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Australia's Bioenergy Roadmap

Appendix – Consultation Overview

November 2021

Prepared by ENEA Australia Pty Ltd and Deloitte Financial Advisory Pty Ltd for ARENA.

Australian Government
Australian Renewable Energy Agency

ARENA

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1. Approach

This appendix outlines the approach and results of the consultation undertaken in preparing Australia's Bioenergy Roadmap. The approach utilised is discussed, followed by results of two streams of Menti polling that were undertaken. Finally, a full review of the stakeholder submissions has been provided.

The Roadmap was developed in broad consultation with governments, industry, researchers and the general public. This was undertaken to ensure the following objectives:

1. Understand key markets and buyers for bioenergy
2. Understand the barriers to development
3. Gather any insights and collect any feedback on the initial analysis and findings
4. Gain buy-in and support from stakeholders
5. Understand the key issues and concerns from the relevant groups.

Stakeholder consultation involved three tranches of engagement with both private and public sectors:

- Bioenergy currently accounts for close to 60 per cent of Australia's renewable energy production.
- Bioheat in Australia accounts for 15 per cent of Australia's heat generation. It is well established in Australia due to high uptake amongst waste-producing industries, including drying processes in the sugar, food, wood, and the pulp and paper industries.
- Bioelectricity accounts for 1.4 per cent of Australia's electricity generation. Bagasse is the leading bioelectricity resource used in Australia, followed by landfill gas. Although bioelectricity accounts for a small proportion of generation, the use of municipal and industrial waste for electricity production has accelerated in recent years.

Workshops

There were 271 attendants in aggregate across workshops held. Some participants attended multiple workshops, therefore the total number of individuals engaged through workshops may be slightly lower.

Workshops involved a range of general as well as sector-specific questions. The feedback received in these workshops has been reflected in the Roadmap.

Table 1 – Workshop schedule

Workshop	Number of attendees	Date
Sector specific	134	
Research	15	Mon 18/05
Agriculture and Forestry	13	Mon 18/05
Organic Residues and Waste	15	Tue 19/05
State, Territory and Local Governments	24	Wed 20/05
Heat and Power	10	Wed 20/05
Biofuel	15	Thu 21/05
Project Developers and Investors	23	Thu 21/05
Biogas	19	Fri 22/05
General Public	137	Fri 22/05

Interviews

One-hour interviews were held between 14 May and 1 June 2020. These interviews covered both general questions and stakeholder-specific questions.

All interviewees were posed the following three general questions:

1. Current state of Australia's bioenergy industry (strengths, weaknesses)
2. Prospects for Australia's bioenergy industry (opportunities, threats)
3. Options to unlock Australia's potential.

The stakeholders engaged in direct interviews are included in Table 5. The feedback received from interviewees has been incorporated into the Roadmap.

Table 2 – Direct-interview list

Interviewee	Organisation
Henry Anning	ResourceCo
Edward Nicholas	Tribe
Gabrielle Sycamore	Jemena
Shahana McKenzie	Bioenergy Australia
Anthony King	Scania
Daniel Burrows	Macquarie Group
Fiona Messent	Qantas
Mac Irvine	Clean Energy Finance Corporation
Steve Rogers	International Energy Agency
Robert Boyd	International Air Transport Association
Garth Lamb	Water Management and Resource Recovery Association Australia
Gavin Matthew, Kevin Peachey	Australian Forest Products Association
Mary Lewitzka, Richard Webster	South Australia Department for Energy and Mining
Jeff Thong, Antony Englund, Megan Wolf	EDL Energy
Sandra Lau, Edwina Pribyl, Mary Wark	Viva
Chris Wilcox, Patrick Gruber, Heather Manuel	Gevo Inc.
Gerald Leach, Warwick Ragg, Bruce Tran	National Farmers' Federation
Cameron Mathie, Matthew Power, Paddy Aicken, Casey Broughton, Mark Williamson, Mary-Anne Wilson, Karen Graham	Clean Energy Regulator

Submissions

On 28 April 2020, ARENA released a call for written submissions from the public. Written submissions were initially due Friday 29 May 2020; however, this was extended to 10 June 2020 following a number of requests. The call for submissions was supported by a discussion paper, which asked several questions related to five key areas of investigation:

- Markets and technology
- Resources
- Public Policy
- Social Licence
- Key Stakeholders.

ARENA received an overwhelming response to the call for submissions from stakeholders, demonstrating deep interest from industry, academia, government and the general public in the Roadmap.

In total, 149 unique stakeholders provided a submission to the Roadmap. Of these, 140 provided additional attached documents as part of their submission, a number of which included multiple attached documents. Overall, ARENA received over 160 documents from the call for written submissions.

The participating submissions reflected a diverse range of stakeholder groups, including:

- Private citizens
- Universities and research institutes
- Non-government organisations, including industry associations and conservation groups
- Small to medium enterprises, including farmers, energy businesses and technology start-ups
- Large businesses, such as multi-national petroleum corporations and airlines
- Various government agencies, in particular a number of local councils and shires.

These submissions were reviewed and have been incorporated into the Roadmap and relevant Technical Appendices.

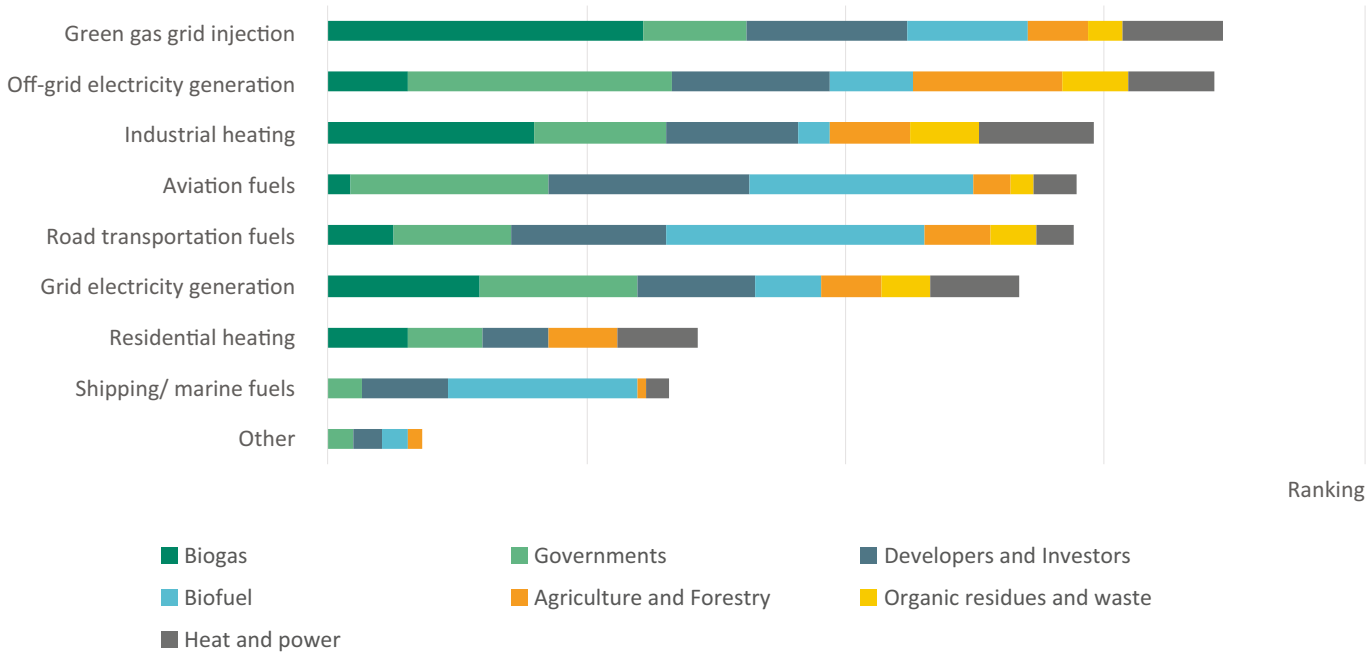
2. Menti polling: Sector-specific workshop

Sector-specific workshop groups were asked three questions via Menti polling:

1. What is the top market opportunity for the bioenergy industry in Australia?
2. What is the biggest impediment to the acceleration of the bioenergy industry in Australia?
3. What is the biggest strength of the bioenergy industry in Australia?

Green gas grid injection ranked as the top market opportunity, closely followed by off-grid electricity generation. As shown in Figure 1, these results are influenced by the number of participants in various sector-specific groups. The biogas stakeholder group ranked grid injection and industrial heating among their top markets, while Governments ranked off-grid generation and aviation fuels among the higher market opportunities. Developers and investors placed relatively similar rankings across the top six markings. The biofuel stakeholder group ranked the three transportation fuels among the top markets (road, aviation and shipping respectively).

Figure 1 – Top market opportunity for Australia's Bioenergy sector (sector-specific survey)



Policy and regulation was ranked as the biggest impediment to the acceleration of bioenergy in Australia. The figure below demonstrates that this was almost unanimous across stakeholder groups (with the exception of the Heat and Power group, which considered access to feedstock and industry experience greater impediments).

Production cost was ranked the second-biggest impediment, followed closely by access to feedstock and consumer willingness to pay. However, the organic residues and waste group did not consider access to feedstock an impediment. Interestingly, access to feedstock was also ranked as the biggest strength of Australia's bioenergy sector in the following question.

Figure 2 – Biggest impediment to the acceleration of Australia's Bioenergy sector (sector-specific survey)

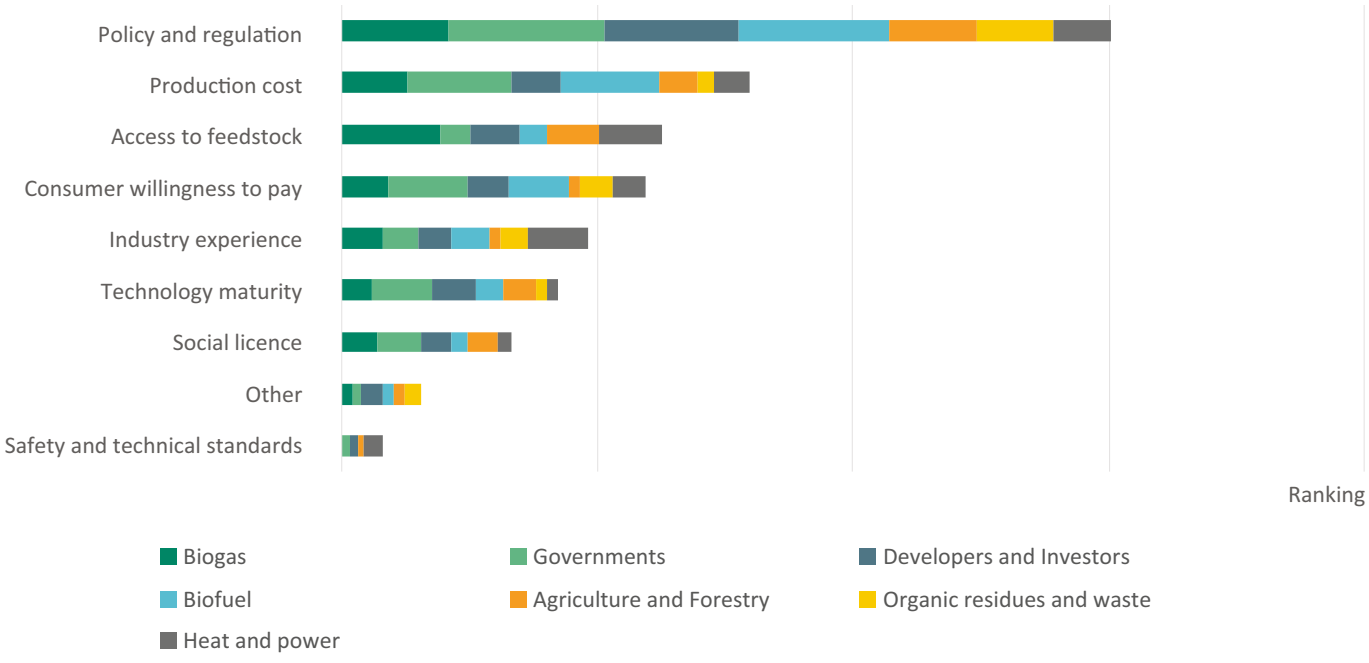
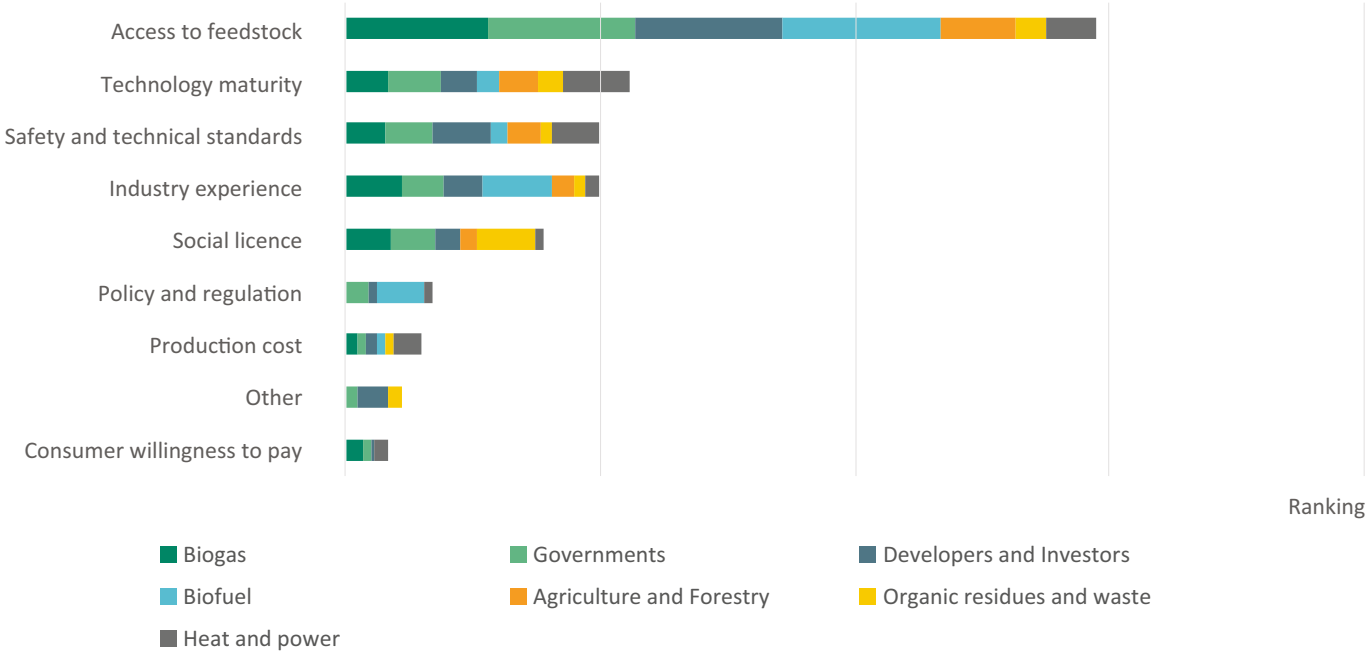


Figure 3 shows that access to feedstock was almost unanimously ranked as one of the biggest strengths, with the exception of the Organic residues and waste and Heat and power groups. Technology maturity was considered the second-biggest strength, while safety and technical standards and industry experience were equally ranked in third place. Consumer willingness to pay was not highly regarded as a strength in the sector, and this aligns with it being considered the fourth-biggest impediment to industry growth.

Figure 3 – Biggest strength of Australia's Bioenergy sector (sector-specific survey)



3. Menti polling: General public session

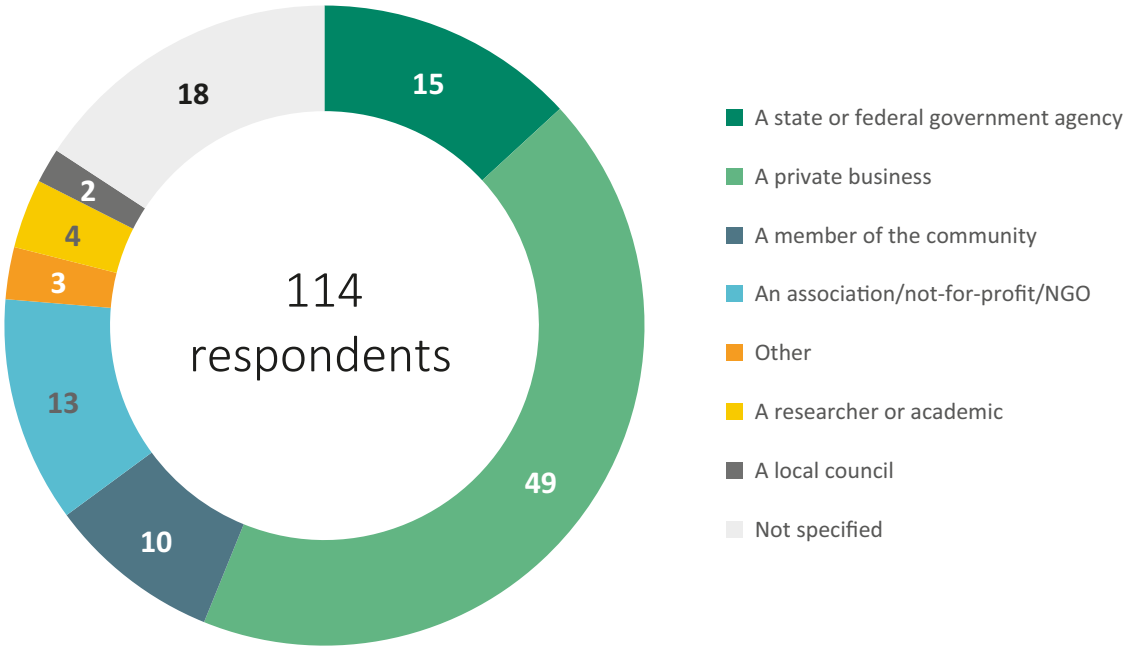
There was a total of 114 respondents to the general public Menti survey. Respondents may have joined at different times and were not required to respond to every question, therefore the response rate to individual questions did vary. General public participants were posed the following questions:

1. Who do they represent? (That is, whether they have participated the workshop on behalf of a specific stakeholder group)
2. What comes first to mind when stakeholders think of bioenergy?
3. What important roles could bioenergy play in Australia?
4. What is the top market opportunity for the bioenergy industry in Australia?
5. What is the biggest impediment to the acceleration of the bioenergy industry in Australia?
6. What is the biggest strength of the bioenergy industry in Australia?
7. What resource has the largest potential for bioenergy in Australia?

Figure 4 shows the breakdown of representation of participants who attended the general public session. 16% of Menti participants did not respond to the question regarding who they represent. Of participants that did respond to the question (96):

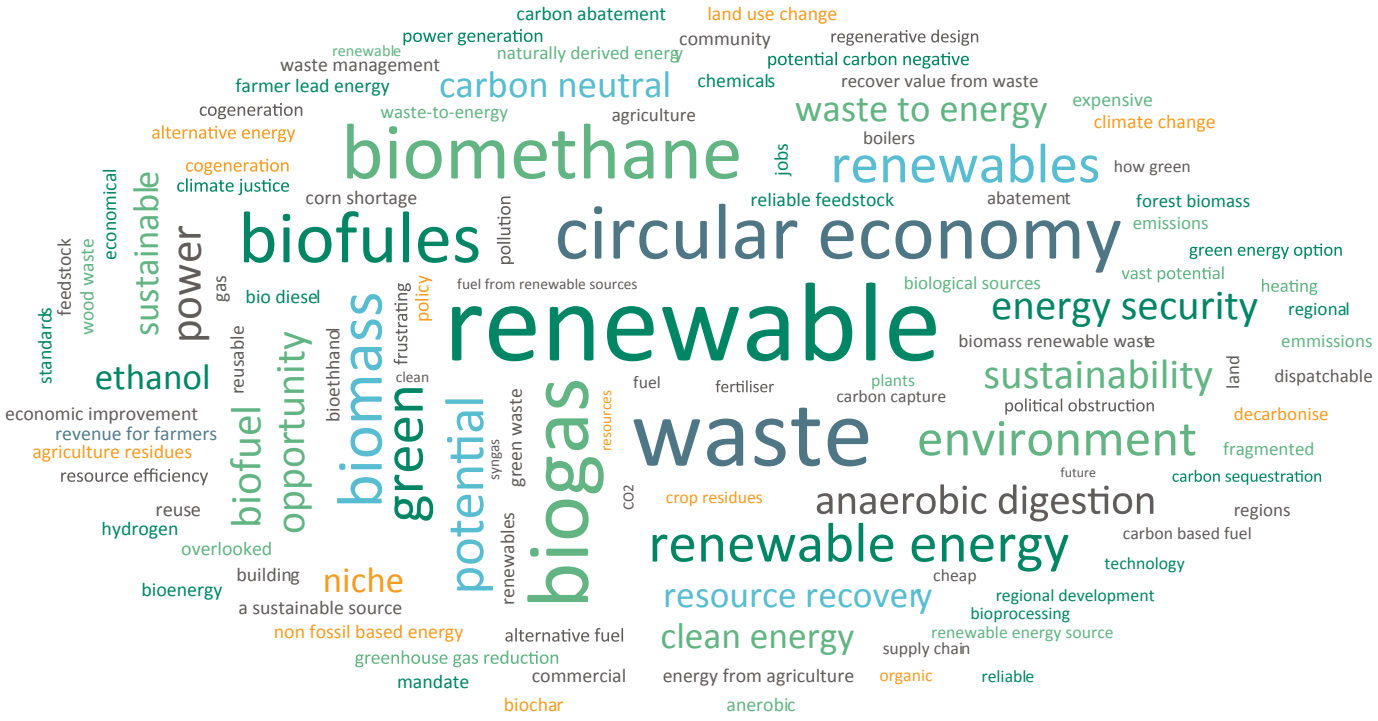
1. 51% were from the private sector
2. 17% were from the public sector (local, state and federal)
3. 13% were from an association/NGO.

Figure 4 – Representation breakdown of general public session survey respondents



A range of responses were received when asked what comes first to mind at the thought of bioenergy. These thoughts were presented in a word cloud, shown in Figure 5. Common themes reflected by the respondents included 'renewable', 'circular economy', 'waste', 'biomethane' and 'environment'.

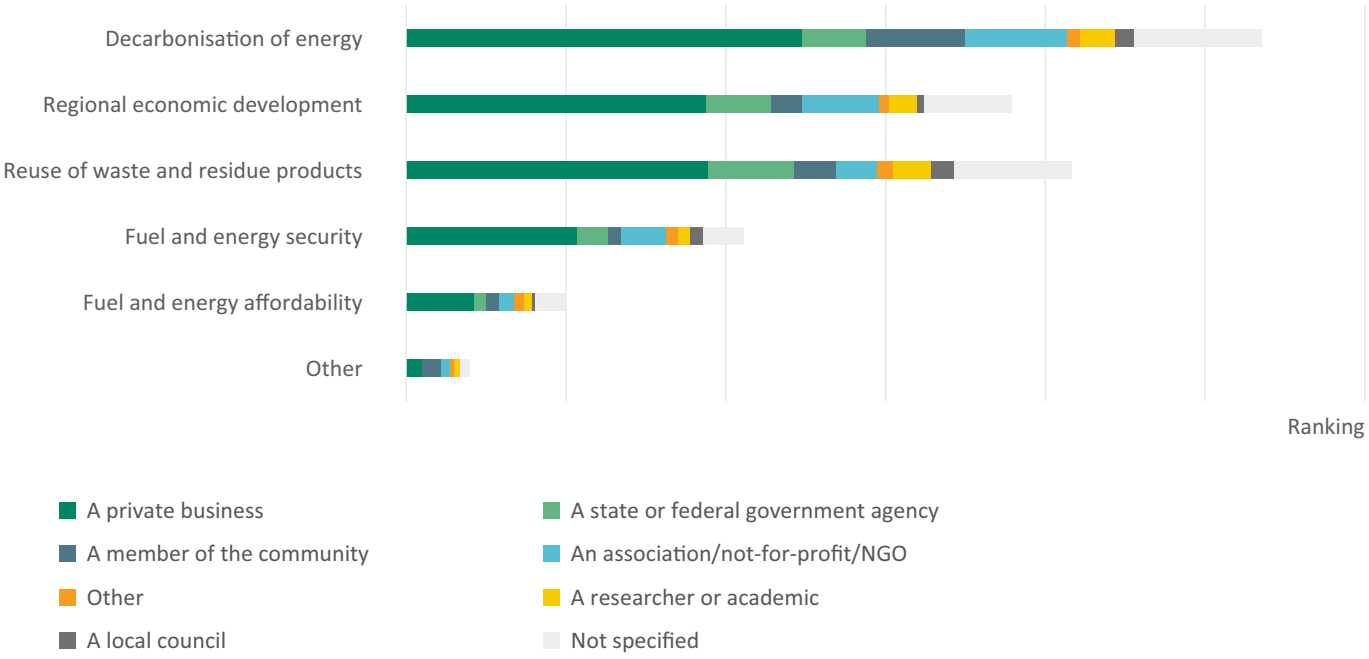
Figure 5 – Bioenergy word cloud



Respondents considered decarbonisation of energy the most important role bioenergy could play in Australia. However, this was followed closely by reuse of waste and regional economic development. Fuel and energy security and affordability were not considered significant roles for bioenergy. Written feedback during the session suggested that in addition to decarbonisation, bioenergy could play the important role of de-fossilisation (that is, less reliance on fossil fuels).

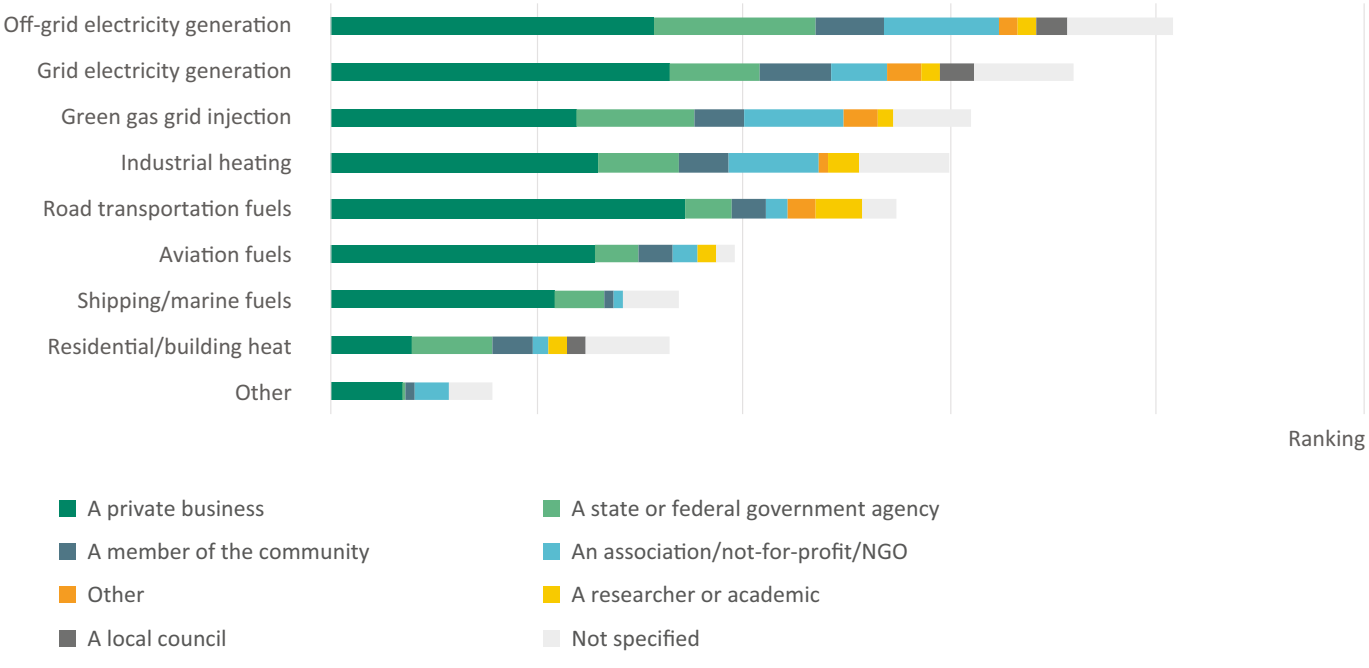
As shown in Figure 6, these results are significantly influenced by private business participants. However, other stakeholder types reflected a similar opinion.

Figure 6 – The role of Bioenergy in Australia (General public survey)



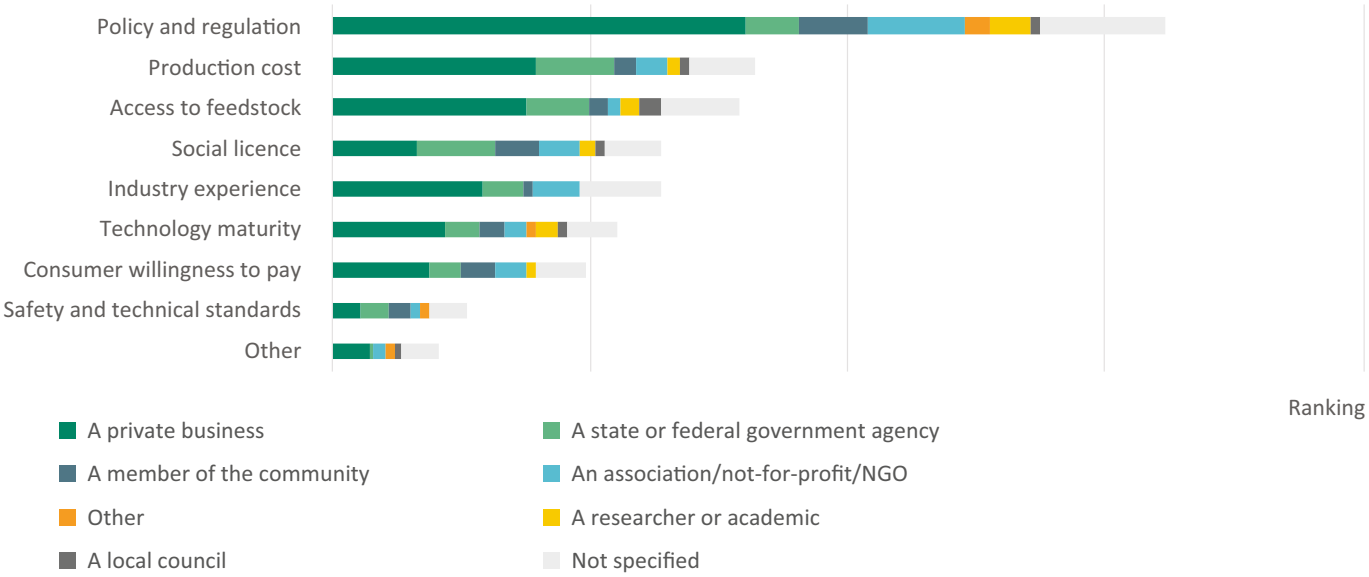
Electricity generation was ranked as the top market opportunity for bioenergy, with off-grid (on-site/stand-alone power systems) marginally ahead of on-grid electricity generation. Interestingly, this outcome does not reflect the majority stakeholder type's opinion, private businesses, who considered road transportation the largest market opportunity for bioenergy in Australia.

Figure 7 – Top market opportunity for Australia's Bioenergy industry (General public survey)



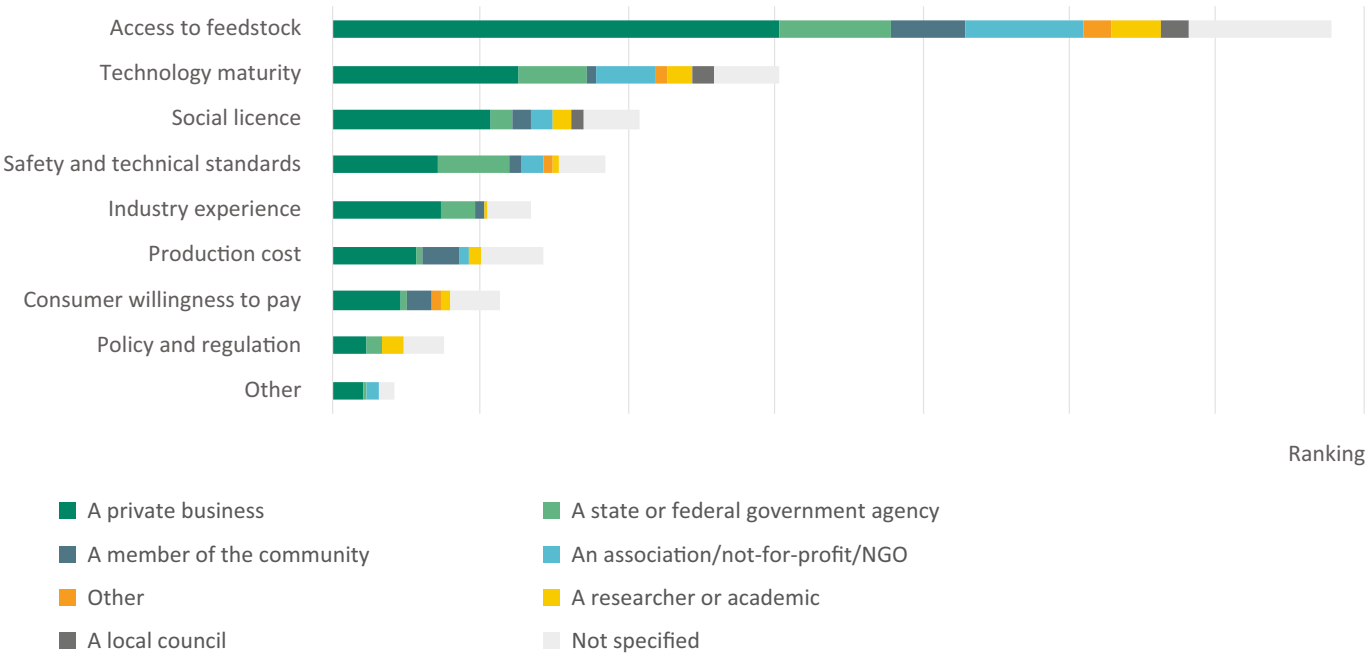
Policy and regulation was ranked the biggest impediment to the acceleration of Australia's bioenergy industry. This is consistent with the sector-specific survey, including the two second-largest impediments being production cost and access to feedstock. However, the general public participants considered social licence a much bigger impediment, compared to the sector-specific survey groups. Although ranked relatively low by private businesses, this outcome was influenced by government, community, association and unspecific stakeholder participants. This is shown in Figure 8.

Figure 8 – Biggest impediment to the acceleration of Australia's Bioenergy sector (General public survey)



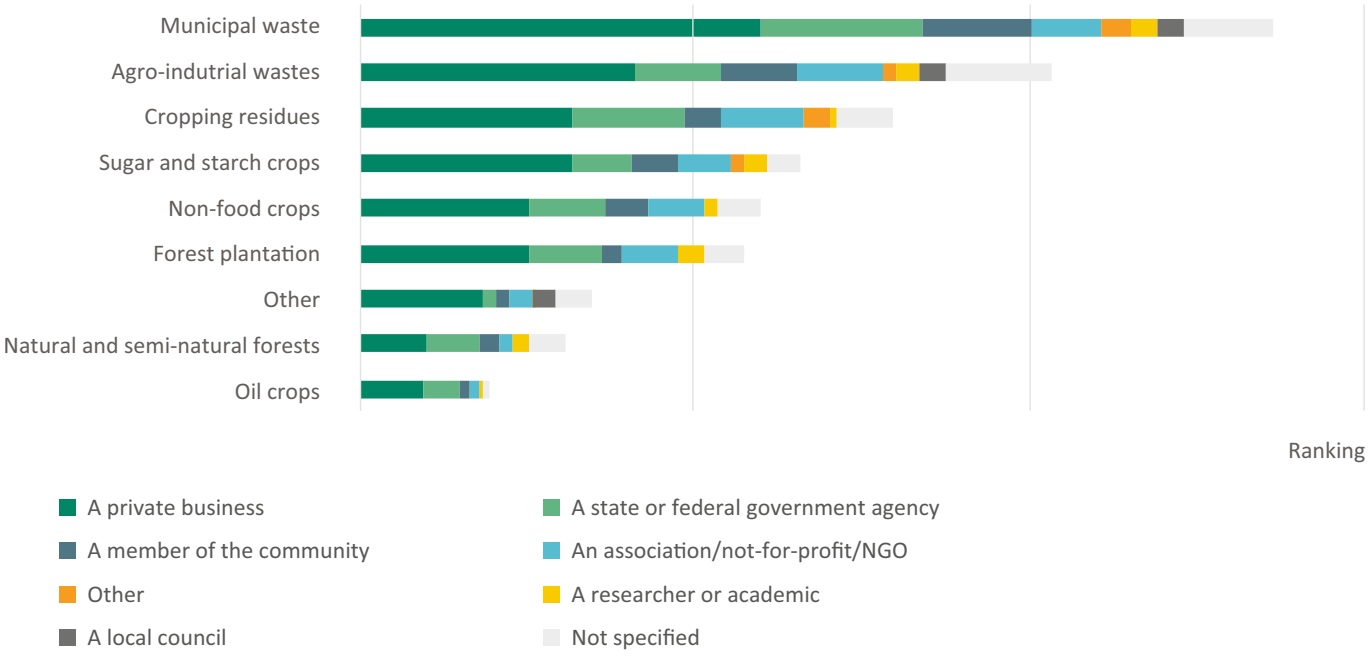
Similar to sector-specific survey groups, access to feedstock was ranked, by far, the biggest strength of Australia's bioenergy industry, followed by technology maturity. Interestingly, social licence was considered the third-biggest strength, primarily by private business participants.

Figure 9 – Biggest strength of Australia's Bioenergy sector (General public survey)



Respondents considered municipal waste the largest potential for bioenergy in Australia. This opinion was relatively consistent across the various stakeholder types. Agro-industrial wastes and cropping residues were ranked second and third, as resources that have a strong potential for Australia's bioenergy industry.

Figure 10 – Largest resource potential for Australia's Bioenergy industry



4. Review of stakeholder submissions

Bioenergy within the energy transition

Most stakeholder submissions agreed bioenergy could play a role in the energy transition. Stakeholders considered bioenergy has the potential to decarbonise a number of energy sectors, and may be critical to the decarbonisation of hard-to-abate sectors such as industrial heats and aviation, while also providing greater flexibility to transitioning markets, such as the electricity grid.

Some stakeholders considered bioenergy opportunities should be reviewed concurrently with other emerging technologies, such as hydrogen, noting that, "separate siloed reviews do not reveal the synergies or full extent of the opportunities that can emerge [1]." Stakeholders provided examples of the potential to use bioenergy both as a direct energy source, or for conversion into hydrogen, including:

- Nissan is developing a fuel cell electric vehicle that uses bioethanol as the source of hydrogen. The electricity is generated by a solid oxide fuel cell system in which hydrogen is produced from bioethanol, stored in the vehicle's fuel tank, processed through a reformer and then reacted with atmospheric oxygen to produce electricity to charge the car's battery [2].
- Chemergy's HyBrTec technology, which produces renewable hydrogen from organic biowaste. The technology is currently in early stages of demonstration [3].

Due to the wide range of potential energy fuels and mixing of feedstocks, it was suggested that carbon-14 testing (also known as radiocarbon dating) be conducted. This would be able to reliably quantify the content of carbon dioxide emissions of fuels and determine whether the energy product is biomass-based, fossil fuel-derived, or a combination [4].

Markets and case studies

A significant number of stakeholders commented on the potential for bioenergy in a number of different sectors, predominantly fuel, gas (i.e. pipeline or industrial processes) and power generation. They placed importance on the fact that the opportunity for bioenergy spanned numerous potential markets.

Stakeholders identified the opportunity for bioenergy as a component of fuel in petroleum and diesel-based internal combustion engines (ICEs) to decarbonise road transportation, freight, shipping and even aviation (known as biojet or sustainable aviation fuel (SAF)). Stakeholders submitted a number of global and local examples where biofuel is already being used in transport and aviation:

- The Indy High BTU facility is the largest green gas project in Indiana, which powers United Parvel Service (UPS) fleets across the Upper Midwestern United States. The project converts landfill methane into around eight million gallons of biomethane ("green gas") each year, which is further converted into biofuel in the form of Liquified Natural Gas (LNG). The project is one of 113 facilities currently operating across North America lowering waste to create renewable gas for products, including transport fuels. Other examples of municipal fleets that use biofuels across the United States include Washington DC, New York and New Orleans. In Europe, examples include waste to biofueled garbage trucks in Berlin, buses and trucks in Helsinki, the municipal fleet in Kristianstad in Sweden, buses in Southern England and Bristol city, and Tesco delivery vehicles in the United Kingdom [5].
- In 2016 bp started commercial supply of SAF at Norway's Oslo airport. bp's SAF has been supplied at 16 airports worldwide across three continents – including in Norway, Sweden, France and in the US. Statistics show that by May 2020, over 240,000 commercial flights had been made on sustainable aviation fuel [6].
- In Australia, a biojet trial was conducted by Virgin Airlines in conjunction with Caltex and Gevo, which was able to utilise existing supply infrastructure to deliver biojet into a wing at Brisbane Airport via the Lytton refinery, the Joint User Hydrant Installation at Brisbane Airport and associated pipelines [7].

Stakeholders noted that bioenergy for use in transport has had the most significant uptake in the United States and Brazil, accounting for 70% of the total amount of biofuels produced globally. One stakeholder submission attributed the successful integration of bioethanol into Brazil's transportation fuels to affordable ethanol prices, established fuel specifications, accessible ethanol-blended fuel bowsers at petrol stations, and progressive sales of flex-fuel vehicles [2].

Stakeholders also commented on the opportunity for bioenergy in heat and power generation, noting that these markets have proven technology and mature commercial markets in other countries. Biomass in heat and power generation can be developed either via new dedicated facilities or used as an auxiliary fuel in existing fossil fuel generation facilities, such as co-firing of biomass in existing coal-fired power generators. For example, stakeholders noted that woody biomass can be blended with coals at a rate of between 5% and 15% of the total energy input and then directly co-fired in a coal-fired boiler, with only minor modifications in design and operational parameters. Moreover, firing 100% of biomass in pulverised coal-fired plants is feasible for high-quality wood pellets and is practiced in England's Drax Power Station [8].

Bagasse is the fibrous residue remaining after the juice of the sugarcane is extracted. According to the Australian Sugar Milling Council, Queensland sugar mills already generate 900,000 MWh of renewable energy from bagasse, of which 425,000 MWh is excess to internal processes and is exported to the national electricity grid [9]. The Mackay Renewable Bio-commodities Pilot Plant (MRBPP), located at Racecourse Mill, is a 38 MW co-generation plant using bagasse. Bagasse fuels Mackay Sugar's factory boilers and enables sufficient production of renewable energy to be completely energy self-sufficient across operations. Excess energy generated from this process is provided back to the national electricity grid. Mackay Sugar is working to introduce additional revenue streams into the business by improving the efficiency in the use of bagasse and molasses – both valuable by-products of the sugar milling process [10]. However, it has been noted that there is a number of barriers for farmers wishing to export bioenergy power into the electricity grid, namely limited network infrastructure and lack of transparency regarding feed-in tariffs.

It was also noted that, although there was a strong opportunity for biogas injection into the gas network, as of 2019, none of the biogas plants in Australia injected gas directly into the gas grid. Due to the lower level of methane content in biogas (~60%), as compared to natural gas (94%-97%), technology is required to upgrade biogas for it to be suitable for grid injection. It was noted that this technology does exist and is currently used overseas. However, is not used domestically [11].

Stakeholders also noted the potential for bioenergy pathways to decarbonise the steelmaking industry. This included the use of biochar or waste plastic to replace coal, as well as the conversion of process gases (Linz Donowitz Gas) into biofuel/chemicals. However, it was noted that these technologies are still in development [11].

In addition to the sector opportunities within Australia, some stakeholders commented that recognition should be given to export market opportunities, particularly while the local market develops. For example, countries that are using biomass to meet decarbonisation targets, such as Japan, where biomass is being co-fired in coal-fired power generators, could provide a potential overseas market for Australian biomass. However, some stakeholders questioned the potential for export of biomass, given the proposed COAG ban on waste exports as well as the cost of transport.

Although stakeholders identified a multitude of market opportunities, many agreed that there were a number of barriers facing further development of the bioenergy sectors in Australia. Key challenges include financial risk and uncertainties due to the current global health and political environment. Stakeholders also considered that Australia was behind other nations in bioenergy development due to poor commercial factors, particularly the high cost of inputs (including labour and electricity) and insecure supply of biomass feedstocks, which make it hard for investors to prioritise projects in Australia when comparing against a global market.

Feedstock and supply chains

Stakeholders identified a wide range of feedstocks that can support the supply of biomass to the bioenergy sector. A key disagreement between stakeholders was the potential use of native forests as a biomass. A submission from the Roundtable on Sustainable Biomaterials (RSB) encouraged ARENA to undertake a national feedstock assessment to determine what feedstocks are most viable and sustainable in different regions of Australia. The organisation considered that an assessment should also consider economic and social benefits within the context of climate change trajectories and suggested an assessment of feedstocks should be based on a set of principles aligned with RSB's twelve principles.[1]

[1.] The twelve principles cover: 1) Legality; 2) Planning, monitoring and continuous improvement ; 3) Greenhouse gas emissions ; 4) Human and labour rights ; 5) Rural and social development ; 6) Local food security ; 7) Conservation ; 8) Soil ; 9) Water ; 10) Air Quality; 11) Use of technology, inputs and management of waste; 12) Land rights.

Another submission, received from a business that has previously received ARENA's Australian Biofuels Investment Readiness Program funding, noted that in order to compete with conventional fuels, bioenergy supply chains must be able to access low-cost feedstocks and extract value from co-products [11].

Many stakeholders considered waste products a primary source for biomass feedstock, particularly municipal solid waste (MSW). Stakeholders considered wastes a cost effective and readily available feedstock that can support carbon reduction and have minimal indirect land use change (ILUC) impact. Stakeholder submissions noted that this should include waste book oil and end-of-life plastics [6].

There are many pathways for waste feedstock, but most submissions commenting on waste focussed on the development of Waste to Energy (WtE) generation. However, there were also several submissions noting the development of technology to process waste into biofuels. One stakeholder noted that there is still significant opportunity for bioenergy from landfill.

The key challenges for waste feedstocks included:

- Current contamination of waste types, noting that separation of materials at the point of generation is critical for optimal recovery of waste
- Unfavourable contract terms where municipal councils typically contract waste disposal over 3 to 5-year terms, while bioenergy projects need 15 to 20-year terms in order to be commercially viable. This is combined with difficulties in aligning multiple contracts with councils to order aggregate enough feedstock volume. A stakeholder noted that councils "are reluctant to be exposed to waste volume or composition risk and want to retain flexibility to increase waste diversion targets without being locked into a put-or-pay contract" [12].

In addition to municipal wastes, agricultural residue was identified as a major source of biomass. Most notably, stakeholders commented on the sugar mill industry and its potential to expand. Stakeholders noted that sugar mills utilise their waste streams to produce bagasse, which can be used to generate electricity and steam. Stakeholders also noted the potential to use molasses for biofuels. The Australian Sugar Milling Council noted that Queensland sugar mills:

- Generate 900,000 MWh of renewable energy from bagasse per annum
- Produce 60 ML of bioethanol from molasses per annum.

The Australian Sugar Milling Council suggested that, under the right commercial and policy settings, this could be expanded to:

- Generate 2,860,000 MWh of renewable energy from bagasse per annum
- Produce 216 ML of bioethanol from molasses per annum.

Stakeholders also suggested the potential to produce bioenergy crops, such as sugarcane and corn maize. This was particularly suggested for currently large unproductive lands across Australia (such as Northern Territory and Western Australia). However, it was suggested by a stakeholder that currently underutilised lands that could not support conventional agriculture or forestry should not be considered as viable land for bioenergy crops. It was noted that while the opportunity cost of the land may be low, the impact on yield due to poor conditions would be reflected in higher costs of production [11].

Several stakeholder submissions were not supportive of the use of native forests for forest-derived biomass (e.g. burning of native forest for heat), noting that this would be a threat to native species and would have high CO_2 emissions. Stakeholders indicated that burning forest-derived biomass is higher emissions intensity than existing coal generation, and that the carbon is not recaptured within critical timelines. These stakeholders proposed that native forests should not be considered a viable feedstock for the bioenergy roadmap [13]. This included a petition from the Nature Conservation Council signed by 6,266 members of the community as well as a submission supported by over 80 organisations and activist groups.

However, some stakeholders commented on the potential for non-native forestry biomass. Stakeholders noted the potential for pellets, for example turning sawmill waste into pellets, which can be used on-site or in the network as a form of Distributed Energy Resources (DER) [11]. Stakeholders suggested that this Roadmap should consider the Australian Government's 1 billion trees initiative, which provides an opportunity for integration of bioenergy with an expanded plantation industry for long-term feedstock supply [11]. Another suggestion was to use forest trimmings, for example canopy and undergrowth thinning, which is needed for bushfire management [1].

Other non-native sources of woody biomass were identified by stakeholders, including bamboo and the Pongamia legume tree. It was noted that Pongamia has historically been assessed to be economically viable. However, the emergence of a new by-product of Pongamia, a plant-based high-protein meal supplement, has made the production of Pongamia biomass commercially viable. Agripath Pty Ltd suggested that the by-product can cover most of the cost of Pongamia production, such that a biofuel could be produced for less than the cost of diesel.

Some stakeholders also suggested there is a role for algae in Australia's bioenergy industry. The University of Technology Sydney noted that microalgae are fast-growing plant-like cells that grow in fresh and marine waters. The use of algal-based biomass could be used to convert bioenergy in the form of biodiesel, biomethane and bioethanol [14].

Stakeholders suggested a variety of processes to convert biomass into various forms of energy, including both traditional methods as well as various novel developments. With respect to mature technologies, stakeholders mostly focused on:

- Anaerobic digestion and co-digestion, which was suggested to have recently received significant traction in Australian agricultural industries as well as potential in wastewater treatment and treatment of food-only waste collections
- Burning, including co-firing in furnaces or waste-to-energy plants.

New development processes included technologies such as 'fast pyrolysis' and various combinations or enhancements on mature technologies. These submissions were primarily confidential proprietary technologies and therefore are not detailed here.

It was noted a major impediment to projects in Australia is the cost of input for processing. Particularly cost of labour, electricity and natural gas, which made project economics in Australia unfavourable compared to international opportunities. Higher labour costs also translate to significantly higher capital costs of projects. While there were limited suggestions on how costs could be reduced (aside from policy intervention), stakeholders did suggest that by-products could significantly improve project commercial viability. In particular, biochar (a by-product of processing biomass), which is gaining market size for a number of industries, such as [15]:

- Agriculture and land management (including for soil revegetation, compost and fertiliser)
- Water (including wastewater and stormwater) for filtration, treatment and erosion control
- Built environment
- Air and environmental management
- Biomaterials and advanced manufacturing (including hard-to-abate industries such as steel making).

In addition to cost, one of the major challenges proposed by stakeholders was scaling-up of production. It was noted that economies of scale would be critical to making the development of a bioenergy industry feasible. Stakeholders commented that while ample sources of feedstock exist, the issue lies at aggregation and distribution, noting that there is no organised distribution system. Moreover, many feedstocks may be seasonal and therefore securing a reliable feedstock source year-round can be challenging.

Many stakeholders also noted that the type of feedstocks available, production systems and end-markets are unique to each region. Therefore, the optimal pathway needs to be assessed at the local level. Stakeholders proposed the development of bioenergy hubs or precincts to increase the attractiveness, benefits and synergies of co-locating producers and processors. Stakeholders suggested that the co-location of processing facilities at existing agriculture or manufacturing sites can help bioenergy production become financially feasible. This would assist in reducing the cost of transporting raw materials and can provide a 'quick-to-market' location to develop and foster technological innovation to commercialise bio-based products and co-products. Aurecon suggested that some of the key operational elements for selecting suitable sites include [16]:

- Land lease area sufficient for entire proposed integrated facility
- Licence to operate for relevant ERA's (Environmentally Relevant Activity)
- Steam for processing heat and energy
- Electrical power
- Water for process, cooling and amenities
- Effluent treatment systems
- Highway road access
- Fibre optic data connection
- Access to agricultural feedstocks for bio refining and co-product production
- Access to process chemicals for production and maintenance tasks
- Proximity to logistics chain for cost-effective feedstock and process chemical supply
- Proximity to logistics chain for product transport, skilled staff, labour and equipment suppliers
- Access to a cargo port for export sales.

It was also noted that different regions would have different comparative advantages. For example, regional areas would have stronger economic potential for forestry and agricultural biomass, while urban areas would have greater access to industrial and municipal waste as a feedstock.

Stakeholders also commented on the lack of reliable feedstock data as a challenge to the industry. Stakeholders suggested information technology should be enhanced to support both industry supply chain connectivity as well as policy-making. One stakeholder submission provided a unique digital solution to the aggregation of feedstocks with industrial producers. The stakeholder has developed a suite of modular process-control systems, named GrowLinkTM¬, that helps physically link industrial businesses with independent businesses. Their technology is aimed at integrating three traditionally separated industries (waste, energy and growing) to offer optimum resource connectivity and support development of a circular economy [11].

Global policy

Stakeholders submitted a range of policies that have supported bioenergy markets overseas, with the most mature policy frameworks evidenced in America and Europe. A number of targets, mandates and credit schemes were identified by stakeholders, including:

- Renewable energy targets which also include renewable fuel targets, such as:
  - California's Low Carbon Fuel Standard ("LCFS"), which is reported to be so effective that feedstocks are sourced from Australia for USA biofuels [17]
  - United States' Renewable Fuel Standard (RFS), which has resulted in every litre of petrol, on average, comprising 10% ethanol in the USA
  - The European Union Renewable Energy Directive (RED) mandates that 20% of all energy usage (including 10% of all energy in road transport fuels) be produced from renewable sources by 2020
  - The United Kingdom's Renewable Transport Fuel Obligation, initially a requirement on transport fuel suppliers to ensure that 12.4 per cent of all road vehicle fuel is supplied from sustainable renewable sources by 2032.

- Bioenergy specific targets and mandates, such as:
  - The Netherlands Air Force has a target of 70% biofuels in their fuel mixture by 2050 with 20% by 2030 [17]
  - The United States' 'Green Fleet' Initiative to source 50 per cent of Defence Force fuel from biofuels in 2016
  - The Canadian Renewable Fuel strategy of 2007 introduced 5% and 2% national biofuels mandates based on, respectively, volume for gasoline and diesel fuel, and heating distillate oil [2].
- Feed-in-tariff (FIT) schemes
  - Japan's FIT regime for renewable energy was introduced in 2012, requiring power utility operators to purchase power from renewable sources, including biomass
  - The United Kingdom's Renewable Heat Incentive Scheme.

In addition to targets and credit schemes, stakeholders considered whether the establishment of a renewable energy Guarantee of Origin (GO) was successful in Europe. Stakeholders reported that supply and demand for renewable GO units more than doubled between 2010 and 2018, and there was increasing demand for bioenergy and clean hydrogen GOs with the request to establish a harmonized European gas GO market [11].

Australian policy

Stakeholders resoundingly agreed that stable and coherent policy is required in order to support the development of a bioenergy industry in Australia. Stakeholders commented that, due to the financial risk involved, long-term stability is needed to encourage investment until the industry can become commercially self-sufficient. Stakeholders noted greater coherency is required between states and supported the development of national policies to ensure consistency across Australia. Stakeholders also considered that policy should be consistent with international frameworks and standards to enable use and benefit in both domestic and international markets.

Complex planning approval processes and regulations, which vary across states, have been identified as a major deterrent for a number of projects. Examples provided by stakeholders include:

- For any bioenergy project exceeding 1MW in size in Victoria, there are more than 12 referral authorities to consider. Moreover, following planning approval from the local authority, projects can be referred to the Victorian Civil and Administrative Tribunal (VCAT) by any member of the public even if they do not hold any regulatory responsibility within that region. This has proved to be a major barrier to specific bioenergy developments in Victoria [11].
- Queensland's Environmental Protection Regulation 2008 (EP Reg) introduced a licence requirement for anaerobic digestion which requires farms seeking to import organic wastes to replenish biomass feedstocks when on-farm wastes are low to obtain appropriate licencing for an 'Environmentally Relevant Activity'. This triggers a number of local government planning mechanisms including a Development Approval and a Material Change of Use [18].
- New South Wales IPART's treatment of new revenue streams such as gate fees from organic waste is considered to be unclear and other water authorities see it as an unregulated service [11].

In additional to complex planning approval processes, stakeholders suggested one of the impediments to securing support from public funding and financing programs (such as ARENA and CEFC as well as state-run programs) can be the requirement for projects to have a significant level of Board commitment, including through funding for the project to progress. It was suggested that the application process be simplified as much as possible, and allow for a conditional pre-approval of funds to assist projects in receiving endorsement and commitment from executives with increased confidence that the conditional support would be available [7].

Stakeholders also commented on the limitations of the federal renewable energy target (RET), submitting that:

- The scheme was not tailored to the available range of technologies and strongly favoured wind and solar electricity generation.
- The RET had the impact of directing biogas into electricity generation, rather than being seen as a key opportunity to decarbonise the gas network.
- Encourages use of biomass for electricity generation rather than for heat, which may not always be the most effective mitigation of emissions.
- Large-scale Generation Certificate prices are expected to remain at historic lows now that the target is largely met, resulting in little incentive for new developers.

Many stakeholders suggested that the RET be extended out further and include other sectors, including fuel and heat.

Similar to the RET, stakeholders also suggested that the Emissions Reduction Fund (ERF) was limited as it does not recognise emissions reduction from biogas injected into the grid. Stakeholders suggested changes to some ERF methods to allow recognition of the deemed destruction of captured methane at the point of capture and injection to the pipeline so as to allow the crediting of ACCUs at that point [11].

Stakeholders also suggested that existing biofuel mandates in Queensland and New South Wales have not been effective in incentivising biofuel uptake. For example, sale of biofuel blended fuels peaked at ~4% in New South Wales in 2012 and has steadily declined to ~2% since [7]. Stakeholders noted that this failure could be attributed to:

- the limited number of biodiesel and ethanol producers, suggesting that in Queensland, fuel service station sites only offer E10 at half their refuelling positions, on average
- a lack of customer uptake of the products (including due to lack of education of consumers)
- the federal excise concession settings, which have limited the importation of alternate ethanol or biodiesel products
- the limited potential to divert feedstock from food-to-fuel value chains, for example wheat being diverted for use as ethanol feedstock [6].

One stakeholder considered that mandates have the practical effect of creating a market to further entrench existing market participants' control while creating barriers to entry for new participants. Since the establishment of the New South Wales Biofuels Mandate, which has been in effect since 2007, no new market entrants have come forward to take advantage of the market assurances provided by the mandate [7].

Stakeholders also considered that the current federal fuel excise was limited. Currently, ethanol and biodiesel can currently claim a lower rate of excise compared to hydrocarbon-based transport fuels, such as gasoline and diesel products. However, stakeholders noted that the current definition of biodiesel, for the purposes of excise calculation, is too restrictive as 'manufactured through the esterification of plants and animal fats'. It was suggested that this limits access by biofuels which are not based on tallow or oil feedstocks such as used cooking oil.

Some stakeholders disagreed with the treatment of landfill in the waste hierarchy policy. Some stakeholders considered that there should be higher landfill taxes or bans on certain types of waste streams (such as recycled materials) [11]. However, other stakeholders considered that the placement of landfill at the bottom of the waste hierarchy does not support bioenergy from Municipal Solid Waste [11]. This divergence in view is likely due to the competing demands for waste between businesses developing Waste to Energy plants and businesses operating landfill biogas plants.

Roadmap actions

Stakeholders touched on a range of actions that the Roadmap should consider in order to effectively develop the Australian bioenergy industry. This includes consideration of other roadmaps and strategies, changes to planning and regulations, extending existing policies and establishing new policies, and increased education and collaboration. Stakeholders considered that the Roadmap should spell out how bioenergy can contribute to renewable resource use and greenhouse gas abatement across the economy [11].

Stakeholders also commented that the Roadmap needs to be aligned with a broader strategy towards a resilient energy future [19]. Stakeholders wanted to understand the relationship between this Roadmap and other roadmaps, including the Federal Government's recently released Technology Investment Roadmap [11]. Stakeholders considered that a national circular economy policy would also help development of waste biomass [6]. Stakeholders suggested that bioenergy strategies in the agricultural sector should be consistent with other carbon policies particularly relating to soil carbon, noting that agricultural engagement in bioenergy should enhance, not detract from, improving soil [20]. It was suggested that the Roadmap should also incorporate the Federal Government's forest industry hub approach, which generate large feedstocks of materials suitable for bioenergy and renewable heat. As both producers and potential users of bioenergy, collaboration can occur within these hubs to increase the availability of biomaterials and increase commercial viability [21].

Stakeholders suggested improvements to existing planning and environmental regulations, namely that the planning system should be streamlined to encourage investment and is consistent with the policy framework and across states [11].

Stakeholders considered that a central feedstock plan should be developed that can be used by all levels of government which identifies and promotes regional bioenergy hubs and addresses municipal solid waste policies. For example, it was proposed that the landfill levy be nationally harmonised to decrease the export of waste material across state and territory boundaries [11]. However, views varied with regards to the treatment of landfill in waste policy; some stakeholders considered that landfill levies should be increased and there should be an acceleration of the closure of landfills that are not properly engineered (such as unlined landfills) [11]. It was noted that landfill which is used to produce bioenergy should be considered under the energy recovery section of the waste hierarchy (and should not be placed in the least-preferred section) [11].

Stakeholders recognised the importance of education and awareness in the development of a bioenergy industry. Educational efforts should be aimed at all parts of the economy, including industry players, policy and decision makers, as well as consumers. Education was considered important in order to strengthen industry knowledge, improve feedstock output dependent on residents, and establish social licence and consumer interest:

- Sharing of industry knowledge was raised as a key facet of industry development, including the importance of industry and research collaboration. Stakeholders suggested a knowledge repository is developed in order to share lessons learned (both domestically as well as international experience) in order to accelerate understanding in the market [19]
- Stakeholders also noted that education of smaller industry players (such as farmers) was important
- Stakeholders also suggested that clear definitions of terms and classifications in relation to the bioenergy industry are established in order to provide certainty [19]
- In addition to clear definitions, it was suggested that standardised methodologies are adopted to assist in producing reliable and repeatable results for industry players [22]
- With regard to wastes, stakeholders noted that education is vital to ensure separation of waste occurs early on, which can ensure cleanliness of the biomass feedstock
- To support the uptake of biofuels, stakeholders suggested increased education to both motorists and automotive sales staff regarding the compatibility of biofuels in vehicles, as well as the benefits that biofuels can bring [11].

Stakeholders advocated for increased financial support, such as funding from ARENA or concessional financing from CEFC, as well as grants as part of a post Covid-19 economic stimulus package. Stakeholders supported funding particularly for innovation and demonstration projects which may find it difficult to secure financial support, which can result in the publication of business cases and case studies for broader industry sharing [11]. It was also suggested that processes and guidelines be reviewed to allow for a pre-approvals process to assist businesses assessing new projects and committing capital [7].

A myriad of policy suggestions was provided by stakeholders through their submissions. These included:

- Extension of the RET and ERF, both in terms of timeframes as well as scope to include heat and transport sectors, or introduction of new targets for those sectors not currently captured in the RET, such as [23]:
  - Clean Fuels Target
  - Renewable Heat Target
  - Green Gas Target
  - Net Zero Organic to Landfill Target
  - ERF/CSF Jobs Target
- Establishment of green credit schemes such as renewable gas or gas-powered electricity certificate scheme, feed-in-tariffs or nutrient credit schemes. A feed-in-tariff mechanism that provides compensation where bioenergy plants provide positive system Strength and Frequency support on the NEM was also suggested [1].
- A guaranteed off-take scheme for feedstocks [11].
- A range of schemes and reforms aimed at putting biogas injected into the pipeline on a level playing field to other bioenergy markets:
  - Development of a traceability mechanism, such as a national Guarantee of Origin scheme, to verify the volume of biomethane injected into the grid for customers [24, 11].
  - Review of the ERF policy to allow ACCUs to be issued at the point of injection into gas grid rather than combustion (which requires each customer to undertake individually and is generally a barrier for pipeline biogas to compete with other markets) [11].
  - Recognition of biomethane injection in the National Greenhouse and Energy Reporting framework [24].
  - Implement a 'gas swap model' [25].

- Although the existing biofuel mandates in New South Wales and Queensland were viewed as unsuccessful by some stakeholders (such as Caltex and bp), other stakeholders still considered a national biofuels mandate should be established to support the development of biofuels. Other mechanisms proposed to support biofuels include:
  - Fleet mandates for bio-fuelled heavy vehicles [26]
  - Regulating vehicle manufacturers to increase the placement of flex-fuel vehicles into the market (such as vehicles capable of using high-ethanol blends) [2, 11]
  - Tax reforms on fuels, such as a tax on biogas transport fuels that is no more than 50% of the tax on diesel/ petrol on an energy-equivalent basis [27]
  - Fuel domestically produced from an end-of-life plastic feedstock is treated as a renewable fuel and eligible for reduced excise rates, similar to the treatment of biodiesel and ethanol [6]

In addition to suggesting a range of policies to support the bioenergy industry, stakeholders considered principles upon which policy and regulation should be developed, including:

- Technology neutrality to enable a range of technology pathways to develop and to provide level playing field for all sectors, industries and technologies
- Innovative and sustainable development, so that support provided assists industry development and innovation without creating a long-term dependency on policy or subsidisation
- Market-based policies that provide flexible market mechanisms and outcome-based regulation
- Environmental sustainability and circularity, so that environmental and social outcomes are considered throughout the value chain and a circular economy, which effectively designs-out waste
- Consistency with industry-backed standards, in line with international expertise and insights [22]
- Stakeholders suggested improvements in infrastructure required to support bioenergy markets. This includes upgrading network interconnections, particularly to regional areas and farms where there is currently strong competition for network capacity, especially in areas where solar farms have been established. (Australian Sugar Milling Council) Stakeholders considered there was a strong opportunity for bioenergy hubs in which a number of feedstocks are located in close proximity to users. It was noted that anchor stakeholders may provide in-kind infrastructure, such as a bio precinct (e.g. road, rail, electricity and water). Co-investment with industry (public-private partnerships) may assist to achieve an agreed investment payback period or lease of facilities arrangements [16].

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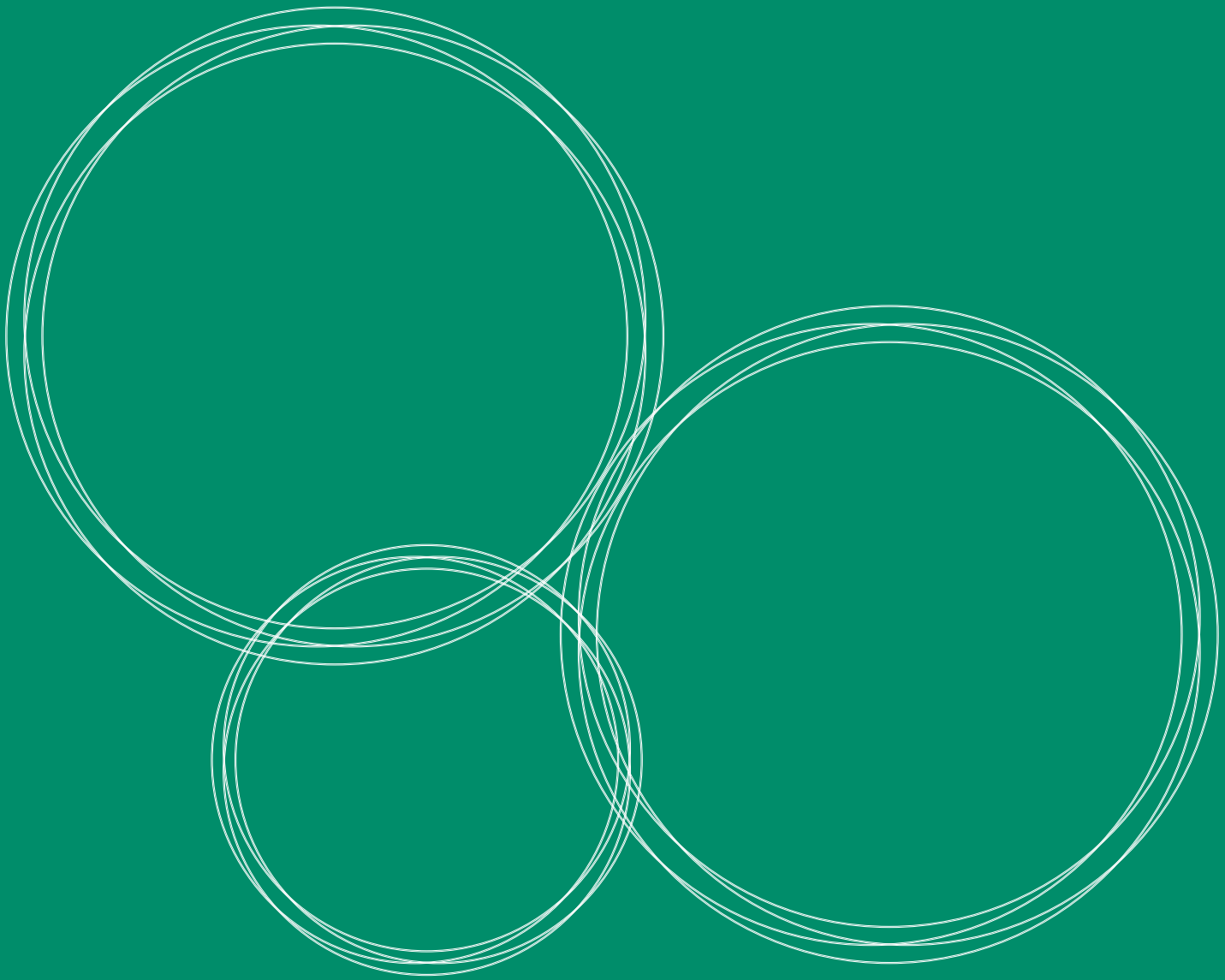

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