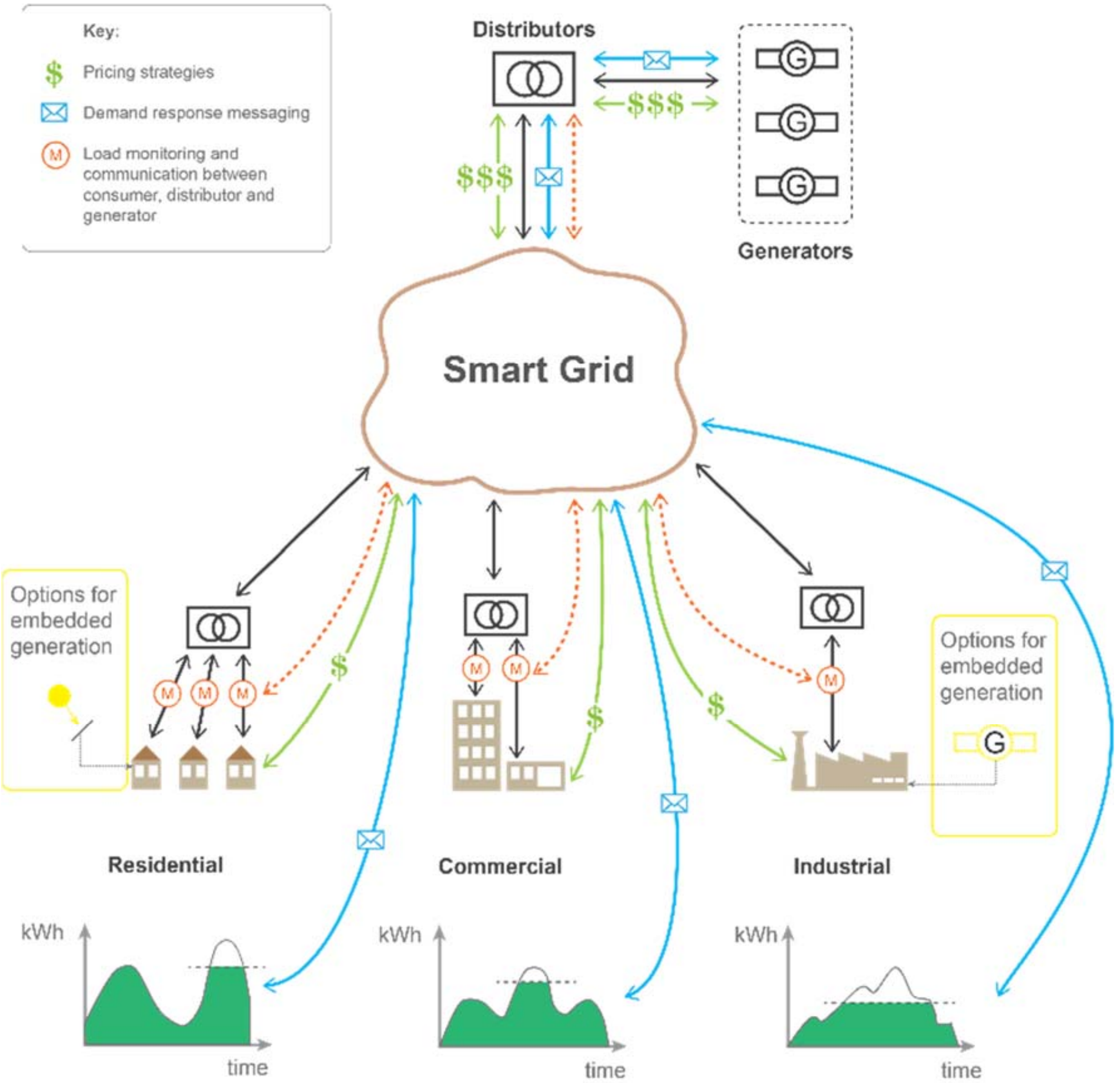


Figure 6-8 Smart Grid System Example

6.2.4 PRECINCT EMBEDDED BATTERY STORAGE

The adoption of on-site (precinct) energy storage systems provides the opportunity for a range of new energy management initiatives. In particular, embedded battery storage systems can be used to provide demand response support and are a key component in reducing peak electricity demand, providing storage for excess renewable energy generation, and the use of smart tariffs and power purchase agreements through the connection with the site-wide electricity grid.

Precinct wide battery storage systems can typically provide improved better integration with the network energy management than building level systems due to their size.

Example: Hornsdale Wind Farm Battery Storage System, South Australia

The 100MW Hornsdale Battery Energy Storage System will be the world's largest lithium ion battery installation.

Installed adjacent to the Hornsdale Wind Farm in the mid-north of South Australia, the battery system will charge using renewable energy from the Hornsdale Wind Farm and then deliver electricity during peak hours to help maintain the reliable operation of South Australia's electrical infrastructure.

Consolidated Power Projects designed and constructed the battery energy storage yard and the 275/33kV substation.

The project included:

— The construction of the battery energy storage yard, including earthworks and foundations

— Installation of Tesla battery power packs and inverters

— Installation and commissioning of 33 x 33kV step up transformers

— Supply and installation of 33kV MV cables linking the battery energy storage system to the new 275/33kV substation located within 400m

— Construction and commissioning of the new 275/33kV substation

6.2.5 ENERGY FROM WASTE: ANAEROBIC DIGESTION PROCESS

Infrastructure Requirements

In a scenario where this type of Energy from Waste facility operates as a standalone energy provider, it will require a central energy centre to house the co-generation plant, thermal storage tanks, flue etc along with the digesters. The size of the facility will determine the scale of the associated plant for processing and treatment. In this scenario, the pipework infrastructure to serve customers within the Parkes SAP is another significant infrastructure requirement. The highly insulated, flow and return pipework reduces in diameter the greater the distance from the central plant and it is essential the pipe runs are minimised as far as possible. This not only reduces capital costs but also reduces heat losses from the system and increases efficiency.

Another potential scenario for this system is for the Energy from Waste process and facility to be incorporated into the operations of an abattoir. In this case, the system is likely to be sized according to the requirements of the abattoir in relation to the either quantity of waste and therefore the amount of biogas that could be produced or sized to meet the baseload energy requirements of the abattoir. The system could however be improved through providing additional organic waste from across the Parkes SAP and therefore increasing the production of biogas use in the co-generation plant. And through connecting other customers to the centralised system and therefore increasing baseload demand and allowing the system to operate at a higher capacity.

Co-location Opportunities

In the first scenario, it would be beneficial to house the central Energy from Waste facility as close as possible to the abattoir where it is expected that waste (pre-treated to an acceptable level) and to other intensive livestock activities where a good supply of organic waste could be sourced. Protected cropping also represents another good supplier of waste material, as well as being an ideal customer for the renewable electricity and heat being produced by the system.

For the second scenario, the same principles apply to co-location opportunities.

6.2.6 ENERGY FROM WASTE: ADVANCED GASIFICATION PROCESS

Infrastructure Requirements

The differences in footprint of current commercially available Energy from Waste technologies tends to be small since many components are similar. However, there are some differences.

The footprint required for close-coupled gasification plants appears to be similar to combustion plants. For gasification plants that incorporate syngas treatment systems, it is of note that the equipment required to polish the gas can take up significant space.

Gasification plants with gas engines can in theory be designed to be significantly smaller than equivalent capacity gasification or combustion plants using a traditional steam cycle. This is because they forego the requirement for a boiler/heat recovery steam generator (HRSG), turbine and condenser, as well as much of the bulky flue gas clean up equipment. However, this is dependent on the particular technology, and in some cases, syngas to gas engine technologies may offer no land take advantages. For example, one of the few commercially operating technologies using waste to produce syngas to gas engines is the Thermoselect process. These plants have relatively large footprints; for example, the 300tonnes per day (tpd) (approximately 100,000tpa equivalent) Chiba plant in Japan has a building footprint of 0.6 ha. This would appear to be a feature of this specific technology, which includes a large horizontal pyrolysis reactor as well as a vertical gasifier and syngas clean up equipment.

Co-location Opportunities

This technology does not require certain land use areas to be co-located to achieve additional efficiencies or better business case outcomes.

6.2.7 GEOTHERMAL AND GROUND SOURCE HEAT PUMPS

Infrastructure Requirements

The key infrastructure requirement for a communal GSHP system is the installation of vertical boreholes to depths of around 100m. If more detailed investigations determined that GSHP would be a viable technology for the energy profiles for specific land use areas, then the cost of the boreholes would likely be the remaining barrier for this technology to be widely adopted by incoming businesses. This would therefore be an infrastructure investment that could enable high levels of energy savings across parts of the Parkes SAP and therefore positively contribute to achieving net zero energy.

Co-location Opportunities

Co-location for this technology would be extremely important and therefore land use areas that have a demand for heat should be located near to each other. This technology is most likely to suit Protected Cropping but may also be able to meet demand within the Intensive Livestock Agriculture and in Advanced Manufacturing within Regional Enterprise.

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7 WATER

The goal for water in the Parkes SAP is a fully **Integrated Water Cycle**, supporting the needs of the precinct and the environment.

To create a Parkes SAP that has a fully Integrated Water Cycle it is important that the Parkes SAP maximises opportunities the for efficient use, reuse and recycling of water resources and that the Parkes SAP ensures the appropriate management of stormwater quality and quantity. To achieve this the Parkes SAP should be designed and delivered in the context of an integrated water cycle in which:

— Sewage, rainwater and stormwater are treated as a water resource rather than waste to be discharged;

— Recycled water is used many times locally – a less wasteful way of using water; and

— Stormwater is retained, slowed down and treated within vegetated systems rather than disposed of swiftly through concrete pipes and channels to receiving waters.

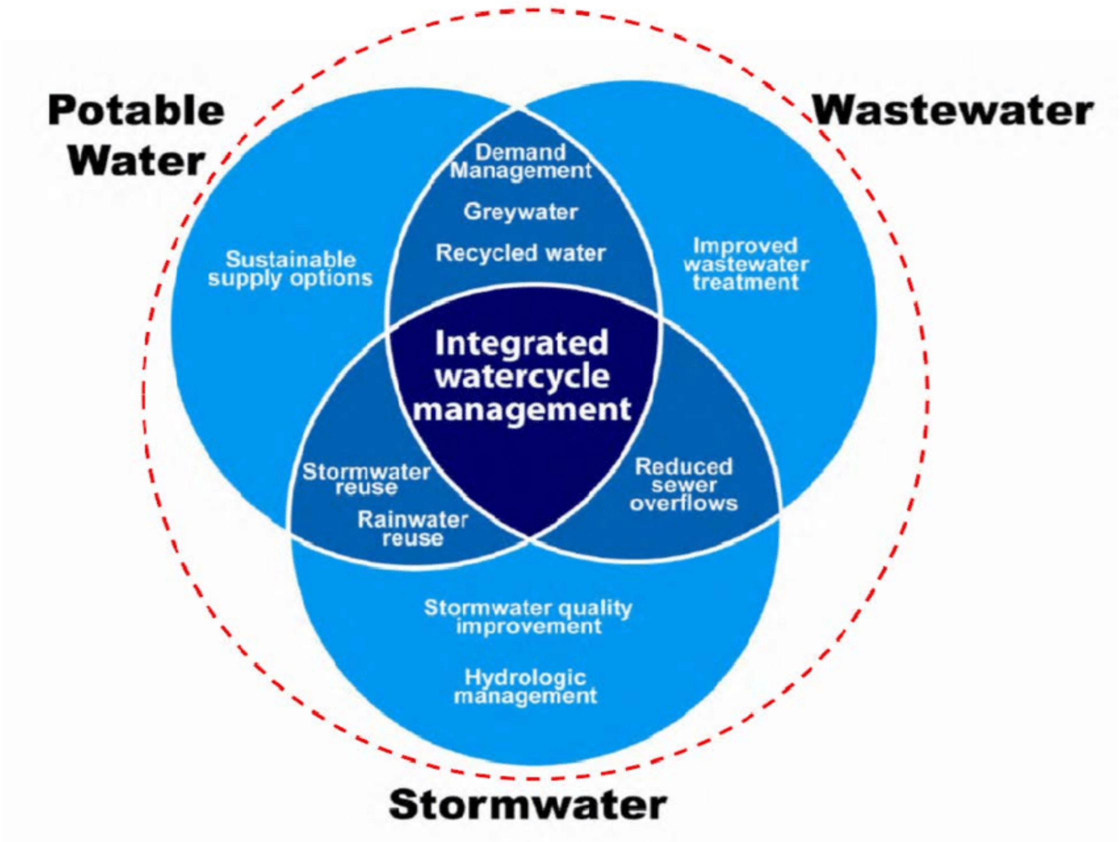

Figure 7-1 Integrated Water Cycle - Source: Hoban & Wong (2006)

7.1 EXISTING ENVIRONMENT

Hydrogeology: A groundwater desktop study has been undertaken to characterise the groundwater system at the site. This considers information on the geology, groundwater levels, groundwater quality and groundwater flow. The study also evaluates groundwater availability to provide information on the potential use of groundwater as a resource.

The preliminary desktop assessment indicates that multiple groundwater sources, legislated under two separate Water Sharing Plans, were identified within the investigation area. Both groundwater sources are likely to contain fresh – slightly saline quality water that is suitable for multiple beneficial uses including drinking water supply, irrigation and stock water supply, and represent extensive groundwater systems. Within the Lachlan alluvium, the water resource is utilised across irrigation and industry as well as water supply for stock and domestic use and local water utilities. This contrasts with the Lachlan fractured rock water source where the resource use is dominated by stock and domestic uses.

A groundwater management strategy based on the final masterplan can confirm and refine the identified desktop values and key concepts to provide a framework for assessing the suitability of the groundwater within the Parkes SAP precinct.

For the full details please refer to the full report prepared by WSP, the Groundwater Desktop Study; Special Activation Precinct, Parkes, April 2019.

Flooding and Water Quality: An assessment of the existing flooding and water quality has been undertaken to support and inform the Master planning process. The following results from the existing conditions flood modelling were noted:

— The Parkes SAP was primarily impacted by local flooding rather than regional flooding in all modelled events up to the Probable Maximum Flood (PMF).

— There are only minor impacts associated with Climate Change when comparing the 1% AEP (Annual Exceedance Probability).

— There are a number of areas with hazard that is dangerous for people and cars within the 1% AEP storm event, in particular in the vicinity of Brolgan Road.

— There is unlikely to be long duration flooding though the site as all catchment are localised flooding however there may be long duration flooding (and isolation) to the west and the south due to regional flows through Ridley's Creek and Gobang Creek.

For the full details please refer to the full report prepared by WSP, the Parkes Special Activation Precinct; Existing Flooding and Water Quality Conditions Report, April 2019.

Existing Water Infrastructure Network:

Parkes Shire Council undertook an integrated Water Management Strategy (IWCM) in 2004 which culminated in the Parkes Integrated Water Infrastructure Renewal Program. The renewal program addressed the following aspects of the Parkes urban water supply and waste water schemes: The Endeavour Dam, Lachlan River & Lachlan River Bore-field, their Water Treatment Plant (WTP) and sewage Treatment Plant (STP) facilities and their Recycled Water Scheme.

The Transport and Infrastructure Planning Study (prepared by Aurecon) confirms that the Parkes SAP investigation area has limited access to water, wastewater and stormwater infrastructure and focuses on the assessing the remaining available capacity of the existing Parkes town water related infrastructure and how that will form part of the strategy to deliver an Integrated Water Strategy for the Parkes SAP. The analysis indicates that the existing Parkes town infrastructure has capacity to meet the water and wastewater demands for the early stages of development requiring augmentation of the existing facilities or construction of new facilities as required when they are operating near capacity.

For the full details please refer to the full report prepared by Aurecon, Parkes Special Activation Precinct; Infrastructure and Transport Evaluation Report, May 2019.

7.2 WATER INFRASTRUCTURE

This section of the report considers the water needs of the land uses proposed within the Parkes SAP and provides information on the types of water infrastructure that should be considered. Table 7.1 and Table 7.2 provide a breakdown of the water characteristic of the various land uses proposed for the Parkes SAP and the opportunities these present.

The water infrastructure options discussed in this section support the goal of a fully Integrated Water Cycle supporting the needs of the precinct and the environment. Fit-for-purpose water technologies should be selected as appropriate for each of the land uses throughout the Parkes SAP.

Table 7.1 Land Use Water Characteristics

LAND USE	CHARACTERISTICS	APPLICATIONS OF ALTERNATIVE WATER RESOURCES	ROLE IN AN INTEGRATED WATER CYCLE
Freight Terminals	Low operational water demand	Material washing Process rinse water Crate and pallet washing Hardstand and vehicle washing Fire protection Cooling Boiler or cooling tower feed water supplement Toilet flushing Heating/cooling (air-conditioning systems) Crop irrigation (surface and subsurface) Constructed Wetland Construction Dust Suppression Stock Watering Environmental Flows Groundwater recharge	Expansive roof areas for rainwater harvesting Demand for non-potable supply from harvested/recycled sources
Regional Enterprise	Medium operational water demand associated with advanced manufacturing		Expansive roof areas for rainwater harvesting
Intensive livestock agriculture	Abattoir: High environmental impacts – odor emissions, waste water treatment and disposal, biohazard treatment facilities. Intensive livestock activities: High water consumption.		High demand for reused/treated water (crops irrigation etc.)
Protected cropping	High water consumption		Demand for non-potable supply from harvested/recycled sources
Green Infrastructure	Natural water consumption		Native planting to reduce irrigation requirements Potential for storm water treatment such as swales, wetland areas etc.
Resource Recovery	Medium Operational Demand.		Expansive roof areas for rainwater harvesting Demand for non-potable supply from harvested/recycled sources
Airport	Medium Operational Demand – dependent of the size and scale of the airport.		Expansive roof areas for rainwater harvesting Demand for non-potable supply from harvested/recycled sources

Table 7.2 Opportunities of Land Use Water Characteristics

INFRASTRUCTURE OPPORTUNITIES
• Rainwater capture – expansive roof areas across warehousing for high-grade RWH for non-potable uses i.e. irrigation, toilet flushing. • Storm water – slowed down, retained and treated (ideally within vegetated systems) for non-potable uses i.e. irrigation, toilet flushing. • Greywater – For 'traditional' greywater harvesting and reuse for non-potable uses (depending on Precinct wide strategy for a potential WRP). • Water Recycling Plant (WRP) – with anaerobic digestion (AD) and energy recovery facility (biogas) and co-generation. • Circular Economy approach to Water - waste water, cleaned waste water, surface water, used cooling water, deionized water, cleaned surface water. • Integrated Water Cycle management incorporating wetlands and the protection of local waterways

7.2.1 ANTICIPATED DEMAND AND ALTERNATIVE WATER RESOURCE AVAILABILITY

The Transport and Infrastructure Planning Study (prepared by Aurecon) tested the three development scenarios identified in Workshop 2 and the final Masterplan by considering the anticipated demand of each scenario, and the opportunity to generate alternative water supply including rainwater, harvested stormwater and recycled water. The study informed the opportunities discussed for water infrastructure for the final Masterplan as detailed below.

Water: New water infrastructure will be required to supply water to the SAP. This will include a new water supply network, water storage reservoir and augmentation of water treatment capacity (either through a new water treatment plant or augmentation of the existing plant) when demand exceeds 3,100 ML/year. A road easement up to 2 metres should be allowed for the water main and land should be set aside for a water storage reservoir and a new water treatment plant.

Water: A water supply management strategy that takes into consideration the expected economic benefits of the precinct and allows for long-term variabilities in water supply (including the proposed raising of Wyangala Dam, which would increase water storage) and future competing water uses.

Wastewater: New sewerage infrastructure will be required to service the SAP. This will include a new wastewater collection network; a new sewage pumping station and a new sewage treatment plant once sufficient sewage is generated. A road easement up to 2 metres should be allowed for sewers and rising mains, and land should be reserved at low points within the development for a sewage pumping station and new sewage treatment plant. Provision for recycled water storage should also be considered. This might be in the form of tanks (which might not be aesthetically pleasing but pose less risk to human exposure) or ponds (which might be aesthetically pleasing but creates a risk to human exposure).

Stormwater: New stormwater infrastructure will be required to manage runoff from the development. Drainage corridors will need to be reserved and will perform multiple functions including stormwater conveyance and improved workability/amenity. Cross drainage infrastructure will be required where flow paths intersect road and rail alignments. Stormwater detention basins and distributed water sensitive design features will be required to manage stormwater quality and quantity to acceptable levels and should be allowed for in the land use planning. These stormwater detention basins might be managed in parallel with recycled water storage ponds, but not shandied (as recycled water has stricter restrictions to human exposure than stormwater).

CONCLUSION

The is an opportunity for the water strategy for the Parkes SAP to include the following to enable the delivery of a fully integrated Water Cycle. Some are discussed in more detail in 7.2.1.1 to 7.2.1.5 below:

— Dual Reticulation - The Parkes SAP should be developed with a dual distribution system to accommodate a potable water supply and recycled water supply ready for connection to all land uses/lots.

— Rainwater capture (Alternative Water Resource) – expansive roof areas across warehousing provides for high-grade rain water capture which could be stored in either a central location or individual building rainwater tanks. Rainwater can be used with a low-level treatment (filtration) for a number of non-potable water uses e.g. irrigation, toilet flushing, wash-down facilities.

— Storm water (Alternative Water Resource) - Harvesting - slowed down, retained and treated (ideally within natural treatment- vegetated systems) for non-potable uses i.e. irrigation, toilet flushing.

— Greywater (Alternative Water Resource) – 'traditional' greywater harvesting and reuse for non-potable uses. Depending on the Parkes SAP wide strategy for a potential Water Recycling Plant (WRP), this can be at building or precinct scale.

— Waste Water Treatment (Alternative Water Resource) - A two-tier wastewater management framework whereby tenants and the Parkes SAP are required to build satellite and centralized wastewater treatment facilities, respectively. A WRP could be combined with an anaerobic digestion (AD) and energy recovery facility (biogas) and co/tri generation.

— Stormwater Management Design Objectives – objectives for stormwater management that address the following matters should be adopted:

  - Frequent-flow management – this objective aims to protect in-stream ecosystems from the effects of increased runoff by capturing the initial portion of runoff from impervious areas. This approach ensures that the frequency of hydraulic disturbance to in-stream ecosystems in developed catchments is similar to pre-development conditions.

  - Waterway stability management – this objective aims to prevent in-stream erosion downstream of urban areas by controlling the magnitude and duration of sediment -transporting flows.

  - Stormwater quality management – this objective aims to protect receiving water quality by limiting the quantity of key pollutants discharged in stormwater from development. It should be focused on a percentage reduction in the loads of sediment, phosphorus, nitrogen, and litter in stormwater runoff generated by development, compared to untreated runoff.

— Shared wash-down facilities – these could be a manual operation or an automatic cleaning facility for industrial equipment. This type of facility can reduce costs for individual businesses and facilitate the management of waste water.

— Buildings in the Parkes SAP should be designed to reduce consumption and encourage recycling and reuse. This can be done: - In the building design, with a focus on water reduction through the use of WELS rated fixtures and fittings, and an industry/land use water audit to identify water reclamation, reuse, recycling and alternative water source use opportunities. Through metering and Building Management Systems (BMS) to alert the building operators to abnormal consumption.

7.2.1.1 DUAL RETICULATION

The Parkes SAP should be developed with a dual distribution system ready for connection to all land uses. A recycled water (purple) pipe supply and a potable (drinking) water pipe supply. Under the system, two separate water piping systems are used to deliver water to the end user.

7.2.1.2 ALTERNATIVE WATER RESOURCES

What is an alternative water resource?

Alternative water sources are those from a source other than the centralised potable water source. The following are the core alternative water resources considered in this report which can either be used 'as is' or treated to achieve a desired quality level.

Rainwater – water collected directly from roof run-off.

Stormwater – untreated rainfall run-off from built up areas, i.e. car parks, landscaping, roads etc.

Wastewater – Water that has been used and would otherwise be disposed of, i.e. discharge water from an industrial process or sinks and basins (greywater), or sewage water (blackwater).

These alternative water resources can be reused or recycled as detailed below:

Reused Water – Water taken from an alternative water resource which is used in a subsequent application without treatment.

Recycled Water – Water taken from an alternative water resource and then processed to improve quality before use in a subsequent application.

Bore Water – Only considered alternative if the aquifer can be sustainably utilised. This means that groundwater recharge must compensate for groundwater extraction.

Why use an Alternative Water Resource?

The RMIT University Non-Residential Alternative Water Resource Guide (2011) cite the following reasons for seeking alternative water resources in non-residential applications all of which are considered to be applicable to the Parkes SAP:

• Improved bottom line	• Reduced energy costs and greenhouse gas emissions
• Reduced water consumption costs	• Improved reputation by reducing the impact of the Parkes SAP on the environment
• Reduces sewage discharge costs	• Behavioural change of precinct occupants, leading to a further commitment to reduce water consumption
• Reduced water and wastewater treatment costs	• A better understanding of how water is used by the land uses/industry types in the Parkes SAP.

Due to its industrial nature the Parkes SAP will have large impervious areas and the presence of a wide range of industrial chemicals and other potential pollutants. As such, the effective application of water harvesting infrastructure for the industrial land uses, Freight Terminals and Regional Enterprise, of the Parkes SAP will need to consider:

— the structural separation of work areas from roofs and car parks to prevent industrial pollutants from contaminating the rainwater and stormwater. This will allow the application of standard stormwater treatment devises (see Figure 7-2).

— maximising rainwater and stormwater harvesting and reuse opportunities. The roofed and impervious areas within the industrial land uses can generate large volumes of water suitable for several uses minimising potable water requirements.

7.2.1.3 STORMWATER HARVESTING

Stormwater harvesting captures stormwater flows from ground surfaces such as roads, car parks and pedestrian areas. All stormwater requires treatment before it can be re-used and as mentioned above, due to its industrial nature, the stormwater from the Parkes SAP is likely to contain pollutants, sediments, nutrients, heavy metals, hydrocarbons etc. which will require the structural separation of work areas from roofs and car parks to prevent industrial pollutants from contaminating the rainwater and stormwater. This will allow the application of standard stormwater treatment devises.

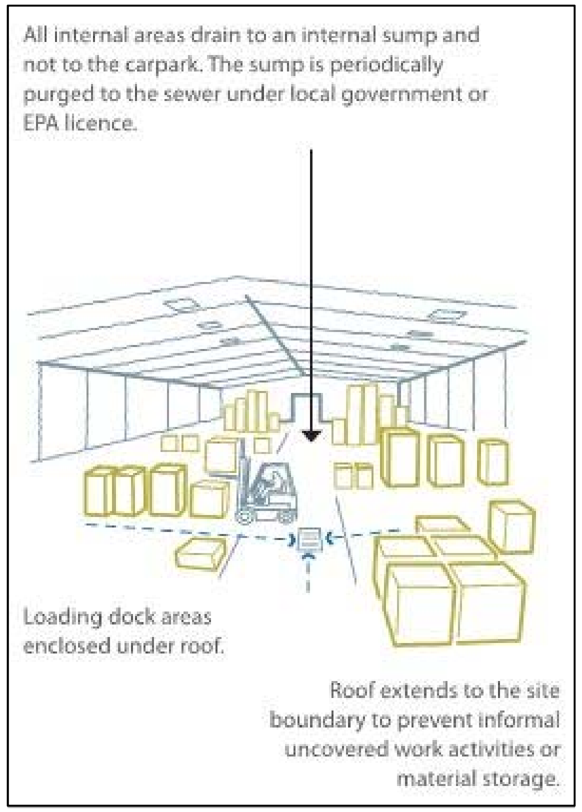

Figure 7-2 Example of Structural Separation (source: Water by Design)

Spatial (land take) Requirements[3]

The spatial requirements for stormwater harvesting systems are site specific and depend largely on the level and type of pre-treatment required and the type of storage system used. As a guide, Best Management Practices (BMPs) to remove particulate and soluble nutrients and fine sediments generally require the greatest land take (e.g. bioretention systems will typically require a land area equivalent to 3% of the contributing catchment area and constructed wetlands may require up to 7% to 10% of the contributing catchment).

The storage element of a stormwater harvesting scheme can also consume significant land area, particularly if above-ground storage systems are used and particularly in larger stormwater harvesting schemes. Water balance modelling is required to establish the final land take requirement for the storage element.
Treatment to disinfect the stored water prior to re-use involves either UV radiation or chlorine dosing. Both processes require only a minimal land take.

Example: The Case Study 'Orange Stormwater to Potable: Building urban water supply diversity' (May 2018) provides a comprehensive review of the application of stormwater harvesting. At the time, it was in fact the first application of harvesting urban stormwater for potable uses at that scale in Australia.
https://watersensitivecities.org.au/wp-content/uploads/2018/05/Orange-stormwater-to-potable-Case-Study-180503-V8_WEB.pdf

7.2.1.4 RAINWATER (ROOF-WATER) HARVESTING

Roof-water harvesting involves the collection of rainwater from roofs and podiums (non-trafficable areas) for storage in above or below ground storage systems for re-use. Rainwater contains substances such as nitrogen that are harmless in most non- potable uses. As such collected rainwater, can be used directly with no treatment for most non-potable water uses although a greater level of treatment may be required for certain industrial uses.

Spatial (land take) requirements[4]

The land take required for a roof water harvesting system is dependent on the scale of the system, which is driven by site specific characteristics such as roof area; end use demand; storage size (optimized to demand) and whether above or below ground storage is used.

Rainwater storage tanks are typically installed at a building/lot scale, however with appropriate infrastructure a diverse catchment can be used to supply centralised storage, treatment and reticulated water supply systems.

Example: Warrnambool Roof Harvesting Project. This roof water harvesting scheme collects and diverts roof water from all new houses and industrial buildings within new estates located in a growth corridor in the Great Ocean Road City of Warrnambool. It is noted that this concept is considers to be an opportunity in most urban areas across Australia with an annual rainfall of over 700mm and Parkes has an average annual rainfall of 585mm. It may still be cost effective in the industrial context with the expansive areas across warehousing but the viability with reduced average rainfall would need to be further investigated.

https://watersensitivecities.org.au/solutions/case-studies/warrnambool-roof-water-harvesting-project/

https://www.clearwatervic.com.au/user-data/Case%20Study_Warrnambool%20RWH_FINAL.pdf

7.2.1.5 WASTE WATER TREATMENT

Waste water includes blackwater and greywater. Blackwater is wastewater from toilets and kitchen sink. Greywater is wastewater from non-toilet plumbing fixtures such as showers, basins, taps and industrial processes. There is an opportunity for the Parkes SAP to implement a a two-tier wastewater management framework whereby tenants and the Parkes SAP are required to build decentralised/satellite and centralized wastewater treatment facilities, respectively. Due to the diversity of industrial wastewaters, the treatment process scheme in the centralized wastewater treatment plant (WWTP) may not suit the characteristics of all effluents discharged from the tenants e.g. an abattoir requiring lot scale pre-treatment before it can be discharged to a centralized facility.

Spatial (land-take) requirements

Spatial requirements will vary depending on operating requirements (i.e. daily throughflow) and treatment processes. It is important to have selected the most suitable treatment process for the particular development and intended end uses as part of the conceptual design process. Table 7.3 below details a range of different treatment processes and their associated operating bounds and spatial requirements. The variety of available decentralised/satellite wastewater treatment processes and their associated operating bounds means there is a suitable system for most uses.

Table 7.3 Summary of Waste Water Treatment Processes

TREATMENT PROCESS	OPERATING RANGE	WATER QUALITY GENERALLY SUITABLE FOR:	FOOTPRINT (M^2)	APPLICATION
Natural – humus filter situated at each building	0.5 - 10 kL/d	Subsurface Irrigation	2 - 1	Single building, clustered development
Biological Filtration + Membrane filtration	0.5 – 100 kL/d	Toilet lushing, irrigation, cold non-potable tap uses	3 - 60	Single building, localised development
Subsurface wetland	0.5 – 360 kL/d	Toilet lushing, irrigation (disinfection required)	2- 800	Single building, clustered development

[3] Reference: Water By Design (2009) Concept Design Guidelines for Water Sensitive Urban Design Version 1, South East Queensland Healthy Waterways Partnership, Brisbane March 2009.

[4] Reference: Water By Design (2009) Concept Design Guidelines for Water Sensitive Urban Design Version 1, South East Queensland Healthy Waterways Partnership, Brisbane March 2009.

TREATMENT PROCESS	OPERATING RANGE	WATER QUALITY GENERALLY SUITABLE FOR:	FOOTPRINT (M^2)	APPLICATION
Membrane bioreactor	0.5 – 500 kL/d	Toilet lushing, irrigation, cold non-potable tap uses (disinfection required)	1 - 200	Single building, localised development
Biological – fixed film bioreactor	1- 150 kL/d	Restricted irrigation (additional treatment required)	2	Single building, clustered development
Biological System – primary setting + recirculating media filtration	2 - 10kL/d	Restricted irrigation	20 - 200	clustered development
Membrane filtration	40 - >3,000 kL/d	Toilet lushing, irrigation, cold non-potable tap uses	7 - 30	Localised development – large scale development
Filtration	9,000 – 38,000 kL/d	Additional treatment required to attain non-potable urban water uses.	4 - 9	Large scale development

Example: Blacktown Workers Club

System capacity – 100kl per day

Source of waste water - toilets, hand basins and other wastewater sources

Recycled use – sport field irrigation

A system called the aquacell sc100 model installed at Blacktown Workers Sports Club has an operating capacity of 100 kilolitres per day. The system includes an aerobic biological treatment zone and an enclosed, submerged ultrafiltration zone. The recycled water is further disinfected using ultraviolet rays. The storage tanks have a total capacity of 108 kilolitres and are used to store recycled water prior to irrigation. A recycled water supply pump is used to transfer this water to the irrigation system and out onto the fields.

7.2.2 WATER IN A CIRCULAR ECONOMY

Water is an important element of the circular economy concept, for each industry/land use in the Parkes SAP we need to understand how they use water, how much they need, how clean, or not, that water is after it has been used for their purpose. This will inform the picture of how land uses can be clustered to enhance the potential for water recycling. For example:

Food Manufacturer – a major water user such as a food manufacturer if located within proximity to a large centralised wastewater treatment and reclamation plant, can significantly reduce their use of potable water by using recycled water to meet part, or all, of their processing water needs.

Warehousing with expansive roofs – as mentioned above large portal frame warehouses generate significant roof-water runoff. At the same time this type of land use usually has minimal on-site demand for the recycled water. Warehouse uses can be collocated with land uses with a high demand for recycled water slowing the excess to be used by adjoining land uses.

Figure 7-3 illustrates a few of the possible water cycles that could be employed at the individual or precinct scale to maximise water recycling opportunities.

The concept of a circular economy is discussed further in Chapter 3.

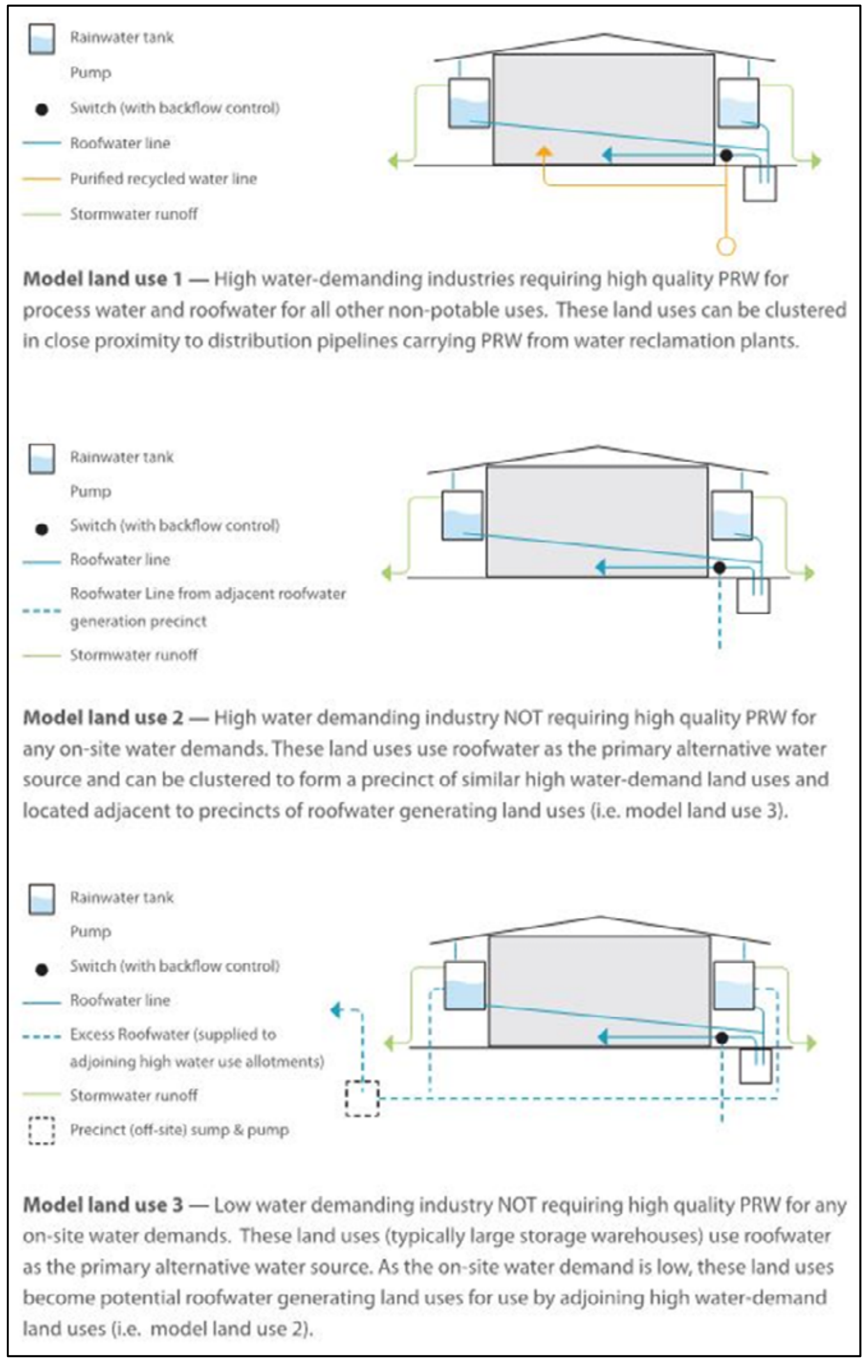

Figure 7-3 Water recycling opportunities for industrial and warehouse land uses (source: Concept Design Guidelines for Water Sensitive Urban Design 2009)

8 RESOURCES

The goal for the Parkes SAP is to achieve resource optimization through the implementation of a Circular Economy Framework for resource efficiency. Essentially treating waste as a resource. This objective also supports the goal to create a Parkes SAP that is Carbon Neutral.

To create a Parkes SAP that is carbon neutral in which all waste is treated as a resource is important to implement the following waste objectives:

— To reduce the amount of waste produced;

— To recycle/reuse as much as possible; and

— To treat what's left over in the most sustainable way.

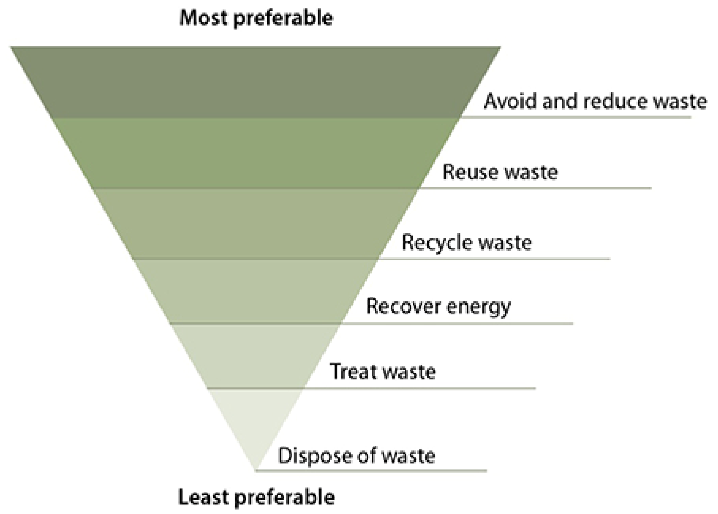

Figure 8-1 The Waste Hierarchy

NSW EPA, The waste hierarchy, http://www.epa.nsw.gov.au/wastestrategy/waste-hierarchy.htm, 14 January 2015.

CONCLUSION

A waste strategy should include the following for the Parkes SAP:

Waste Infrastructure

— A resource recovery facility or recycling facility to service the Parkes SAP to reduce waste outputs. (This will need to be planned in coordination with the recently upgraded Parkes Waste Facility on Brolgan Road. The upgrade adapted the landfill to focus on recycling and resource recovery rather than just waste disposal. It is intended that it will operate as the central waste landfill and will progressively receive waste from waste transfer stations located throughout the Parkes Shire).

— Shared recycling facilities and waste disposal areas – these can reduce waste and recycling costs for small businesses as well as facilitating improved exchange and recycling of resources in general.

— The development of an energy from waste plant to dispose of waste that is not otherwise recoverable while producing electricity. Currently EFW (anaerobic digestion and advanced gasification) is being considered within the Parkes SAP in the context of recommended energy infrastructure but also in the context of providing a facility that can accept waste at a state-wide national scale using the rail infrastructure network (see Chapter 6.2 for more detailed information on the proposed infrastructure). The emissions from EFW are dependent on the type of process that is decided upon. It is important to establish that the plant will generate more electricity than it uses to operate, and that the emissions will be effectively captured, offset or mitigated in accordance with the Parkes SAP's goal to be carbon neutral. There is also the opportunity for using the by-product heat generated for heating across the Parkes SAP also discussed in Chapter 6.

— Implement organic waste to compost, or nutrient recycling, across the Parkes SAP, in partnership with a waste management company. This aligns with the waste that will be generated by some of the anticipated land uses in the Parkes SAP i.e. protected cropping, intensive livestock and agriculture.

Operational Waste Management

— Understand the specific waste management and disposal practices for land uses within the Parkes SAP and utilise the circular economy to use waste as resources between industries as much as possible.

— Continuously looking for innovation to reduce the import of waste to the Parkes SAP and creation of waste within the Parkes SAP.

8.1.1 WASTE IN A CIRCULAR ECONOMY

The circular economy, discussed in Chapter 3, shows the benefits of viewing waste as a commodity, and how by-products from one industry are inputs for another. By collocating appropriate industries in the Parkes SAP, it is possible to reduce Vehicle Miles Travelled (VMT) and the cost of importing new resources, when recycled or waste resources can be readily available on site.

9 MOBILITY

The goal for Mobility within the Parkes SAP is that it should be a low carbon, active and **Future Ready Mobility** network that appropriately serves the needs of the industries within the Parkes SAP balanced with the needs of its occupants.

A significant contributor to the greenhouse gas emissions generated by an industrial area is that of transport. The provision of efficient transport networks, including freight, road, rail, cycling and pedestrian routes and access can reduce travel distances and facilitate the use of less greenhouse gas intensive modes of transport. The location of the Parkes SAP, adjacent to an established transport network, provides the opportunity to reduce greenhouse gas emissions associated with transport and improve industrial freight efficiency.

The development of a traffic management strategy, which addresses access to industrial developments including noise management and parking needs can encourage increased public transport use, walking and cycling and can ensure that the use of land is maximised and while emissions from transport sources are minimised.

In the design of the layout for the Parkes SAP it is important to consider the accessibility of public transport networks such i.e. bus services and whether there could be shared passenger and freight rail services on the existing rail network. Shared passenger and freight rail services not only provide more efficient alternatives for the transfer of goods and materials but also more energy efficient transport options to employees, reducing the need for car parking and increasing the amount of land available for industrial use or shared services.

The layout of the Parkes SAP will have a substantial impact on the efficiency of the transport network and the access to and attractiveness of the public transport, cycling and walking within the Parkes SAP. Careful consideration should also be given to the interface between the Parkes SAP and the adjacent areas of Parkes to inform the design of the traffic and transport infrastructure and services to maximise the opportunities of the relationship between the existing and the new and the transport network.

CONCLUSION

The is an opportunity for a transport strategy for the Parkes SAP to support the implementation of the following ideas, some are discussed in more detail in section 9.1:

— Design a safe, equitable and feasible road layout with a clearly defined access hierarchy to facilitate the traffic flow of heavy goods delivery vehicles as well as commuter and visitor traffic.

— Active Transport - Locate and plan public transport routes, as well as safe and connected dual-use pathways, footpaths (which should be included on all local roads) and bicycle facilities (including end-of-trip facilities);

— Maximise Land Use - Promote efficient use of land through the optimisation of transport/mobility infrastructure e.g. shared access, storage and parking.

  ✓ A Central Parking Facility for PAX connected to the Parkes SAP's Public Transport Infrastructure would allow for the separation of Freight and PAX movement by only allowing a measured amount of commuter and visitor traffic access to the wider Parkes SAP road network.

  ✓ Vehicle Freight is aggregated at a Parkes SAP shared distribution hub and transported by shared-use commercial (electric) vehicles throughout the Parkes SAP.

  ✓ Identify where the Parkes SAP layout can integrate any developed areas. This includes integrating driveways, crossovers, landscaping and parking areas; services and locate these facilities in a central, easily accessible location.

— Design for future mobility - emerging technology in the transport sector. Automated Freight Handling; Autonomous Vehicles – for Public Transport and for the freight movement network; an Electric Logistic Fleet - Freight EV Charging Station as part of the shared Parkes SAP distribution hub.

9.1 TRANSPORT INFRASTRUCTURE

9.1.1 ACTIVE TRANSPORT CONNECTIONS

Investment in active transport at the Parkes SAP level has many benefits:

— Provides transport options

— Reduces traffic and pollution

— Increases road safety

— Can have health and fitness benefits

— Creates the opportunity to develop linear parks and green space along footpaths and cycleways, to increase permeable space, increase habitat, and improve air quality.

The Parkes SAP should invest directly in urban design that includes pedestrian and bicycle infrastructure which embeds connection to Parkes and the proposed public transport network. The buildings must be included in the network as they provide end of trip facilities.

9.1.2 FUTURE MOBILITY CONSIDERATIONS

9.1.2.1 ELECTRIC VEHICLE (PRIVATE CAR)

Electric vehicles (EV) have are a critical consideration in fuel switching away from fossil fuels and transitioning to a net zero emissions society. It is foreseeable that the adoption of EV by the public will increase as carbon emissions standards improve and EV's reduce in cost. EV's provide the opportunity to change the vehicles that are used on site and could be used to provide load shedding capability when connected to the grid.

Furthermore, the way we use our vehicles is going to change as we move away from traditional technologies such as gas and diesel to electric vehicles. It is important that the infrastructure required for these services is future proof and flexible enough to change as older technologies are phased out.

It is recommended that electric vehicle charging infrastructure needs to be provided in both in the public/shared car parking and within each lot throughout the Parkes SAP.

9.1.2.2 ELECTRIC VEHICLES (LOGISTICS FLEET)

It is commonly accepted that the logistics fleet will have made a significant start in the transition to electrification within 5 years. This will mean that to ensure the logistics provision for the site is future ready it must be able to accommodate an electric logistics fleet. The Australian Electric Vehicle Association have reported that the economics of electronic trucks are compelling, with the possibility of very large savings compared to diesel-powered trucks. Not only is the payback period on a truck significantly reduced other benefits include:

- Regenerative braking (use of the electric motor as an electrical generator when slowing, and returning some of the energy to the battery and NOT wasting it as heat, noise and wear of the brakes);
- Increased energy efficiency (through reduced fuel costs);
- Much reduced brake wear;
- No engine-braking noise issues (providing the ability to operate outside of truck noise ban times);
- Ability to operate in areas where pollution would be a problem;
- Less down-time through not needing to do regular diesel engine services and maintenance;
- Many fewer components to wear or break;
- Better capacity to integrate driving safety and efficiency upgrades (platooning, anti-jack-knifing, semi-autonomous driving, and in long-term: autonomous driving).

It is recommended that a Freight EV charging station is provided as a shared facility within the Parkes SAP.

9.1.2.3 HYDROGEN POWERED VEHICLES

Hydrogen fuel cells can power vehicles and can support the decarbonisation of the transport sector. The commercial challenges for both electric and hydrogen vehicles are reported to relate to reducing costs and developing the supporting infrastructure.

In May 2019, the ACT Government announced that it will pilot a hydrogen refuelling station in the nation's capital. It is considered to be another step towards realising hydrogen-powered vehicles on Australian roads. To deliver this the ACT Government is reported to be partnering with ActewAGL, Neoen and Hyundai to open the facility in December 2019.

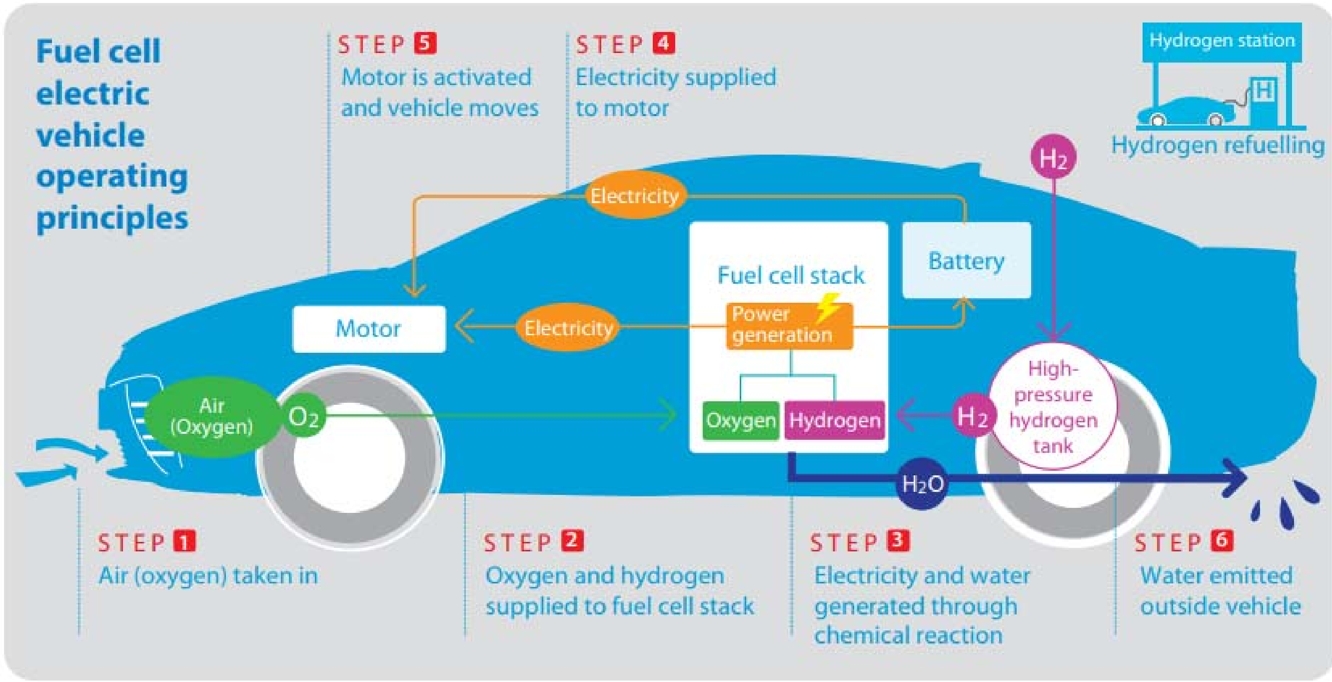

Figure 9-1 Schematic of a hydrogen fuel cell vehicle (Source A hydrogen road map for South Australia)

9.1.2.4 AUTOMATED FREIGHT HANDLING

State-of-the-art machinery and software are available to facilitate the automation of the handling of all containerised freight in a logistics park. The QUBE facility at Moorebank Logistics Park in Sydney announced in 2018 that it expected fully automated operations to be established across the facility by 2022 with an anticipated reduction in emissions of 110,000 tCO2e per annum. It will be the first in the world. It is also noted that the procurement of the latest low-emission automated technology aligns with QUBE's existing commitments to significantly reduce carbon emissions under a loan facility with the Clean Energy Finance Corporation.

To be both competitive and future ready the Parkes SAP should be considering this technology for the freight and logistics provision on the site. This will require the development of technical options for the intermodal operations and terminal infrastructure layouts, such as rail track, road, and terminal handling equipment. Figure 9-2 provides an overview of the Recommended Direction of Development for Intermodal AFTS from a study undertaken by The Korean Association of Shipping and Logistics, Inc in 2018.

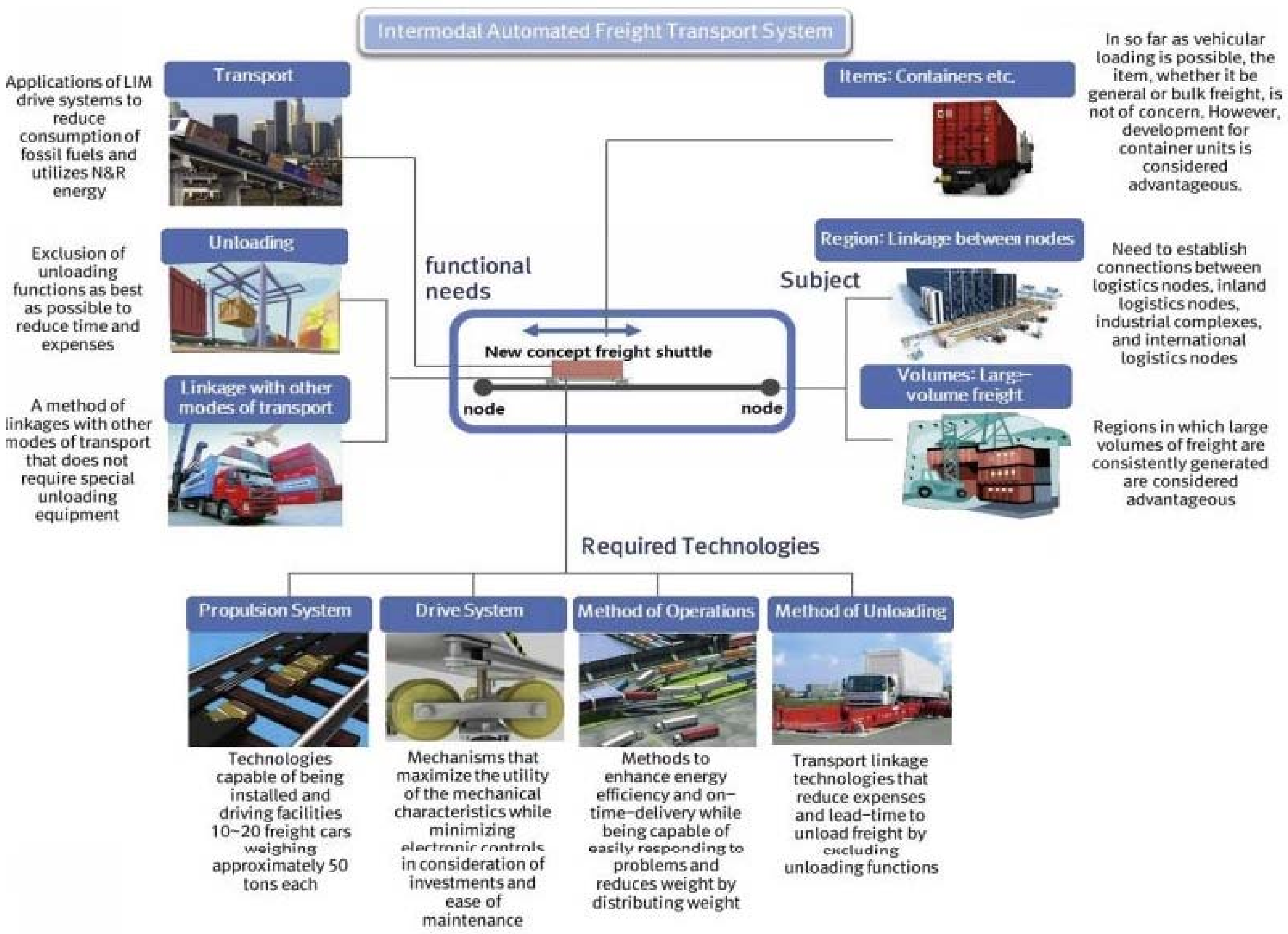

Figure 9-2 An Overview of the Recommended Direction of Development for Intermodal AFTS (Source: Technical Trends Related to Intermodal Automated Freight Transport Systems (AFTS), 2018, Seungjin SHIN, Hong-Seung ROH, Sung-Ho HUR)

A summary of Automated Freight Transport Systems (AFTS) found in the US as well as Europe and Asia can be found in Appendix D.

9.1.2.5 CONNECTED & AUTONOMOUS VEHICLES

The innovation in autonomous vehicles is evolving rapidly and will likely become part of the transport and mobility systems of many cities, and likely the Parkes SAP, within the life of this development (and possibly within its construction life of 5-10 years).

It is recommended that flexibility is built into the Parkes SAP to take advantage of the potential that autonomous vehicles may provide:

— For buildings with basements, flexible basement and riser planning with additional clear height to enable servicing for occupied uses (such as tech hubs, indoor public realm or other non-vehicular uses.

— Street parking interface with built form has the potential to be converted to a porch area as drop-off becomes more critical than parking.

— Street parking has the potential to be returned to the public realm as water sensitive urban design solutions like swales.

An important benefit of connected and autonomous vehicles (CAV) is that they can move more quickly and efficiently by being aware of their own location and trajectory in relation to the surrounding environment at all times. When applied to mass transport options, such as a shuttle bus, CAV can deliver reduced running costs and potential for greater frequency than traditional modes of transport.

The Parkes SAP should plan for autonomous vehicle charging and drop off locations and should aim to integrate these services with buildings and the public domain.

9.1.2.6 ON DEMAND TRANSPORT

On Demand Transport Services can be requested by users on demand, usually through a smartphone app. These services include ride-sharing, car-sharing and car-pooling, and even public transport services (it is noted that at this time the Parkes Region is not serviced by any car share programs e.g. GoGet or rideshare programs e.g. GoCatch, and Uber). Since October 2017, Transport for NSW has been trailing On Demand Transport services which will allow customers to book transport from or near their home to a local transport hub or landmark. The program involves a handful of trial areas across the greater Sydney Metropolitan areas, Central Coast and Illawarra using mini-buses and mini-vans.

BIKE SHARE PROGRAMS

Shared cycle schemes are operational in several Australian cities. Opportunities to link bike sharing schemes should be explored for the Parkes SAP as first mile/last mile option for people traveling from Parkes to the Parkes SAP and within the Parkes SAP.

10 GREEN INFRASTRUCTURE

The goal for the Parkes SAP for green infrastructure is for **blue & green infrastructure** reflecting connection to country. Community and social outcomes are important in the design of an industrial development. Addressing amenity, social needs and wellbeing, community access and facilities, and security and safety as part of the design of the Parkes SAP can have significant benefits. The social and community benefits can lead to a more productive workforce, a greater ability to attract and retain staff, higher land values, less vandalism and antisocial behaviour and improved integration and tolerance from adjacent non-industrial land uses.

Biodiversity within the Parkes SAP will provide numerous quantifiable benefits to occupants. More greenspace will mean more drainage during flood events, increased canopy cover will mean reduced heat island effect, all meaning less resources will be required to respond to extreme weather events, making a more resilient Parkes SAP.

The green infrastructure within the Parkes SAP will comprise a combination or some or all of the following; protected vegetation, offset planting areas/rehabilitation, WSUD stormwater treatment i.e. wetlands, and green biodiversity corridors. The green infrastructure provides an opportunity to embed sustainability directly into the Parkes SAP.

The green infrastructure within the Parkes SAP will provide important opportunities including:

— Enabling connectivity to and within the Parkes SAP with forms of both public and active transport

— Supporting habitat and biodiversity

— Managing surface water effectively and mitigating climate risk with green infrastructure

CONCLUSION

A green infrastructure strategy should include the following for the Parkes SAP, discussed further in section 10.1.

— Integrate the area into the local environment through site-responsive design which recognises, protects and where possible rehabilitates important landscapes, landform, natural areas and hydrological systems;

  ✓ Use continuous tree cover and structured footpath canopies to mitigate heat in outdoor spaces where people will be.

  ✓ Thread greenspace throughout the Parkes SAP to provide precinct-wide natural cooling.

  ✓ Provide active recreation spaces (sports fields, walking and cycleways) within the Parkes SAP's greenspace

— Develop the road network to provide stormwater conveyance capacity during extreme events.

— Ensure protection of significant environments and landscapes by providing adequate buffers from development and/or incorporating them into public open space or infrastructure corridors as appropriate.

— Connect parklands with linear greenspace across the Parkes SAP to allow flora and fauna habitat continuity.

— Use native and adapted landscape plantings that thrive in hot, dry local conditions. Native bushland species should be selected to support native biodiversity and support and encourage the natural ecology of the local ecosystems. There is a unique opportunity to maintain and even rehabilitate important ecological function to creeks; for place-making, biophilia and biodiversity purposes.

10.1 GREEN INFRASTRUCTURE

10.1.1 HABITAT AND BIODIVERSITY

Maximizing biodiversity values within the Parkes SAP will be critical to the occupant's enjoyment and use of available open space. A Biodiversity Assessment has been completed for the location that will become the Parkes SAP. The outcomes of this study have informed the strategy for green infrastructure in the Parkes SAP Master Plan to ensure natural habitats are not threatened as a consequence of the land being converted to an industrial development and to ensure that the biodiversity is encouraged within the built environment.

There are many important benefits that a meaningful biodiversity plan brings to development projects:

— Amenity benefits of a biophilic environment to the occupants, and the talent attraction benefits to business;

— Direct eco-system services through pollination for any urban or peri-urban agriculture and urban water management;

— Broader socio-ecological benefits of better functioning natural systems (catchments, waterways, maintenance of genetic diversity and attendant resilience).

An avoidance hierarchy has been adopted proposing the retention of habitat and biodiversity in three tiers of importance.

— **Tier 1:** All EPBC listed communities; BC Act listed communities – serious and irreversible impacts; all areas identified (including paddock trees) listed in PVPs, certifications or notifications; and retain all hollow bearing paddock trees.

— **Tier 2:** All other BC Act Threatened Ecological Communities; and Class 2 and 3 paddock trees (eucalypt, Casuarina and Kurrajong).

— **Tier 3:** Other native vegetation; and all other paddock trees and Class 1 paddock trees.

These tier areas have been mapped and incorporated into the Parkes SAP Masterplan, determining the location of the built form.

10.1.2 WATER SENSITIVE URBAN DESIGN (WSUD)

WSUD is the engineered approach to landscape that provides precincts with effective storm-water management systems – regulating both the quantity and quality of overland flows while also providing high amenity public space and local ecology hotspots.

It is composed of a wide range of urban water management practices:

— Erosion & sediment control

— Rainwater tanks

— Swales

— Porous pavements bio retention systems (rain gardens)

— Constructed wetlands, infiltration systems

— Water harvesting and reuse schemes

WSUD can provide multiple benefits to the Parkes SAP:

— Climate adaptation through low solar absorption and improved shading with canopy cover;

— Amenity benefit to the community through a biophilic urban environment

— Urban water management with water-sensitive urban design.

The quantifiable benefits of WSUD include the value of the reduction in nutrients in water-ways, the avoided costs associated with downstream waterway rehabilitation and maintenance, the potential increase in property values based an amenity and recreational benefits and avoided development costs for conventional pits, pipes and earthworks to manage storm-water treatment and retention.

The primary benefits of WSUD for Parkes SAP are likely to be the increased amenity and ecological activity that artificial wetlands and swales can foster as well as the potential for stormwater capture and re-use as part of an integrated water management system.

While green infrastructure can be provided at the individual building level, it is most effective as part of a continuous system, that can allow for overflow, storage and distribution of excess water. Green infrastructure can serve multiple functions – providing amenable recreational or community space, urban biodiversity nodes and water management in the case of storm events.

The flooding analysis revealed the following:

— There will be no flooding impact from major creeks and short duration flooding in the precinct.

— The intensification of land use will require management of water quality and water quantity. Specifically, the precinct will require:

  ✓ areas for the conveyance of surface water

  ✓ A hybrid rainwater re-use system and bio-retention treatment for surface water quality

  ✓ A hybrid detention basin system and floodway management for the surface water quantity to provide immunity for key infrastructure.

  The Parkes SAP Master Plan was developed with inputs based on the above approach which will result in a system of floodways and detention integrated within the built form.

11 DIGITAL INFRASTRUCTURE

Parkes SAP will benefit from the provision of a fully integrated, high speed, high data volume, digital technology and communications platform on which all other technologies and business are built. A focus on wireless communications and the automated sharing of data between devices will improve communications, knowledge sharing, behaviour management and trending, and the automated creation of opportunities for economic growth and efficiencies.

From the Transport and Infrastructure Evaluation report (prepared by Aurecon) it is understood that Parkes and the Parkes SAP Area are serviced by all mobile carriers with both 3G and 4G services. The Parkes SAP area is also currently serviced by the fixed wireless network which is partially available across the study area, with the southern boundary and north-western corner of the Parkes SAP receiving little to no coverage.

Due to the development of the Parkes National Logistics Hub, there will be telecommunications and internet upgrades, and these must be extended into the Parkes SAP to avoid isolated, inefficient, and ineffective systems, with the addition of NBN so that the site is connection and "investment" ready.

CONCLUSION
The code for Smart Cities could be adopted to ensure that the Digital Infrastructure developed for the Parkes SAP embraces technology, data and intelligent design as a catalyst for positive change. The Parkes SAP should have 5G Capability to be future ready.

11.1.1 THE CODE FOR SMART CITIES

The Code for Smart Cities, developed by the Smart Cities Council in partnership with the GBCA, has the purpose of helping to guide urban development by embracing technology, data and intelligent design as a catalyst for positive change. The Parkes SAP should consider the 5 guiding principles which are outlined below, when implementing smart cities infrastructure.

— Principle 1 – Strategic – The smart community should be guided by a strategy that identifies how investments in technology and data solutions will be made to accelerate liveability, productivity and sustainability outcomes.

— Principle 2 – Connected – The smart community will have access to best-in-class and ubiquitous connectivity while ensuring interoperability of connected devices.

— Principle 3 – Aware – The collection, integration, analytics and communication of data is used as a basis for awareness and optimisation of services and performance within the smart community.

— Principle 4 – Responsive – A culture of ongoing positive change is afforded through the insights and intelligence gathered from data.

— Principle 5 – Innovative – Creativity, equity and agility help to advance the opportunities for innovation within the smart community.

The Code is relevant from the planning stage of the project, through development and operational stages. When considering a smart community, the Parkes SAP should plan for long term goals, as well as opportunities with quick payback, in terms of financial return, job creation, business start-up opportunities and civic enthusiasm. The smart city efforts must be integrated across the Parkes SAP and readily accessible to all occupants to be successful.

12 ASSURANCE

There are several third-party assurance mechanisms that could be appropriate for the Parkes SAP on both a building and Precinct level.

During the development of the ESD Plan the different third-party assurance mechanisms available in the context of the Parkes SAP's sustainability objectives have been considered to identify the most appropriate assurance structure that should be considered for the Parkes SAP. A table detailing the various third-party assurance mechanisms considered can be found in Appendix F.

In providing our recommended approach we have evaluated the requirements of the various rating tools that could be applied to the Parkes SAP to achieve internationally recognised sustainability ratings. Table 12.1(right) details the ratings/frameworks recommended and how they relate to the precinct components. Figure 12-1below considers how the sustainability strategy goals relate to the recommended ratings/frameworks and provides an overlay of responsibility (Development Corporation or Land Developer/owner) and the project stage to which it is applicable. Each rating/framework is discussed in more detail in Chapter 12.1.1below.

Precinct Component/Rating tool Framework Focus	Holistic Sustainability	Carbon Neutrality
Precinct	UNDIO International Framework for Eco- Industrial Parks (December 2017)	NCOS - Precincts
Buildings	Green Building Council of Australia - Green Star Design & As Built (v1.1 released 03 July 2017) or LEED Building Design & Construction: Warehousing and Distribution Centres (v4.0)	NCOS-Buildings/Organisations Green Building Council of Australia's Carbon Positive Roadmap.
Infrastructure	Infrastructure Sustainability Council of Australia (ISCA) IS Rating Scheme (IS Version 2.0 released 01 July 2018)	NCOS- Precincts

Table 12.1 Internationally Recognised Sustainability Ratings/Frameworks

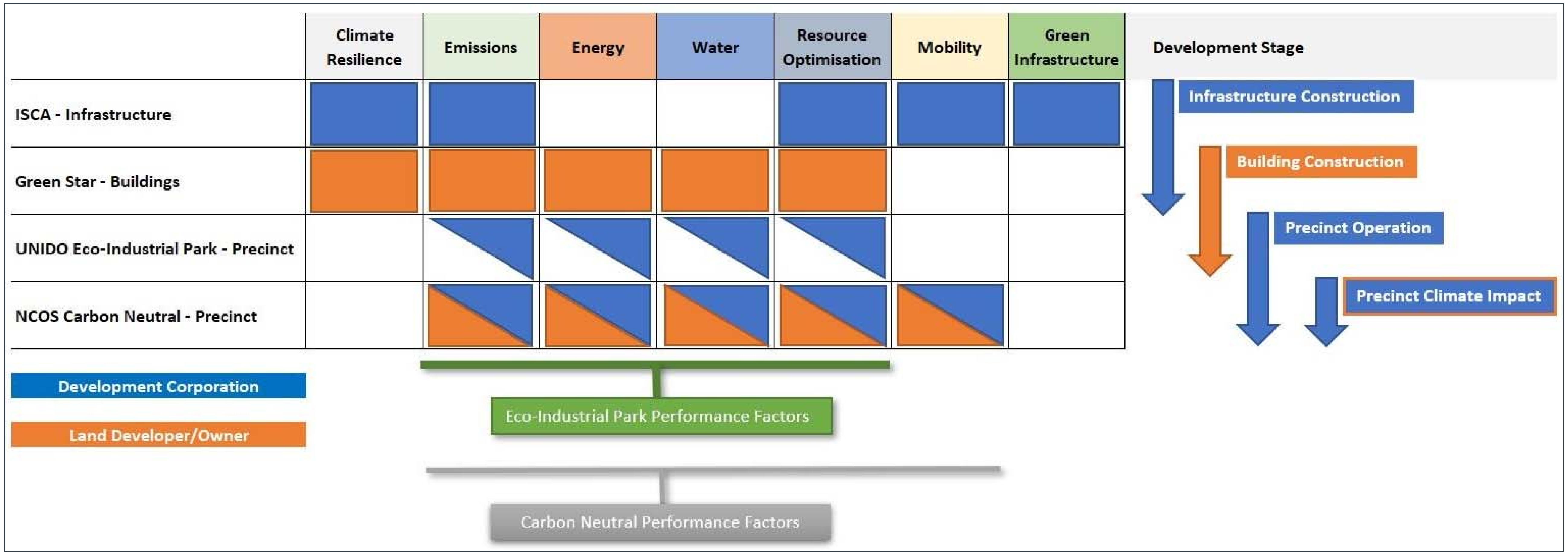

Figure 12-1 Sustainability Ratings/Frameworks Responsibility and Project Stage Matrix (Source: dsquared Consulting, Adelaide)

12.1 HOLISTIC SUSTAINABILITY

12.1.1 *PRECINCT*

THE INTERNATIONAL FRAMEWORK FOR ECO-INDUSTRIAL PARKS

As discussed in sections 2.5 and 3.2, EIPs can be defined as dedicated areas for industrial use at a suitable site, that ensures sustainability through the integration of social, economic, and environmental quality aspects. These aspects are incorporated into the siting, planning, management, and operations of EIPs.

The framework acknowledges that industrial parks have potentially positive and negative impacts. While they serve to contribute to the socio-economic growth of a country or a region, they also have the potential to cause negative environmental and social impacts including: climate change, pollution, resource depletion, health and labour issues, and attendant community disruption. It also acknowledges that the activities and regulatory environments that define national governance legislation, regulations and structures for industrial parks vary considerably across the world. Therefore, the framework also recognizes the need to consider local contexts and sensitivities when applying these requirements. The EIP framework starts from the position that relevant policies and regulations must be complied with. It then sets specific additional performance requirements across management, environmental, social, and economic topics.

Components that are common to EIPs are:

— a sustainable park management structure;

— park- and where applicable, firm-level resource efficiency and cleaner production;

— industrial symbiosis and synergies;

— interactions with the local community and natural environment;

— spatial planning and zoning;

— socially acceptable working and living conditions; and

— collective use of park-level infrastructure, such as utility services and facility management.

The within the EIP, Park Management Structure, is a key entity that deals with management and day-to-day operations, land use services, park infrastructure and facilities, promotion and marketing, and interactions with authorities and the community on behalf of the industrial park. The structure and operating approach it provides are crucial to achieving the objectives of EIPs in tandem with resident businesses and the wider community. This role could form part of the responsibility for the Development Corporation and/or the business concierge during the different development lifecycles of the Parkes SAP.

The international framework for Eco-Industrial Parks (EIPs) contributes to the following UN Sustainable Development Goals:

CONCLUSION
Through our evaluation of the internationally recognised sustainability ratings that could be applied to developments of the scale of the Parkes SAP, the International Framework for Eco-Industrial Parks is considered to provide the most appropriate structure to provide strategic and operational direction for sustainability for the Parkes SAP Master Plan. The Master Plan and Design Guidelines can incorporate prerequisites and performance requirements like those provided in the table below in a way that will provide rigor to the requirements but also flexibility for the Parkes SAP to respond to changes in the market, delivery mechanisms and technology over time as the masterplan continues to evolve. It is noted that the International Framework for Eco-Industrial Parks in its current form does not translate into a formal international EIP labelling and certification.

Table 12.2and Table 12.3 below outline potential performance prerequisites and performance requirements for the Parkes SAP (adapted from the International Framework for Eco-Industrial Parks) which will support the Parkes SAP Sustainability Goals and governance structure for the delivery of the precinct:

- Emissions;
- Water;
- Energy;
- Resource Optimisation;
- Green Infrastructure;
- Mobility; and
- Climate Resilience.

The prerequisites highlight what would be the basic requirements for development in the Parkes SAP and the performance requirements focus on the expected performance levels of development within the Parkes SAP.

Table 12.2 Parkes SAP Prerequisites - adapted from the International Framework for Eco-Industrial Parks

PARKES SAP PREREQUISITES			
Topic	**Sub-topic**	**Description/Requirement**	**Goal alignment**
Management and monitoring	Environmental/Energy Management Systems (EMS and EnMS, respectively)	The SAP has an appropriate, functioning EMS and EnEMS systems (for example, ISO 14001 Environmental Management Standard and ISO 50001 Energy Management Standard) in place to set and achieve targets, and covering key issues (for example, energy waste and material use; water; point-source emissions; and the natural environment).	N/A (Governance: Development Corporation/Business Concierge)
Energy	Energy Efficiency	Energy efficiency strategies are in place for the SAP management infrastructure and major energy-consuming resident firms.	Energy Emissions

PARKES SAP PREREQUISITES			
	Exchange of waste heat energy	A program/mechanism is in place to identify opportunities for common energy and heat exchange networks to be established, including support programs to assist resident firms with implementation.	Energy Emissions
Water	Water efficiency, reuse and recycling	Water-saving and re-use plans are important to reducing total water consumption. The SAP and businesses should have systems in place to increase water savings and reuse.	Water Emissions
Climate change and the natural environment	Air, GHG emissions and pollution prevention	The SAP seeks to limit and mitigate all point-source pollution and GHG emissions, including air, waterway, and ground pollution. A set of measures at the SAP level is introduced (for instance, low-carbon technologies, energy efficiency measures, waste heat) to reduce GHG emissions.	Climate Resilience Emissions
	Environmental assessment and ecosystem services	Protection of the sensitive natural environment is key to environmental and community well-being. The SAP demonstrates an understanding of the potential impact of SAP activities on priority ecosystem services in and around the vicinity of the SAP.	Emissions Climate Resilience Green Infrastructure.
Social Infrastructure	Primary Social Infrastructure	Essential social infrastructure must be provided in the SAP, or its surroundings, for its workers and local community to function properly. This infrastructure including for example, local shops, restaurants/cafeterias, recreation areas, medical facilities, banks, postal offices, and emergency fire facilities.	N/A (All goals are relevant through the overall masterplanning of the precinct)

Table 12.3 Parkes SAP Performance Indicator - adapted from the International Framework for Eco-Industrial Parks

PARKES SAP PERFORMANCE INDICATORS			
Management and monitoring	Environmental/Energy Management Systems (EMS and EnMS, respectively)	Firms have functioning and fit-for-purpose EMS/EnMS systems. Summary information from these management systems is provided to SAP Development Corporation, who will aggregate and report on data at the SAP level.	Governance: Development Corporation/Business Concierge Energy Water Emissions Resource Optimisation
Energy	Energy consumption	The SAP has adequate metering and monitoring systems in place to measure energy consumption at both the SAP and firm levels.	Emissions Energy
	Renewable and clean energy	The SAP leverages available renewable generation sources, with plans to increase contribution for shared services (for example, solar street lamps, biomass, hydro, natural gas, and so on).	Emissions Energy
	Energy efficiency	Energy efficiency opportunities should be actively identified at the SAP and firm levels to reduce energy use and associated greenhouse gas emissions. EIPs should identify and promote technological and process-related interventions in their own and resident business operations.	Emissions Energy
Water	Water consumption	A mechanism is in place to appropriately monitor water consumption across the SAP and ensure demand management practices are in place in case of water stress. Extraction from water sources (such as rivers, and groundwater sources) occurs at sustainable levels.	Water
	Water treatment	The SAP has provisions in place to appropriately treat, recycle and reuse treated wastewater. No effluents significantly impact potable water resources and the health of local communities or nearby ecosystems	Emissions Water
	Water efficiency, reuse and recycling	The SAP and businesses have systems in place to increase water savings and reuse.	Emissions Water

PARKES SAP PERFORMANCE INDICATORS			
Waste and material Use	Waste/by-products re-use and recycling	A program/mechanism is in place to promote and encourage reuse and recycling of materials by firms in the SAP (for example, raw materials for process and non-process applications)	Emissions Resource Efficiency
	Dangerous and toxic materials	Program/mechanism in place with clear targets to reduce and avoid the use of dangerous and hazardous materials by firms in the SAP.	Emissions Resource Efficiency
	Waste disposal	A functioning waste collection, treatment and disposal system is in place to ensure that unused waste materials are treated and disposed of in proper landfills.	Emissions Resource Efficiency
Climate change and the natural environment	Flora and fauna	Native flora and fauna are important to maintain the proportion of natural areas. They are integrated within the SAP and natural ecosystem where possible.	Climate Resilience Green Infrastructure
	Air, GHG emissions and pollution prevention	A mechanism is in place to avoid, minimize, and/or mitigate significant point-source pollution and GHG emissions. This should cover gases (CO2, methane (CH4), nitrous oxide [N20], Chlorofluorocarbons [CFCs], and hydrofluorocarbons [HFCs]), local particulate and air pollution emissions (for example, sulphur oxides [SOx], nitrogen dioxide {NOx), as well as chemicals and pesticides use and management.	Climate Resilience Green Infrastructure Emissions

12.1.2 INFRASTRUCTURE

INFRASTRUCTURE SUSTAINABILITY COUNCIL OF AUSTRALIA

The IS Rating Scheme (IS) is Australia and New Zealand's only comprehensive rating system for evaluating sustainability across the planning, design, construction and operational phases of infrastructure programs, projects, networks and assets. IS evaluates the sustainability performance of the quadruple bottom line (governance, economic, environmental and social) of infrastructure development.

The IS rating focuses on: Management Systems, Procurement and Purchasing, Climate Change Adaptation, Energy and Carbon, Water, Materials, Discharges to Air, Land and water, Land, Waste, Ecology, Community Health, and wellbeing, Heritage, Stakeholder Participation, Urban and Landscape Design and Innovation.

CONCLUSION
All infrastructure projects that are eligible to be rated using the IS Rating Scheme should be required to seek a certified rating (whether it is being delivered by the Development Corporation or a Land Developer/owner). The outcomes of individual certifications will complement and feed into any performance reporting required under the UNIDO Framework.

12.1.3 BUILDINGS

GREEN STAR DESIGN AND AS BUILT

The Green Star – Design & As Built tool can be applied to new buildings or major refurbishment projects. All space uses as defined by the BCA can be certified, apart from parking garages (BCA Class 7a and 10). Projects are assessed at both the design stage (optional) and as built stage (after Practical Completion). Certification is only issued for buildings that achieve four, five and six stars.

Design and As Built considers the following key sustainability attributes:

- Energy;
- Water;
- Indoor environment quality;
- Materials;
- Ecology;
- Emissions;
- Management;
- Innovation

Green Star New Buildings

It is noted that the GBCA have just released a consultation paper on evolution of Green Star. The consultation paper indicates that the new rating tools will:

- Introduces a new set of categories and credits reflecting issues relevant to the market now and in the future
- Prioritises the elimination of carbon emissions from the built environment
- Establishes a clear, well-defined entry point for best practice Green Star ratings
- Caters to distinct sectors through the introduction of sector specific credits
- Sets new levels of achievement for project teams with the highest of ambitions.

The time frame for release of the new rating tools is 2020. As such, in the project timeframe for the Parkes SAP (20 – 40 Years) buildings within the Parkes SAP that are eligible to be rated using the Green Star rating tools will be using the new rating tool, the details of which are not yet fully defined.

LEED FOR BUILDING DESIGN AND CONSTRUCTION – WAREHOUSES AND DISTRIBUTION CENTRES

This rating system is designed for facilities used to store goods, manufactured products, merchandise, raw materials, or personal belongings, like self-storage. LEED BD+C: Warehouses and Distribution Centres addresses the differences in energy use, site selection, and resource usage from more heavily occupied buildings, while still applying the principles of sustainability. It is anticipated that some companies that will seek to locate to the Parkes SAP may be American owned. As such their preference is usually to use the USGBC's rating tool rather than the GBCA's Green Star rating tool.

CONCLUSION
All buildings within the Parkes SAP that are eligible to be rated using one of the third-party building rating tools/systems mentioned above should be required to seek a certified rating (whether it is being delivered by the Development Corporation or a Land Developer/owner). The outcomes of individual certifications will compliment and feed into any performance reporting required under the UNIDO Framework.

12.2 CARBON NEUTRALITY

As discussed in Chapter 4 the Parkes SAP could be certified using NCOS for Precincts and the occupants of the Parkes SAP are encouraged to seek their own individual certification either NCOS for Buildings or NCOS for Organisations.

13 DEVELOPMENT LIFECYCLES & GOVERNANCE

The phases of the planning and development, and the development lifecycles of the Parkes SAP are described as:

1. Site Selection and Assessment
2. Master Planning and Subdivision
3. Development
4. Operational Occupancy

This Chapter of the ESD Plan defines how the Parkes SAPs Sustainability Goals will be addressed through these differing development lifecycles.

1. Site Selection and Assessment (Complete)

This phase of the planning and development of the Parkes SAP has been undertaken by the joint Government Agencies. Through consideration of the site's location and features it was selected as an optimal position in regional NSW for a Special Activation Precinct. The Parkes SAP was chosen due to the opportunities offered by the intersection of the east-west rail line and the Melbourne to Brisbane Inland Rail project. It is anticipated that the Parkes SAP will create new jobs in the freight and logistics industry and optimise opportunities in the agricultural industry. The rail network will mean regional suppliers will be brought closer to their customers, allowing local products to be delivered across Australia and around the world.

The ESD Plan is one of a suite of technical studies that have been commissioned by the joint Government Agencies, including site opportunities and constraints and other required technical investigations as required to inform the development of the planning policy framework for the site.

2. Master Planning and Subdivision (In-progress)

The second phase of development uses the information obtained from the site selection and assessment process to determine the optimal form of development for the Parkes SAP. This phase uses the suite of technical studies that have been undertaken to inform a series of workshops. This culminated in a week-long Enquiry by Design (EBD) Workshop held in Parkes with all key stakeholders. The primary outcome of this process was the preferred Parkes SAP Masterplan which provides the framework for the provision of infrastructure as well as the structure and form of the development outlining transport corridors, an indication of street and block layout, natural features to be retained and water management measures.

The Parkes SAP Master Plan is one of three key components of the statutory framework that provides the regulatory framework for the approval of development in the Parkes SAP, the Masterplan, the Activation Precinct State Environmental Planning Policy (SEPP) and Design Guidelines (see Figure 12.1).

The governance of the statutory framework will be a collaboration of four key agencies, the Department of Planning Industry and Environment , the Development Corporation, and Parkes Shire Council.

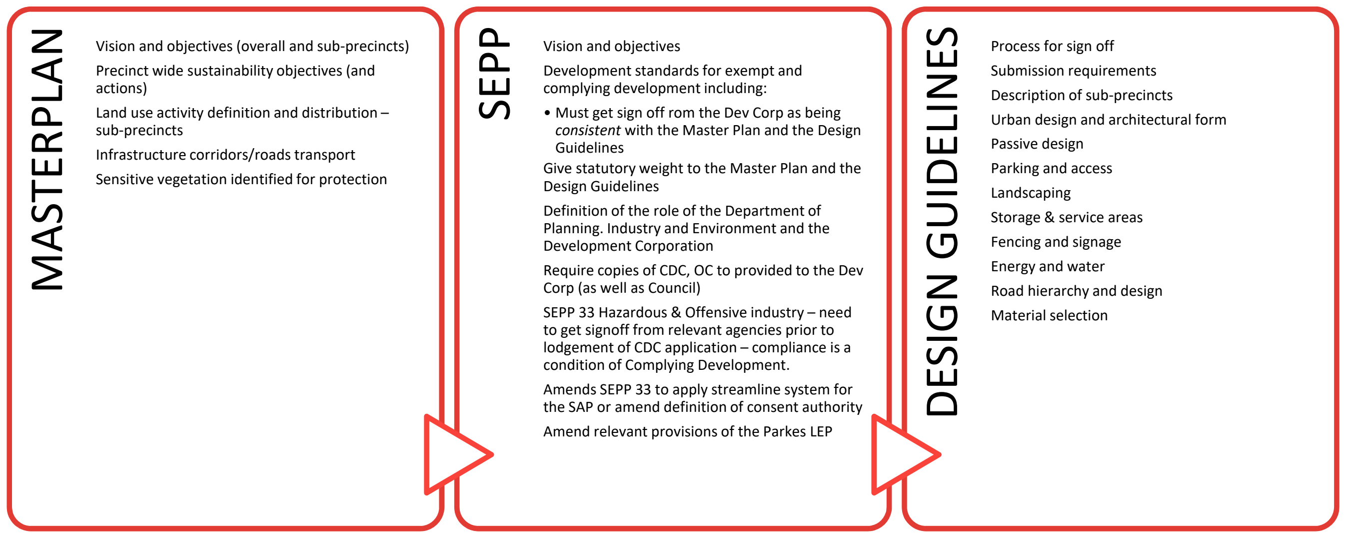

Figure 13-1 Statutory Framework for the Parkes SAP

This ESD Plan will inform the preparation of content for the design guidelines focused on ESD, specifically Water, Energy, Waste and Material Use, and Climate Change and the Natural Environment.

The design guidelines will articulate the specific practices to be adopted in the design and construction of individual developments in the Parkes SAP reflecting recognised best practice, and the performance requirements of the UNIDO Framework.

Areas or disciplines of ESD Plan that are to be addressed include:

— Energy
— Water
— Resources (specifically waste)
— Mobility/Transport (including active transport and electric vehicle infrastructure)
— Green Infrastructure
— Climate Resilience
— Circular Economy

3. Development (Future)

The development phase involves the design and construction of the buildings and associated infrastructure within the Parkes SAP which will require approval. The new Activation Precinct SEPP is intended to facilitate more streamlined environmental approvals of exempt and complying developments, encouraging the rapid design and development of the Parkes SAP while maintaining the overall precinct environmental performance attributes.

The approvals process will be managed by the four key agencies in accordance with the Master Plan, Activation Precinct SEPP and Design Guidelines. The importance of the four key agencies as the governance structure, will be critical in achieving sustainable development in the Parkes SAP. It is noted that it is appropriate that to date a collaboration between the Local and State government has provided the centralised management body function for the delivery of the statutory framework for the Parkes SAP. An alternative centralised management body may be identified to better suit the ongoing operational phase of the Parkes SAP.

4. Operational Occupancy (Future)

There are strategies and actions that can be implemented to improve the operation of individual premises, and the development as a whole, recognising that it is during the operational phase that resource efficiencies, economic and social benefits and environmental benefits i.e. reduced emissions will be realised.

Of key importance to the operational phase of the Parkes SAP, is the establishment of an appropriate centralised management body. The centralised management body will seek out opportunities for maximising resource efficiencies and provide ongoing support to occupying businesses. This will be particularly important for the for the management and coordination of the shared infrastructure (energy, water etc.) and the concept of a circular economy, which is the keystone to the 'Preferred Future' for the Parkes SAP. These are fundamental to the delivery of the ESD Plan.

It is also anticipated that the centralised management body for the Precinct will be responsible for the NCOS – Precincts certification, which is a based on the reporting and audit of the emissions that occur as a result of the operations of a precinct.

The development timeline for the Parkes SAP extends over a 20-40-year timeframe. It will be important that the management approach is adaptive to changes and has provisions for the monitoring, evaluation and review of the ESD goals and requirements as detailed in the statutory framework with clear roles and responsibilities for any necessary responses/actions required.

The additional strategies and objectives for the operational occupancy phase of a development are usually achieved by their incorporation into a business plan or environmental management plan/system for the development. This approach would provide a structure to the planning and implementation of the goals of the ESD Plan by incorporating them into the daily and long-term operations of the occupying businesses.

14 CONCLUSIONS

This report has sought to consider the options for water, energy; waste and carbon, and the ways in which environmental efficiencies and interrelationships between uses can be developed across the Parkes SAP to optimize this.

Developed through a series of workshops and week-long Enquiry by Design workshop a 'Preferred Future' for the Parkes SAP was defined, which is based on a set of sustainability goals, key considerations, and actions and outcomes that will be enabled (see Table 2.1).

This process provided the basis for the identification of how environmentally sustainable development can be realised in the design and delivery of the Parkes SAP through the statutory framework, the Activation Precinct SEPP, the Master Plan and the Design Guidelines. The report specifically addresses emissions, energy, water, resources, mobility, green infrastructure, climate resilience and assurance detailing in each section opportunities for how to enable the delivery of the identified sustainability goals and the 'Preferred Future' for the Parkes SAP (these are also summarised in section 1.1).

The next step for the delivery of the identified sustainability goals and the 'Preferred Future' for the Parkes SAP is the development of the ESD design guidelines. The design guidelines will articulate the specific practices to be adopted in the design and construction of individual developments in the Parkes SAP reflecting recognised best practice, and the performance requirements of the UNIDO Eco Industrial Parks Framework.

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APPENDIX A

ENQUIRY BY DESIGN WORKSHOP MATERIAL

APPENDIX B

EBD PLAN ON A PAGE

APPENDIX C

ESD SCENARIOS ANALYSIS

APPENDIX D

AUTOMATED FREIGHT TRANSPORT SYSTEMS (AFTS)

APPENDIX E

KALUNDBORG SHARED NETWORK EXAMPLES

APPENDIX F

RATING TOOL/FRAMEWORK SUMMARY