USING THE CIRCULAR ECONOMY- POTENTIAL PATHWAYS FOR THE GOULBURN VALLEY, VICTORIA, AUSTRALIA

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ABSTRACT

The Goulburn Valley is home to thousands of farms, orchards, packhouses, processors and manufacturers as well as storage, logistical transport and service providers, connected through multiple supply chain relationships.

The Goulburn Valley's rare combination of large volume and diverse food production, processing, manufacturing and transport, generates year-round supplies of local waste materials and wastewater, demand for water, and all are located in a highly compact geographical area.

This means the Goulburn Valley is well-placed to take advantage of circular economy and transformative renewable energy technology that includes:

- Active leadership and support from local and state government organisations, urban water utility, energy provider and the local transportation, supply chain logistics, manufacturing, industrial and agri-food business sectors
- Recognition of the key and central role water and the urban water utility has in the circular economy and a net zero emissions future
- Conversion of industrial and municipal waste and recycled wastewater into biogas and renewable hydrogen to fuel the region's heavy freight trucks to powering packing, processing and manufacturing
- Enabling direct renewable energy and fuel supply between farms and factories, local network storage, and local renewable energy suppliers
- Adding large batteries and local network storage to improve reliability and resilience

This has the potential to transform the Goulburn Valley region into an Australian first and world-leading, modern and sustainable processing, manufacturing and

transport powerhouse. This transformation will secure access to reliable, affordable and sustainable energy that is generated and used locally to grow a more resilient and prosperous industrial base and attracting new businesses and providing high quality jobs. This approach can be replicated by similar agri-food, manufacturing/industrial, transportation and logistical regions and hubs across Australia, New Zealand, and the world. The Goulburn Valley can resource recovery hub be a catalyst for a megatrend in sustainable energy production and waste management that needs to be accelerated, and more widely adopted, to allow a global approach to meet the challenges of climate change, industrial transformation and to become a net zero emissions world.

This paper will outline the unique and successful collaboration that has led to the release of the circular economy thought leadership white paper on 28 April 2022. An example output of this partnership is attached. A Victorian government renewable hydrogen funding grant was secured in January 2022. This is a first step towards bringing the circular economy white paper recommendations to life to build a stronger, more resilient, and future ready Goulburn Valley region.

KEYWORDS

Circular economy, renewable hydrogen, recycle water, urban water utility, decarbonisation, collaborative partnerships, regional resilience and prosperity, climate change adaptation.

PRESENTER PROFILE

Kevin Werksman is Aurecon's global water markets leader providing strategic advice to water utilities on major infrastructure projects and transformations. Kevin brings extensive planning, commercial, economic, business and strategic change expertise.

1. INTRODUCTION

As Australia rises to the challenge of reaching net zero emission by 2050, significant shifts will be required in our communities and economies. We will need innovation, new technologies and new ways of thinking to move away from relying on fossil fuels. In addition, current linear processes generate large amounts of waste; extraction, use and disposal accounts for 45 per cent of greenhouse gas emissions.

As we move deeper into the 21st century, we must shift the functions of our regions and organisations to eliminate waste and create low carbon economies. As identified in the Goulburn-Murray Resilience Strategy, the circular economy represents an opportunity to not only improve the resilience of the region, but also increase its prosperity through the generation of new business models and the creation of new jobs.

This paper identifies potential pathways to embed the circular economy into the Goulburn Valley region through closing off the linear parts of the energy, waste and water cycles. In particular, this paper considers the impact the emerging hydrogen economy may have on how circularity could proceed in the region.

To deliver on this project, Aurecon and Goulburn Valley Water (GVW) engaged with local industries in the Goulburn Valley to identify opportunities through examining existing waste, water and energy practices, and what aspirations there might be in the future. These interviews uncovered new opportunities in transportation electrification, power supply resilience, wastewater treatment, food production and resource recovery. However, it also highlighted some of the challenges the region needs to collectively address to realise these changes.

One aspect is abundantly clear. To deliver on the opportunities for new industries, to address waste and pollution and to create new jobs, it is going to take new approaches, new partnerships, and a different way of thinking. This work is a collaboration between Greater Shepparton City Council, the Committee for Greater Shepparton and the Goulburn-Murray Resilience Taskforce led by Goulburn Valley Water and Aurecon.

Why are we working together?

We know that new challenges require new approaches. And, as we respond to the opportunities the circular economy represents for regions and organisations to increase resilience and generate prosperity, there will need to be new partnerships, new connections and new relationships. Aurecon and Goulburn Valley Water are putting this ethos into practice by partnering on the project to identify ways to embed the circular economy into the Goulburn Valley region in a way that honours the local industries, geography and needs of such an important agri-food hub.

2. DISCUSSION

2.1. THE GOULBURN VALLEY REGION, OPPORTUNITIES AND CHALLANGES

The Goulburn Valley region sits on the land of the Yorta Yorta Nation, at the junction of the Goulburn and Broken Rivers in northeast Victoria and Southern New South Wales. The region compromises seven municipalities: Greater Shepparton, Mitchell, Moira, Mansfield, Campaspe, Murrindindi, and Strathbogie Shires.

The region is known for its high-quality produce that are vital for Australians lifestyle and prosperity. There is a significant industry and employment momentum in the region, specifically in agriculture, processing, dairy, meat production, manufacturing and logistics. Figure 1 indicates the economic attributes of the Goulburn Valley. The region is part of Melbourne's northern growth corridor, and the constantly developing transport route to Sydney.

With an industry base that is dependent on agriculture and food manufacturing, the Goulburn Valley region is heavily dependent on consistent energy and water supplies. It is currently heavily dependent on fossil fuel transport options for regional supply chains and getting goods to export markets. In addition, these industries must respond to an estimated 2.3 million tonnes of greenhouse gas

emissions across industry and respond to the waste generated as part of their processes. Figure 2 shows waste and pollution flow through the structures of the Goulburn Valley (GV) regional economy. There are clear flows of waste and emissions where, if the first two principles for the circular economy are applied, designing out waste and pollution and keeping materials at their highest value for as long as possible.

Huge opportunities do exist in the region for taking a collaborative approach to transition towards renewable energy sources to reduce current dependencies, and to develop circularity within the region, by connecting wastes and key inputs.

Figure 1: Economic attributes of the Goulburn Valley

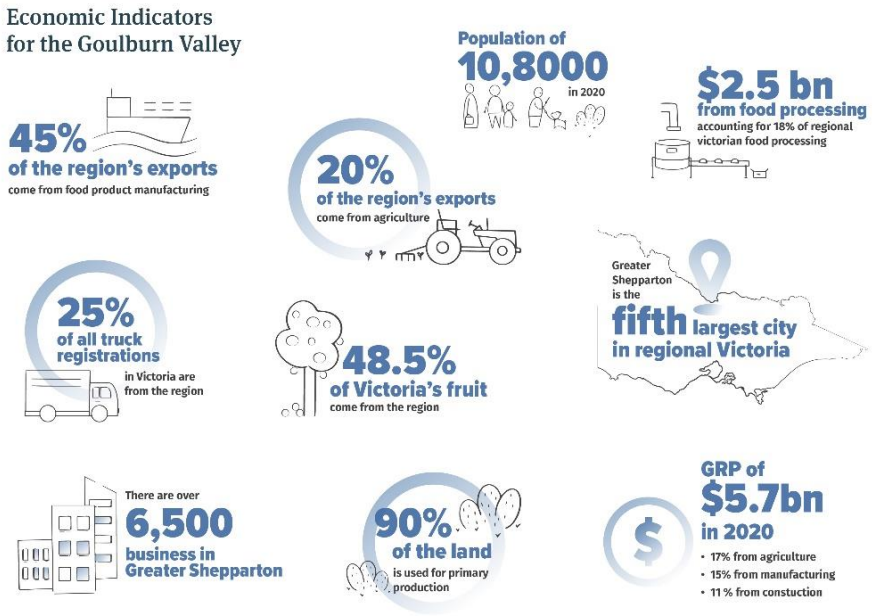
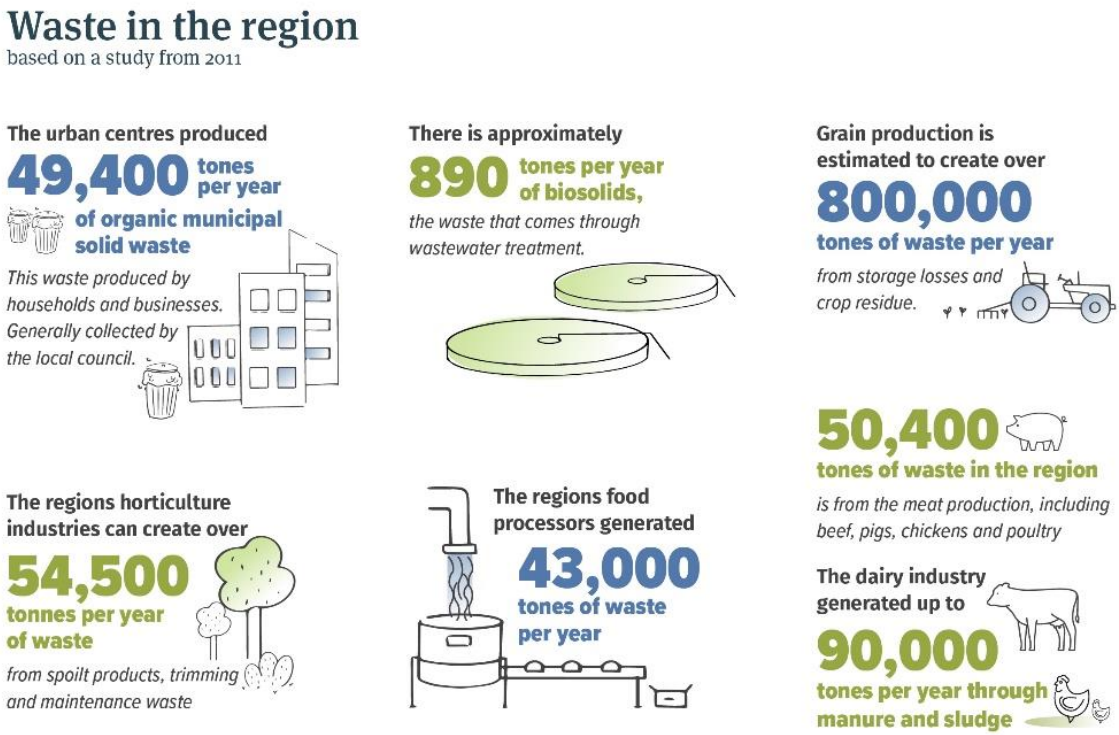


Figure 2: Waste volumes in the Goulburn Valley



2.2. CIRCULAR ECONOMY

Born out of the theory of industrial ecology, the circular economy is a concept that is rising in importance and urgency as economies world-wide seek to readjust in response to rising pollution, increasing resource scarcity and decarbonisation.

The extraction, use and disposal of resources and materials accounts for 45 per cent of carbon emissions (McArthur, 2021). In order to fully consider our carbon footprint, we need to consider how materials and resources circulate through the economy.

The aim of the circular economy is to keep materials at their highest possible value for as long as possible. Figure 3 depicts the shift to the circular economy. This is achieved by adherence to three principles:

1. Design out waste and pollution
2. Circulate products and materials for as long as possible
3. Regenerate natural systems.

Key to the circular economy is taking our existing linear economic systems and bringing systemic approaches to remove waste and allow materials to circulate through an economy as opposed going to landfill.

In 2020, Circle Economy estimated global circularity at 8.6%, which reflects a decline from 9.1% in 2018 (Circle Economy, 2020). According to Boston Consulting Group analysis, in order to reach long-term sustainability, global circularity levels need to reach at least 50 to 70 per cent (Boston Consulting Group Analysis). This clearly highlights the need to apply these principles to progress towards global circularity. It is estimated that applying these three principles to

the Australian economy could generate AUD 1860 bn in direct economic benefits and reducing 165 Mt of CO_2 per year by 2040(PWC, 2021).

Increasingly, companies that are applying the circular economy principles to their business models and operations are seeing significant economic returns. McKinsey has identified six activities that can contribute to delivering on the circular economy when applied to asset heavy industries. They provide a series of clear opportunities:

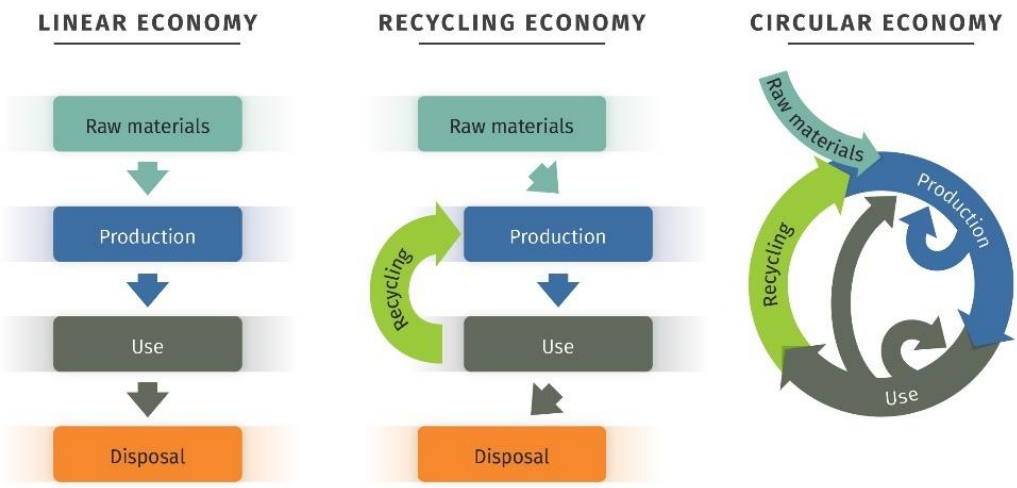
1. **Optimising** — Improve the performance and efficiency of assets; remove waste from their supply chains; and leverage big data, automation, and remote sensing.
2. **Regeneration** — Shift to renewable energy and materials, retain and regenerate the health of ecosystems. Return recovered biological resources to the biosphere.
3. **Looping** — Keep components and materials in closed loops. For finite materials, this means remanufacturing products or components and (as a last resort) recycling materials. For renewable materials, it involves anaerobic digestion and the extraction of biochemicals from organic waste.
4. **Exchanging** — Replace old materials with advanced renewable ones; apply new technologies, such as 3-D printing and electric engines.
5. **Virtualising** — Displace resource use with virtual use - designs, services, fleets of autonomous vehicles, and virtual offices.
6. **Sharing** — Maximise utilisation of assets through sharing networks or pools of products; reuse them throughout their technical lifespans; and prolong those life spans through maintenance, repair, and design for durability.

However, asset owners and organisation that produce, manage and process resources and materials, organisations such as water utilities, agriculture and food manufacturing, must also consider how they build the infrastructure required to enable the circular economy to flourish.

Examples of the Circular Economy in action:

- **Kalundborg Symbiosis** – Started in 1961, Kalundborg Symbiosis is the world's first industrial symbiosis. The symbiosis consists of 23 different streams covering water, energy and materials. This promotes local growth and fosters the green transition.
- **UK National Industrial Symbiosis Programme** - Launched in 2005, the UK's National Industrial Symbiosis Programme (NISP)(International Synergies, 2005) facilitates business opportunities, which keep resources circulating in the economy in a productive cycle, creating 100 million pounds in cost savings and 39 million tonnes of industrial carbon emissions reduced.
- **Sundrop Farms, South Australia** - Sundrop Farms, located in Port Augusta, South Australia, is the first agricultural facility of its kind and is estimated to produce 17,000 metric tonnes of tomatoes annually (Better Worlds Solutions, 2020). It counteracts the requirement for fresh water and fossil fuels through combining solar power with desalination.

Figure 3: The shift to the circular economy



2.3. THE CIRCULAR PATHWAY FORWARD

In responding to embedding the circular economy as part of regional resilience in the Goulburn Valley area, there are three key loops that can be created (Figure 4). The focus of these loops are the areas where new infrastructure is required to generate circularity at scale across the region to close waste, water and energy value chains. One aspect to note, is that a key feature of the circular economy is the connectivity it drives between industries and businesses. While each of the loops can be pursued independently of one another, to achieve long-term and fully realised outcomes, all three need to be addressed to generate resilience. Each loop proposed here as a pathway to circularity in the region responds to a different part of the value chain or ecosystem, linking up different parts of the ecosystem as it relates to energy, waste and water.

LOOP 1 — Valuing waste — making the most of local biomass and reducing waste to create alternative energy sources and nutrient supplies.

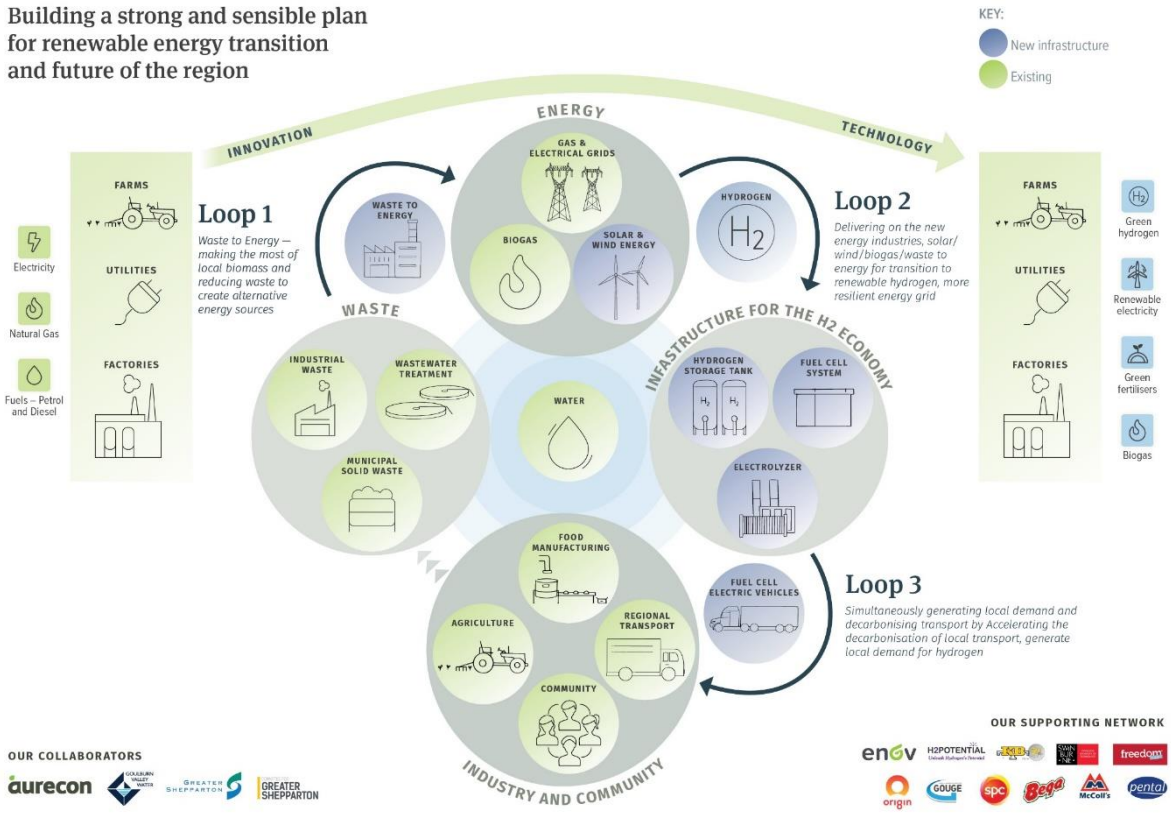
LOOP 2 — Hydrogen production — delivering and scaling new energy technologies for transition to a more resilient energy system.

LOOP 3 — Hydrogen transport — accelerating the decarbonisation of local transport and generating local demand for hydrogen.

These three opportunities relate strongly to several strategic settings across Australia in relation to the circular economy. Furthermore, they require collaboration and systemic responses from a network of actors and organisations. It is important to note that each of these opportunities is not mutually exclusive, and the Goulburn Valley region may find itself needing to address all three over time. While there are many different ways to contribute to the circular economy, this paper focuses on the opportunities that target addressing the loops in the waste, water and energy nexus.

This approach will transform the entire region by increasing efficiency and self-sufficiency which will build a buffer for the region to absorb future shocks. Lack of resilience is hurting regional communities and economies. With time and greater awareness of the importance of developing resilience in communities, people are adopting an active 'adaptation and transformation' mindset and are looking for opportunities to leverage natural resources within the region.

Figure 4: The transitions for the Goulburn Valley



2.3.1. Loop1- Valuing Waste

The aim of loop 1 is making the most of local organic biomass to create alternative energy sources, increase local energy resilience and offset energy costs for GVW and local industries, reduce organic waste from Municipal Solid Waste (MSW), and agricultural and manufacturing processes and link up the waste produced by the horticulture, agricultural and food processing industries into energy production and resource recovery (refer to Table 1 for more information). The following actions is necessary to be taken:

1. Waste to energy facilities co-located with existing facilities or in conjunction with new assets
2. Supply agreements for biomass feedstock and partnerships with local industries
3. Transport services for biomass 4. Generation of local demand for 'green gas', ultimately supported by offtake agreements

Bioenergy & Waste to Energy:

Bioenergy is the term given to renewable energy that is produced by living organisms. Such energy is generated from organic biomass and biofuels, and is commonly found in the form of biogas, which is a combination of different gases, predominantly methane and carbon dioxide. Waste to energy is a process that takes a waste feedstock and creates energy, typically in the form of gas, heat or electricity. Waste to energy is often associated with incineration processes, which at times may involve using waste products that have a higher order reuse potential to create energy. Due to the higher order the reuse potential of such feedstocks, the level of circularity of incineration processes is at times questioned. Newer approaches to waste to energy therefore employ bioenergy processes such as anaerobic digestion to consume organic feedstocks such as food and other biomass wastes that have no higher order reuse potential and generate biogas.

Bioenergy and Waste to Energy processes are considered opportunities to participate in the circular economy as they divert materials from landfill, providing a secondary usage. This diversion from landfill eliminates greenhouse gas emissions that are caused by the decomposition of organic wastes in landfill, instead allowing for specialised processes to capture the gases produced, use these gases to generate energy, as well as having the potential to produce other products such as biofertilisers, which then become feedstocks to the food and fibre cycle, showcasing circularity.

There are already a number of manufacturers in the GV region operating biogas/bioenergy facilities. However, these are relatively small in scale and are only used in a "behind the meter" fashion to reduce the natural gas usage of the manufacturers who operate such systems. As gas companies seek to respond to decarbonising economies, biomethane, a refined biogas product is being considered as a replacement for mains gas.

The Australian Government is currently developing a roadmap, due to be released in 2021, which will identify the role the bioenergy sector can play in Australia's energy transition (ARENA, 2022). The Victorian Government has also increased the Victorian Renewable Energy Target (VRET) to 50% by 2030. This builds on Victoria's previously legislated renewable energy generation targets of 25% by 2020 and 40% by 2025.

Over time, biogass is expected to become increasingly viable for commercial scale applications. As outlined in the Victorian Renewable Energy Action Plan, to support the development the waste-to-energy facilities AUD 2 million will be provided. In addition, biogas may play a role in reducing emissions from natural gas. Victoria's Gas Substitution Roadmap Consultation Paper identifies substituting natural gas with biogas as one of the key pathways to decarbonise the existing gas network.

2.3.2. Loop2- Hydrogen Energy

Producing hydrogen from waste and biogas can reduce organic waste from MSW and agricultural and enable local hydrogen economy implementation ensuring the region is not dependent on external supply chains, increase local energy resilience and offset energy costs for GVW and local industries, enable local hydrogen

economy implementation ensuring the region is not dependent on external supply chains, and use for local recycled water (refer to Table 1 for more information). For this purpose, the following actions is necessary to be taken:

1. Local hydrogen production and storage facilities
2. Access to high quality water sources: recycled water is a potential solution
3. Reliable renewable energy source
4. Local demand for hydrogen either through:
    a. Injection into gas network
    b. Hydrogen refuelling for transport

Hydrogen Economy:

Hydrogen has long been considered an alternative fuel source to power the economy. Over the past decades, economies like Japan and Germany have been investing in technologies that enable hydrogen to power transportation, electricity grids and even provide high grade heat for metal refining. Transitioning to a hydrogen economy is recognised as a critical path towards decarbonisation. Another critical aspect of the hydrogen economy is that it represents another industry for Australia, creating new jobs, businesses, and export opportunities across the country. By 2050, based on current market conditions, the hydrogen economy has the potential to add AUD 11 bn a year in additional Gross domestic product (GDP) and around 7600 jobs. Should global hydrogen markets develop faster than anticipated, this figure could be AUD 26 bn per year (CSIRO, 2018). Australia's hydrogen production is forecasted to grow from 0 (2019) to 20 tonnes by the end of 2050. Globally, there is a 330 million-tonne gap that needs to be filled. There are a number of hydrogen projects already in Australia, that run across the whole value chain and each of the use cases. While it is still an emerging opportunity, there is significant investment from all levels of government and foreign partners to deliver on the economic and decarbonisation opportunities hydrogen offers.

In terms of how the hydrogen economy can contribute to developing a circular economy, it is primarily through the principle of designing out waste and pollution and the circular activities of optimising, looping and exchanging.

- Exchanging – replacing fossil fuel energy sources with renewable and low carbon options
- Looping – ensuring recycling water and biogas is used fully in the economy
- Optimising – making use of local biomass and resources to generate local energy sources and removing waste from supply chains.

2.3.3. Loop 3- Hydrogen Transport

The objective of loop 3 is creating local demand for hydrogen, decarbonization of warehouse operations and local transportation of goods to markets and providing Goulbourn Valley industries with alternative fuels for decarbonistion (refer to Table 1 for more information). For this purpose, the following actions is necessary to be taken:

1. Investment in hydrogen transport pilots by manufacturers and logistics companies
2. Local refuelling facilities

3. Local hydrogen supply and storage facilities
4. Uptake in the use of hydrogen for freight purposes
5. Local business and community vision for a hydrogen economy in the region
6. Shared alignment on carbon reduction KPI's and commitment to achieve Net Zero through trusted collaboration and partnerships

Hydrogen for Transport:

One of the key use cases for hydrogen is in transportation, a sector facing increasing pressure to reduce carbon emissions. In Australia, approximately 18% of the country's greenhouse gas emissions are from transport. In addition, Australia is reliant on an overseas fuel supply chain, and subject to global shocks (Climate Council, 2016). Hydrogen is viewed by many economies and manufacturers as a key decarbonisation response for the transport sector.

Worldwide, there are pilots for hydrogen fuel cells in every transport mode, including aviation, rail, heavy freight, warehousing, haulage, buses and personal vehicles, with manufacturers racing to produce and integrate these technologies in their product lines. This is also being considered for agricultural machinery and processes.

Some of the advantages hydrogen fuel cell vehicles have over electric vehicles include speed for refuelling, range and the weight of batteries. In addition, it is forecast there will be significant competition for the minerals needed for battery technologies. For some economies, the investment in hydrogen vehicles is in direct response to these potential resource constraints. Hydrogen for transport forms a contribution to the circular economy by exchanging a fossil fuel intensive process with a renewable one. In addition, should the hydrogen be produced locally and from local renewable energy, it increases local energy resilience and removes the potential waste created by long energy supply chains.

It is worth noting that we do not propose hydrogen for transport as an either/or against the use of electric vehicles. Rather, to respond to the rate of decarbonisation required to maintain 1.5°C, it will be necessary to pursue each and every avenue available. The proposal to consider hydrogen in the transport mix is in response to how it can form part of the circular economy, through renewable green hydrogen and its connectivity with biogas from organic waste and the water industries.

Table 1: The Circular Pathway Forward

LOOP 1 – Waste to Energy - making the most of local biomass and reducing waste to create alternative energy sources	**LOOP 2 – Hydrogen production – Delivering and scaling new energy technologies for transition to a more resilient energy system.**	**Loop 3 - Hydrogen transport - accelerating the decarbonisation of local transport and generating local demand for hydrogen.**
Short term opportunities - Explore new demand for exiting biogas facilities as green gas injection or to offset LNG usage - Build a new waste to energy facility - Map waste production and usage in the region, updating the 2008 study. - Access government (state and federal) and public funding for the implementation of waste to energy facilities to divert organic biomass from landfill **Medium term opportunities** - Expand biogas facilities and processing in the region - Export excess energy to either the electricity grid or gas network - Provide alternative gas supplies to LNG for decarbonisation pathways **What local challenges does this address?** - Energy security - Carbon emissions from biomass	**Short term opportunities** - Access commercialisation and innovation funds like "The Renewable Energy Business Ready Fund" by DELWP - Installation of a hydrogen electrolysis facility - Provide a local supply to enable local hydrogen transport pilots - Refuelling station as part of a transport corridor between Sydney and Melbourne and other export routes. - Supply hydrogen for local industrial processes, including food manufacturing **Medium term opportunities** - Scaling and growing renewable hydrogen production facilities in the region - Establishment of new jobs and skills development for the region **What challenges does this address?** - Decarbonisation of supply chains	**Short term opportunities** - Hydrogen powered forklifts for warehousing operations - Refuelling station to create a state-wide network and corridor - Participation in new technology pilots and commercialisation of research with universities - Hydrogen powered local fleets **Medium term opportunities** - Ensure the Goulburn-Murray region remains a destination and can service hydrogen transport as new corridors emerge - Service agricultural machinery as that industry adopts new fuels **What challenges does this address?** - Decarbonisation of supply chains - Scope 2 and 3 emissions reduction - Generating local demand for hydrogen

- Resource and nutrient losses - Lack of jobs in the region - Waste management and diversion **How does this address circularity for the GV region?** - Waste of resources and materials - Municipal solid waste and landfill - Low reuse of recycled wate **Partners** - Local agricultural/horticultural industry organic biomass source - Local government for MSW recovery and kerbside/household organics wastes. - Manufacturing industry biogas demand - Local commercial entities generating organic waste (e.g. café's, supermarkets) - Local gas networks for potential green methane injection **Case Studies** - Wollert Waste to Energy & Lilydale Waste to Energy, Yarra Valley Water - Renewable Organics Network, Barwon Water - Kwinana Waste to Energy Project - Hazer Commercial Demonstration Plant, Western Australia	- Energy security and supply **How does this address circularity for the GV region?** - Implementing new energy technologies and displacing fossil fuels - Demand for biogas from local production - Use of recycled water in the region **Partners** - Hydrogen technology provider - Energy companies, gas networks and renewable energy providers. - Transport companies - Local government - Funding partners, including Federal bodies like ARENA and CEFC, and state government funds. **Case Studies** - Blended Hydrogen Network, Winlaton UK - Hydrogen Powered Data Centres, Microsoft - Australian Hydrogen Centre	**How does this address circularity for the GV region?** - Reducing pollution from fossil fuels - Generation of a local fuel source **Partners** - Machinery and OEM manufacturers - Technology companies - Freight companies - Other regions to ensure enough connectivity of supply - Local industry - Universities and research bodies **Case Studies** - ActewAGL hydrogen refuelling station in ACT - Materials Handling Systems, Plug Power - Hyzon Motors

3. CONCLUSIONS

As markets and communities and the organisations themselves call for change, the transition to a net zero future requires communities and industries to work together. With the combination of industries, community, and infrastructure in the Goulburn Valley, it represents an ideal community to accelerate the transition to the new economies, using technology and innovation. Three infrastructure loops include valuing waste, hydrogen production, and hydrogen transport are identified in this paper which represent clear pathways for the Goulburn Valley to transition towards a just and profitable future. Implementing this new layer of technology would allow the region to:

- Accelerate the decarbonisation away from fossil fuels across the manufacturing and industrial base
- Secure the future of major food manufacturing hubs
- Secure transportation and supply chains for the region, Victoria and across Australia
- Decarbonise building heating and water utility operations
- Build great regional resilience and prosperity by:
  - Buffering against future shocks such as natural disasters and pandemics
  - Attraction growth and retention of manufacturing and industry
  - Creation of jobs of the future from the uptake of new technologies and innovations
  - Fortifying of water, energy and fuel infrastructure
  - Strengthening supply chains for food and manufacturing.

Responding to these challenges requires new forms of partnerships, new forms of collaboration and finding new ways to stop waste and resources leaking out of our economies.

ABBREVIATION

ARENA: Australian Renewable Energy Association

CEFC: Clean Energy Finance Corporation

DELWP: Department of Land, Water and Planning

GDP: Gross domestic product

GV: Goulburn Valley

GVW: Goulburn Valley Water

LNG: Liquefied Natural Gas

MSW: Municipal Solid Waste

OEM: Original Equipment Manufacturer

VRET: Victorian Renewable Energy Target

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