

Bioenergy in Australia's Circular Economy

Our overlooked renewable
energy opportunity

Version 1.0 2021



Bioenergy and bioproducts – renewable energy and material generated from organic waste – can accelerate Australia to a carbon neutral 2050. But we haven't even begun to realise bioenergy's potential here.

Anything we make out of fossil fuels we can make out of bioenergy. Bioenergy is an energy made from renewable sources like plants, animals and their by-products and residues. Bioplastics, biofibres, bio-oils and biomaterials are other useful outputs. The process of converting organic waste to energy is proven, and in use, here and around the world.

Bioenergy accounts for one tenth of the world's total primary energy, and its share is growing. In Australia, it accounts for just 0.9 per cent of our electricity output. Yet, the resources we need to make it are abundant.

The Australian Renewable Energy Agency's (ARENA) Australia's BioEnergy Roadmap (November 2021) estimates that, by the start of the next decade, the country's bioenergy sector could:

- Contribute about \$10 billion in extra GDP per annum
- Provide 26,200 new jobs
- Reduce emissions by about nine per cent,
- Divert an extra six per cent of waste from landfill
- Enhance fuel security.

Here we present the case for how Bioenergy could become a key pillar of Australia's circular economy of the future. We show the way forward for Australia to realise the immense opportunities in bioenergy other countries are already taking advantage of.

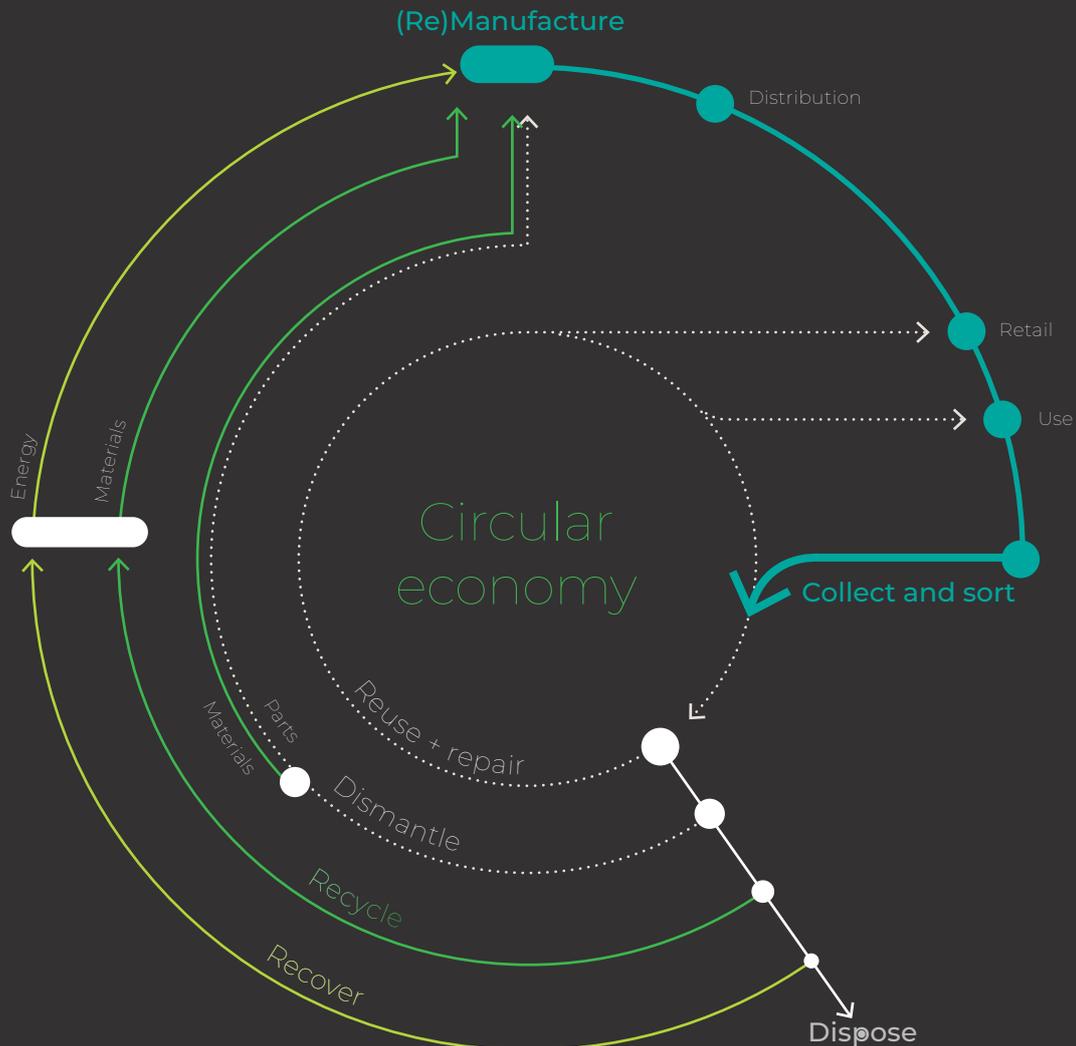
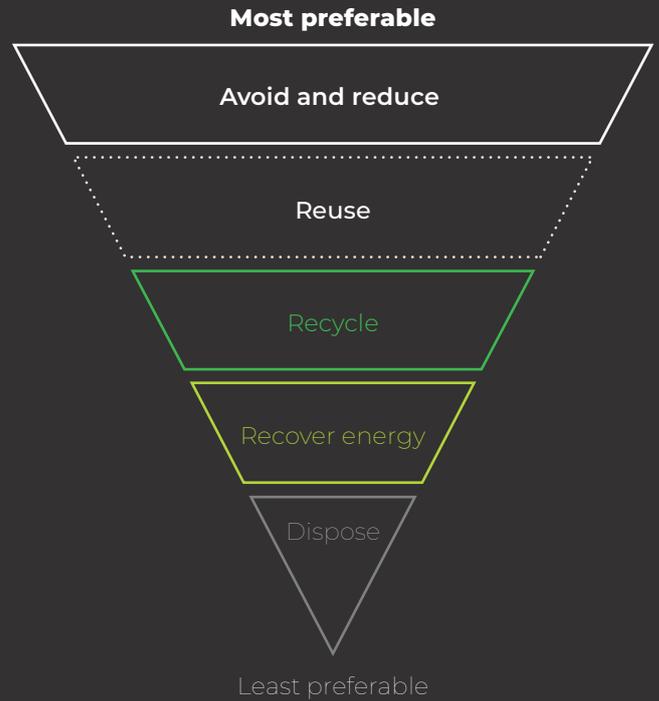
Bioenergy can support Australia's energy transition, help address greenhouse gas emissions and climate change, and reduce waste to landfill. It can give rise to a thriving new economic sector, bringing jobs and industry to Australia's regions and rural communities.

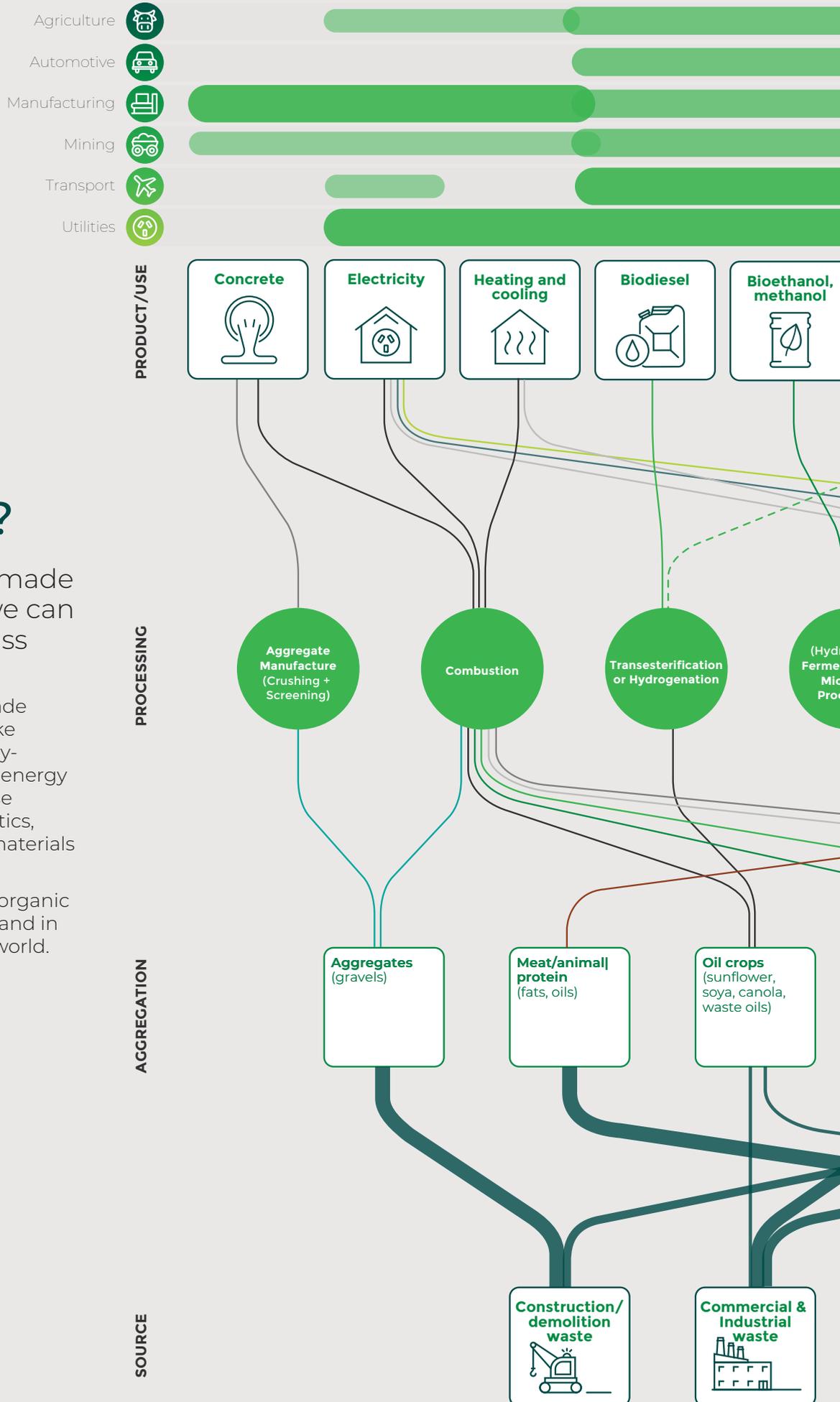
Bioenergy is Australia's overlooked renewable energy opportunity.

Circular economy thinking — re-using existing materials and avoiding waste — will benefit all of society, reduce business costs and our impact on the planet.

Bioenergy production is based on these principles. It solves reducing landfill waste and carbon emissions, and it creates much-needed renewable energy. It has the potential to be a significant part of Australia's future circular economy.

Waste hierarchy





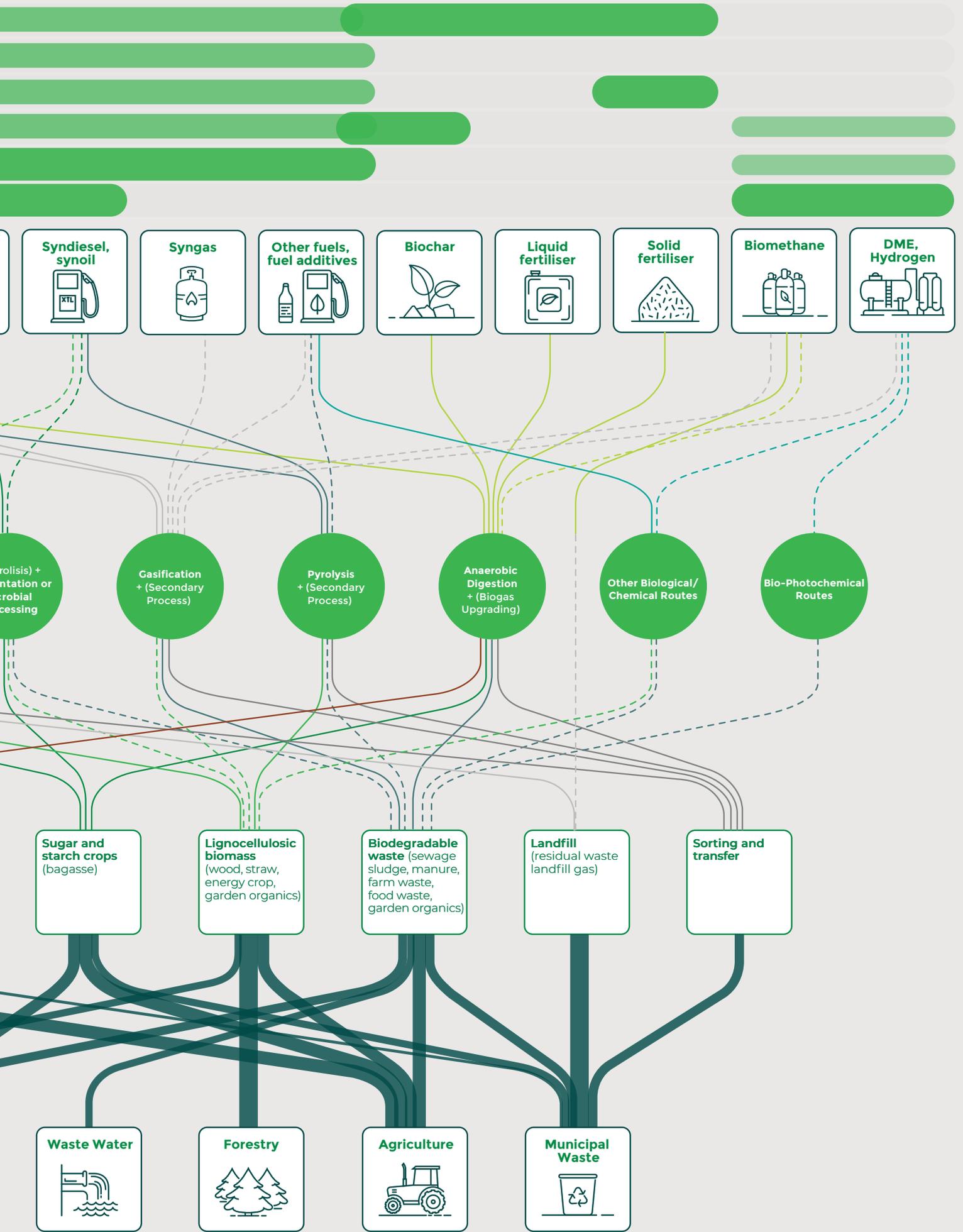
What is bioenergy?

Anything we have made out of fossil fuels, we can make out of biomass and bioenergy.

Bioenergy is an energy made from renewable sources like plants, animals and their by-products and residues. Bioenergy is one of the products these sources can make. Bioplastics, biofibres, bio-oils and biomaterials are other useful outputs.

The process of converting organic waste to energy is proven, and in use, here and around the world.

Schematic view of the variety of commercial (solid)



Solid lines) and developing bioenergy routes (dotted lines) from biomass feedstocks through thermochemical.

A net zero carbon emissions future for Australia, and the world

As traditional coal and oil consumption decrease, we'll see a mix of bioenergy, solar, wind, hydropower, and other renewables come to the forefront of energy supply.

Bioenergy makes sense, today more than ever. It's the only renewable source that can replace fossil fuels in all energy markets – heat, electricity and fuel for transport. Bioenergy, if sustainably produced, is a renewable and carbon neutral form of energy. And it provides stability as more volatile sources of energy are introduced.

Sustainable bioenergy is playing a key role in helping the European Union increase energy security and meet ambitious emissions reduction targets. Significant global investment is driving the development of biofuels to service the aviation, marine and heavy haulage sector. Bioenergy and bioproducts can be a significant growth sector for the Australian economy.

All around us: the ubiquitousness of this untapped, secure and sustainable energy supply

Biomass – the by-products of agricultural, food, forestry and waste industries – is all around us. And we are becoming better at understanding exactly where to find it, and in what quantity and quality.

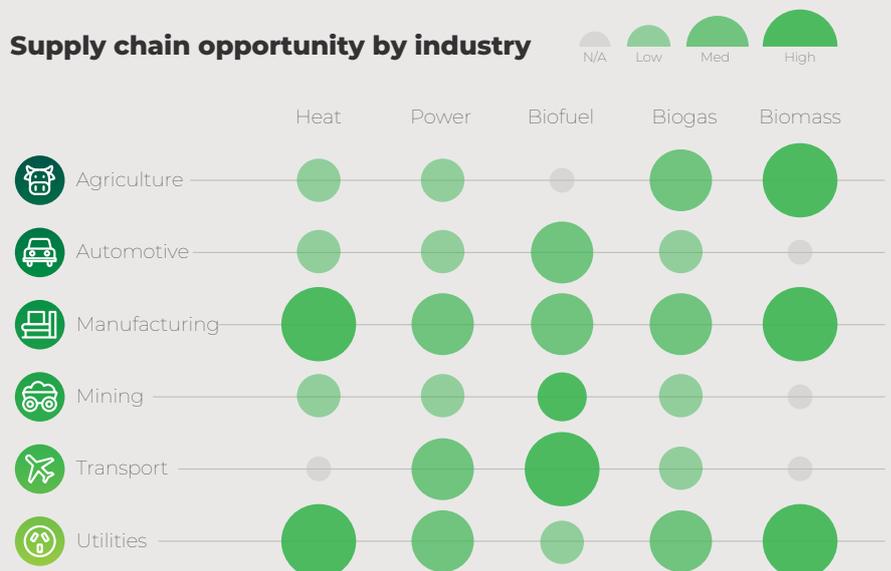
The Australian Biomass for Bioenergy Assessment (ABBA) 2015 – 2021 Project provides a national database of biomass resources for bioenergy. This interactive online map is available to project developers, policy makers and others to inform bioenergy project decision-making. The project will improve links between biomass suppliers and end users.

The Australian Renewable Energy Mapping Infrastructure Project (AREMI) is a central source for sharing mapping data and information with the renewable energy industry. CSIRO's Data61, Australia's Centre of Excellence in Information and Communication Technology Research and Development, is developing this platform. The project consolidates data housed by multiple organisations such as Geoscience Australia, the Bureau of Meteorology and CSIRO. AREMI makes it easier for renewable energy projects to get off the ground in Australia.

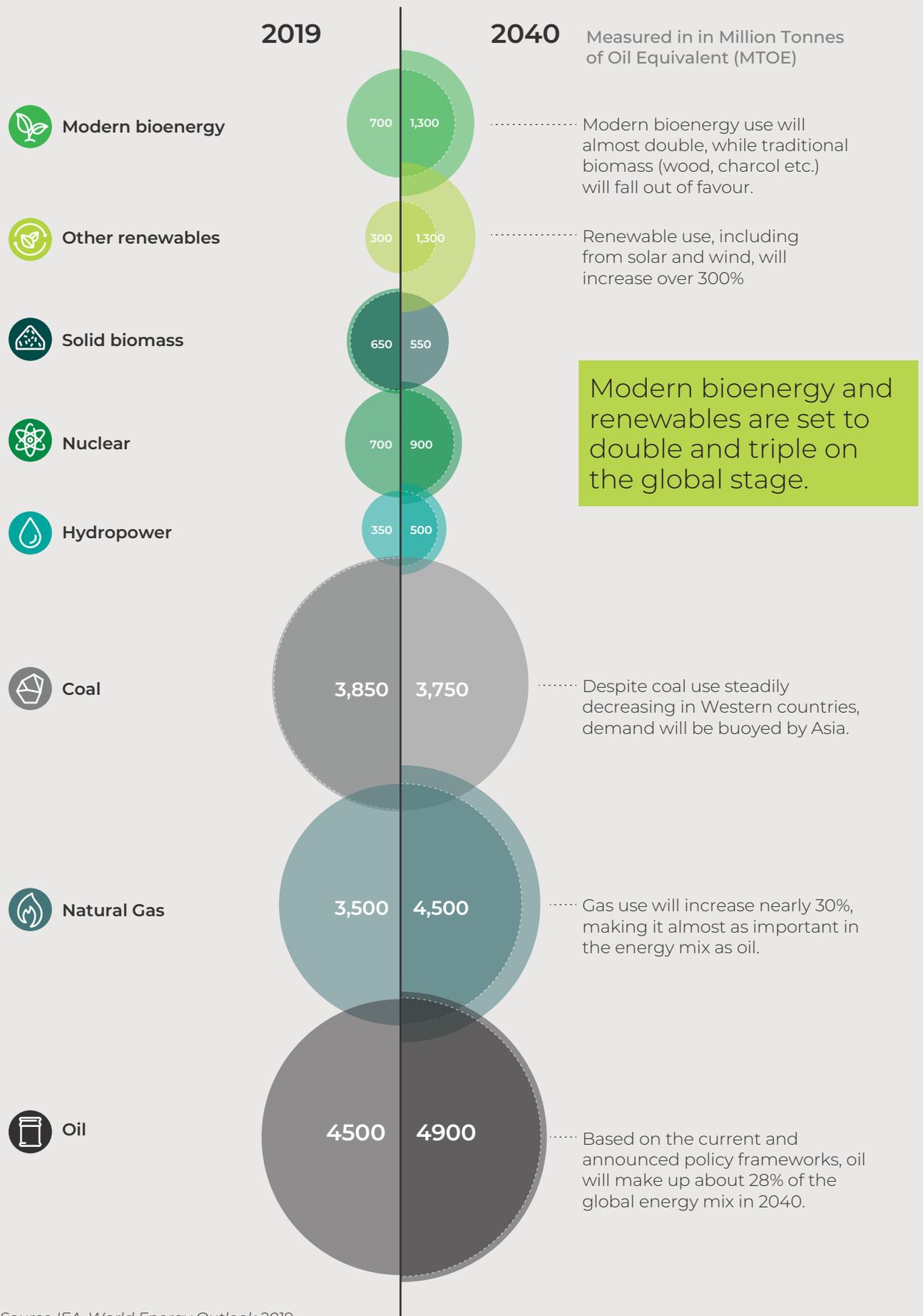
The Geological Survey of New South Wales has developed the **NSW Renewable Energy Map**, a state-wide renewable energy resource map, documenting resource potential and existing infrastructure for solar, wind, geothermal, bioenergy, hydro and ocean resources.

The major feedstocks for bioenergy are crop and forestry residues. These resources are abundant but underused. We can turn waste that currently creates harmful emissions, human health and environmental impacts into productive, versatile, storable energy. Easily integrated with our existing infrastructure, it would directly reduce methane emissions and waste to landfill.

Supply chain opportunity by industry



Changes in the Global Energy Mix 2018 vs Stated Policy 2040



Source IEA, World Energy Outlook 2019

Before our eyes: bioenergy will be integral to the global, rapid energy transformation

Governments worldwide are moving to more circular economies over the traditional linear models (make – use – dispose).

A circular economy is restorative and regenerative. It extracts the maximum value from resources, then recovers and regenerates products and materials at the end of their service life. Greater use of bioenergy, as part of a renewable energy mix, using proven and commercially-ready technology, has many benefits including a pathway to net zero carbon emissions(*):

1. Abatement potential

To limit global warming, we need to pull carbon out of the atmosphere. Bioenergy can help us meet the Paris Agreement goal of keeping the global average temperature increase “well below 2 degrees”, reaffirmed at the 2021 COP26 UN climate summit in Glasgow. ARENA's bioenergy roadmap estimates the bioenergy sector could reduce emissions by about nine percent, by 2030.

3. Employment

The development of a strong bioeconomy can provide skilled employment opportunities to regional areas. The International Renewable Energy Agency (IRENA) 2019 review shows global employment in the bioenergy sector had grown to 3.18 million jobs in 2018. ARENA's bioenergy roadmap estimates the bioenergy sector could contribute 26,200 jobs by 2030.

4. Competitive advantage

Achieved by firming of renewables, use of existing infrastructure, supporting multiple sectors, reducing emissions, driving investment in regional Australia and providing significant co-benefits.

5. Greater energy security

With the COVID-19 pandemic highlighting vulnerabilities in Australia's supply chains, the production of renewable energy from biomass can enhance national energy security. Biofuel production lessens reliance on imported oil and petroleum products, promoting energy security. Modelling for ARENA's bioenergy roadmap calculates bioenergy could provide up to 20 per cent of Australia's total energy consumption by the 2050s.

Keep 1.5 alive

COP26 resolved to strive to limit the temperature increase above pre-industrial levels to 1.5 degrees, with diplomats and activists issuing the rallying cry to 'keep 1.5 alive'. This is viewed as the threshold beyond which the effects of climate change become increasingly dangerous to people and ecosystems.

2. Economic opportunities

The Australian Clean Energy Finance Corporation estimates that bioenergy could attract at a minimum \$3.5-\$5 billion investment, mostly in regional economies. Infrastructure Partnerships Australia estimates the investment opportunity in energy-from-waste at \$8.2 to \$13.7 billion by 2030. ARENA's recent bioenergy roadmap estimates the bioenergy sector could contribute \$10 billion in extra GDP per annum by the start of the next decade.

Source: Bioenergy Australia submission – Technology Investment Roadmap June 2020

** Source: <https://www.abs.gov.au/statistics/environment/environmental-management/waste-account-australia-experimental-estimates/latest-release>

6. A flexible alternative to fossil fuels

The need to switch to fossil fuel-alternatives is pressing but hampered by the inflexibility of existing infrastructure and the asset life of vehicles, planes and marine assets. But biofuel is at an advantage. Unlike other fuel sources, bioenergy technologies can operate using existing infrastructure. This is an advantage over other solutions, such as electrification and hydrogen blending, that require infrastructure upgrades.

“The fossil fuel era is coming to an end, the energy transition is becoming the guiding principle worldwide.”

Svenja Schulze, German Environment Minister, 26th UN Climate Change Conference of the Parties, Glasgow 2021.

7. Reduced waste to landfill

Australia generated 75.8 million tonnes of solid waste in 2018-19, with 27 per cent going to landfill (20.5 million tonnes) (**), creating poor environmental outcomes, including large greenhouse gas emissions. Bioenergy is a commercially viable solution that can recover resources at their highest order use, diverting an extra six per cent of waste from landfill by 2030, according to ARENA's bioenergy roadmap.

Case Study

Werribee's waste revolution: Wyndham City Council's plan to turn rubbish into electricity



The Werribee tip on Melbourne's south-western fringe receives about 270,000 tonnes of landfill every year. Now, Wyndham City Council has a \$30 million plan to turn some of the waste collected into electricity. A new system will sort landfill on arrival. A waste-to-energy system will convert the green waste and leftover food that comes to the tip into electricity. A new sorting shed will divert 50 per cent of landfill. The residual waste will be baled and placed into landfill neatly. The council sees converting waste to energy as the only alternative at scale to landfill. Contractors at the tip already collect methane from the landfill and pipe it to a power station that provides electricity to about 6,000 homes in Wyndham. The Werribee proposal will be the first at a council-operated landfill in Victoria, but there are already organic waste-to-energy projects in Wollert, in Melbourne's north, Melton in the west, and a large project at Laverton, not far from Werribee, has the approval to go ahead.

* Source: Wyndham Council: <https://amp.abc.net.au/article/100632106>

The path forward

What's in the way: barriers to a bigger bioenergy sector

Australia lags other developed countries in the creation of a bioenergy sector.

Bioenergy as a proportion of total energy supply leaves us in the bottom quartile of Organisation for Economic Co-operation and Development countries. This is due to financial, regulatory, supply and institutional barriers, including a:

- Lack of consistent government policy support to drive investment
- Market access challenges due to fossil fuel competition
- Risk-averse investment environment within the Australian energy industry
- Lack of education of the community and industry on the opportunities and benefits of bioenergy
- Lack of incentives or confidence among farmers to participate in bioenergy production
- Limited contractor, operator and investor experience with bioenergy projects.

Charting a path: policies, initiatives and incentives for a flourishing bioenergy sector

To build a thriving bioenergy sector in Australia, we need:

- Long term, stable government energy policy supporting decarbonisation
- Mandated decarbonisation of emission intensive industry and energy providers
- Financial support for technology development and development capital
- A culture of learning, education and innovation within the state environmental regulators.

Momentum for bioenergy is growing. Between 2012 and 2020, ARENA committed \$131 million to 38 bioenergy related projects valued at \$1.4 billion. This funding is fuelling the competitiveness or increased supply of renewable energy in Australia.

But we need to build the momentum. Bioenergy Australia advocates the following initiatives to further catalyse the bioenergy sector.

Overseas experience shows that consistent, sustainable policy support with industry partnerships is integral to establishing and growing a bioenergy industry. Policy by itself, however, is insufficient. Industry should build its capabilities, develop innovative projects and business models and clearly articulate where bioenergy has a comparative advantage against other low emissions alternatives. These integrated efforts have proven to be successful in other jurisdictions and are expected to foster equivalent benefits in Australia.

(ARENA Australia's Bioenergy Roadmap, p17).

Source: Bioenergy Australia submission – Technology Investment Roadmap June 2020

** Source: <https://www.abs.gov.au/statistics/environment/environmental-management/waste-account-australia-experimental-estimates/latest-release>

A Clean Futures Target

1.

A Clean Futures Target to decarbonize the national transport, gas, and heat sectors, by a variety of measures, such as:

A Clean Fuels Target

With a 10 per cent reduction in transport related GHG emissions relative to 2020 levels by 2030. Individual annual and fuel type targets would be set after appropriate modelling. The target should be supported by incentives for sustainable fuels.

A Renewable Heat Target

Extend the use of renewable biomass to the generation of heat energy (e.g. process steam for drying in papermaking or sawmills). Including renewable heat in the renewable energy target (RET) could contribute the equivalent of several thousand GWh in renewable energy per annum from the wood and paper products industry in Australia.

A Green Gas Target

A recommendation that the government consider establishing a near-term aspirational target for cost-effective renewable gas injection into the gas networks by 2030.

Net Zero Organic-to-Landfill Target

Waste should be recovered for its highest order use wherever economically feasible. Instead of going to landfill, collect and convert organic waste into higher-value products, such as biogas or biomethane, pyrolysis gas, and biochar. This target would contribute to the national transition to a more circular economy.

A Bio Industries Fund

2.

A Bio Industries Fund to support the development of a bioenergy sector, for example by:

- **Upgrading existing bioenergy facilities** to increase productivity, reduce costs, or develop into new industries.
- Undertaking feasibility assessments to assess the commerciality of opportunities to **convert low-value residues** into new energy products under a circular economy approach.
- **New project development** of replicable low cost, high value projects such as anaerobic digestors for local councils, food and agriculture processing facilities and wastewater treatment.

To further bolster the bioenergy sector, Bioenergy Australia also advocates:

- Mandating a portion of clean fuels across government fleet and procurement contracts
- Extending excise reduction support to renewable fuels.
- Funding the development of the Clean Fuels Challenge and Clean Fuels Network, identifying outlets selling Euro 6-compliant fuel, and recognising significant fuel users who commit to cleaner fuels. The aim is to support the development of the local biofuels industry, resulting in lower transport sector emissions and greater national fuel security.
- Developing a renewable gas certification system, so consumers buying green gas know it is of standardised quality and manufactured in Australia.
- Developing a renewable gas injection tariff to introduce feed-in-tariffs to provide biogas producers with a fixed price purchase guarantee for 20 years.
- Implementing a 'gas swap' model for biomethane and natural gas, which would allow natural gas consumers to receive the benefits of the green attributes of biomethane supplied and delivered across a multi-user natural gas network.

Blazing a bioenergy trail

Policies and initiatives advancing the bioenergy sector in Australia

QLD

Biofutures 10-year Roadmap and Action Plan

The Queensland Government Biofutures 10-year Roadmap and Action Plan sets out activities to grow the emerging bioenergy sector and position the state as an Asia-Pacific hub for the biofutures industry.

Resource Recovery Industry Development Program

The Queensland Government's Resource Recovery Industry Development Program provides \$100 million in funding and other support over three years to develop a high-value resource recovery industry in Queensland. A key fund objective is to grow biofutures and resource recovery industries and attract investment in new infrastructure.

TAS

Tasmanian Bioenergy Vision

The Tasmanian Government is investing \$3.8 million to implement renewable energy initiatives, including the development of a Tasmanian Bioenergy Vision in 2021. The government says renewable energy could create thousands of jobs and benefit the state for decades to come.

Tasmanian Bioenergy Future Online Summit

The Tasmanian Government hosted a Tasmanian Bioenergy Future Online Summit in November 2020 to provide an opportunity for the agriculture, farming, industrial, energy, transport, mining, and local government sectors to understand potential opportunities in bioenergy and the bioeconomy.

Tasmanian Renewable Energy Action Plan 2020

The Tasmanian Government's Tasmanian Renewable Energy Action Plan 2020 wants to "accelerate the adoption of bioenergy. Bioenergy is an internationally recognised form of renewable energy and Tasmania has an abundance of underutilised wood waste and other feedstocks". The Department of State Growth is developing options to expand the

domestic processing and bioenergy sectors.

Tasmania Energy Strategy

The Tasmania Energy Strategy released in 2015 included \$200,000 funding for biofuels, \$550,000 in funding for forest residues and \$1.25 million in funding for wood and fibre processing. The energy strategy is under revision with stronger bioenergy support expected.

Tasmanian Agriculture Research, Development and Extension for 2050 White Paper

The Tasmanian Government's Growing Tasmanian Agriculture Research, Development and Extension for 2050 White Paper outlines investment in sustainable growth and productivity of Tasmanian agriculture and food sectors. A circular economy model is identified as emerging priority and the bioeconomy sits under this priority.

Waste Action Plan

The Tasmanian Government's draft Waste Action Plan, released in 2019, is a framework for the discussion with local government, business and the community on how best to address our waste and resource recovery challenges. It includes an action to continue to investigate and provide appropriate support for energy-from-waste and bioenergy options, including the management and use of forest residues.

NSW

NSW Circular Economy Policy Statement

NSW Circular Economy Policy Statement – Too Good to Waste (February 2019) aims to guide NSW Government decision making as it transitions to a circular economy. The statement provides a framework for implementing initiatives throughout the product life cycle. The NSW Government pledges to be an early adopter, where the benefits are clear.

NSW Energy from Waste Policy

NSW Energy from Waste Policy (June 2021) recognises that the recovery of embodied energy and resources from the thermal processing of waste can offset the use of non-renewable energy sources and avoid methane emissions from landfill.

NSW Climate Change Policy Framework

NSW Climate Change Policy Framework (October 2016) acknowledges the shift to a net-zero emissions economy is likely to create new opportunities in sectors including agriculture, advanced energy technology, and the government will look for opportunities to grow emerging industries.

NSW Decarbonisation Innovation Study

NSW Decarbonisation Innovation Study (August 2020) highlights some of the benefits of bioenergy, including in heating and electricity generation, reducing fossil fuel use, and as a potential value-add for landholders to generate income from waste feedstock and underutilised land. The NSW DPI Climate Change Research Strategy is investigating bioenergy opportunities.

NSW DPI Net Zero Plan Stage 1: 2020-2030

NSW DPI Net Zero Plan Stage 1: 2020-2030 looks at landfill diversion policies, and the development of waste-to-energy facilities, and the creation of biogas from organic waste to generate electricity, or to make the natural gas supply 'greener'. The NSW government will establish a Clean Technology Program to develop and commercialise emissions reducing technologies.

The Climate Change Fund

NSW Office of Environment & Heritage introduced The Climate Change Fund in 2007 under the Energy and Utilities Administration Act 1987 which encourages energy and water saving activities and contributes to research and development programs, some of which support the application of biomass production for bioenergy.

Biofuels mandate

NSW introduced the first biofuels mandate in Australia, in 2007. The mandate required certain fuel retailers to sell a minimum percentage of biofuels, as a step towards reducing NSW's dependence on fossil fuels and reducing the state's reliance on imported petroleum products. Queensland followed suit with a mandate in 2017. The number of service stations offering E10 has increased.

Case Study

Powering business expansion through wood waste-fuelled boiler



MSM Milling is an oilseed crushing, refining and packaging operation in Manildra, New South Wales. In 2019, it completed its Biomass Fuel Switch project, replacing LPG fuelled boilers with a 5 MW biomass fuelled boiler using locally sourced timber residue, or wood waste, as a fuel source.

The boiler delivers a 70 per cent reduction in thermal energy costs and will result in net emissions reductions of more than 80,000-tonnes of carbon dioxide equivalents during the life of the project (the equivalent of removing 1,500 cars from the road each year). The project will produce 7,147kg/h of steam output at full capacity, to be used in milling and processing operations.

The increased capacity to produce steam at a lower cost with a renewable resource allows the business to expand operations without the risk of exposure to volatile LPG price fluctuations. MSM Milling is one of the first examples of a large Australian agricultural company reducing its costs and environmental impact by using biomass for thermal energy.

Still to be designed

(refer to word version)

Western Australia

Waste recycling plant

The Western Australia Government announced in January 2021 it will invest a \$2 million grant from the Collie Futures Industry Development Fund to secure a \$9.4 million waste recycling plant for the Collie region. Renergi Pty Ltd will build a commercial-scale demonstration plant to recycle municipal solid waste and waste biomass to produce bio-oil and biochar. The bio-oil will be sold to local industrial customers as a liquid fuel to generate industrial heat, while the biochar will be sold to WA farmers as a soil conditioner. The project contributes to the circular economy by diverting council waste from landfill and turning it into energy and other valuable by-products.

Biomass scoping study

The WA Government's Biomass scoping study summarises national and international activity in the use of agricultural by-products for the production of bioenergy and biofuels.

BioFuels taskforce

In 2007, the Western Australian Government created a BioFuels taskforce to examine Biofuel opportunities. The taskforce made 22 recommendations.

Western ways: bioenergy potential in Australia's biggest state

The Western Australia Government estimates Western Australian farmers produce more than 10 million tonnes of waste biomass every year, presenting commercial opportunities for new industries. By-products include cereal straw, dairy effluent, plantation residues, grape marc and tomato vines and remain not widely commercialised. Annual cereal straw totals about seven million tonnes and, the government says, has significant commercial potential. It says an ethanol plant, such as built in Crescentino, in northern Italy, could convert 220 000 tonnes of straw into 40 000 tonnes of ethanol.

Businesses using biomass in Western Australia

In a southern hemisphere first, garden supplies company Richgro, in Jandakot, south of Perth, installed an \$8 million enclosed anaerobic digestion plant to turn waste that would have gone to landfill into clean energy and power that it can export back to the grid. Richgro Managing Director Geoff Richards said: "Much like how the stomach of a cow works, the organic waste is simply and naturally broken down into biogas (carbon dioxide and methane) and organic fertiliser called digestate." The company recycles solid and liquid waste from breweries, chicken farms, supermarkets and other food suppliers. The plant can process an average of 137 tonnes of commercial and industrial organic waste per day or 50,000 tonnes per year. It has diverted 9,000 tonnes of waste from landfill to date. It is also producing an average of 60,000 litres of biofertiliser per day. The plant can generate 28,800 kilowatts per day, enough to power 1,800 households a day with clean energy. The company built the plant with \$500,000 funding from the state government, \$1.1 million from the Federal Government and a \$2 million loan from Clean Energy Finance Corporation.

Morton Seed and Grain in Wagin process oats for the local and international breakfast cereal markets. They have replaced their gas and electricity power supplies with a bioenergy unit that produces all the heat and power they need using the oat husks as a fuel source.

Macco Feeds in Williams have replaced their gas-fired boiler with a wood-fired boiler to supply the heat and steam they need to make their products. They use up to 4000 tonnes of mallee and plantation grown woodchips per year and generate up to 1.7 megawatts of energy.

Anergy, based in Bunbury, designs, develops, builds and operates thermal renewable power plants using high temperature pyrolysis technology.

"There's huge potential in Australia to be looking at material value through waste conversion. So much is going into landfill." Dr Nick Florin, Research Director at the Institute for Sustainable Futures (ISF), University of Technology Sydney.

Still to be designed

(refer to word version)

Victoria

The Victorian Government's Recycling Victoria: A new economy (February 2020) is a circular economy plan to "cut waste and boost recycling and reuse of our precious resources". It encourages investment in waste to energy infrastructure, including facilities that use organic waste via bioenergy or provide precinct-scale energy.

PULLOUT

Water corporation's food waste to energy facility reduces landfill, cuts greenhouse gas emissions – and keeps customers' water bills down

Yarra Valley Water operates an anaerobic digestion facility at its Aurora Sewage Treatment Plant in Wollert. The facility accepts 33,000 tonnes of food waste per year (sourced from markets and food manufacturers) and produces 22,000 kilowatt-hours of electricity a day—enough to power 1,300 homes. This bioenergy powers not only the waste to energy facility itself but also the neighbouring sewage treatment plant. The remaining energy goes to the grid.

The Victorian Government's \$500 million Sustainability Fund which receives funds from Victorian landfill levies to redistribute as grants to support projects, programs, services or technologies that will benefit Victoria environmentally, socially and economically. The 2020-21 Sustainability Fund Activities Report lists support for a variety of bioenergy waste-to-energy projects.

The Waste to Energy Infrastructure Fund directly supports investment in waste to energy technologies that support the state's transition to a low carbon economy and the creation of full-time employment.

Sustainability Victoria's Bioenergy Infrastructure Fund is funding from the Waste to Energy Infrastructure Fund to support investment in waste to energy technologies that will help the state transition to a low carbon economy by reducing greenhouse gas emissions and diverting waste from

Case Study

Flying high on mustard seeds



More than 95 per cent of QANTAS' greenhouse gas emissions come from jet fuel. QANTAS has joined forces with bioenergy and agricultural technology companies in North America and is working on a program with Australian farmers to commercialise biofuelled alternatives to jet fuel. Sustainably-grown, non-food mustard seed (*carinata*) is a promising alternative, 80 per cent less emissions-intensive than conventional fuel. QANTAS operated the world's first dedicated biofuel flight, from Los Angeles to Melbourne, in January 2018. QANTAS is investing \$50 million in biofuel research and development, between by 2030, to support its goal of net zero emissions by 2050.

