



Bioenergy state of the nation report

**A report on Australia's
bioenergy performance**

For Bioenergy Australia

November 2018

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Summary

Bioenergy Australia is committed to accelerating Australia's bio-economy. Their mission is to foster the bioenergy sector to generate jobs, secure investment, maximise the value of local resources, minimise waste and environmental impact, and develop and promote national bioenergy expertise into international markets.

Bioenergy presents a considerable opportunity for Australia to embrace. The Clean Energy Finance Corporation estimate a potential investment opportunity of between \$3.5 billion and \$5 billion in energy from urbane waste, agricultural waste and forest residues.⁹ With respect to

biofuels, increased use of 10 per cent ethanol-blended petrol (E10) in Australia could create more than 8600 jobs and attract \$1.56 billion in investment and generate more than \$1.1 billion in additional revenue in regional areas.^{1a}

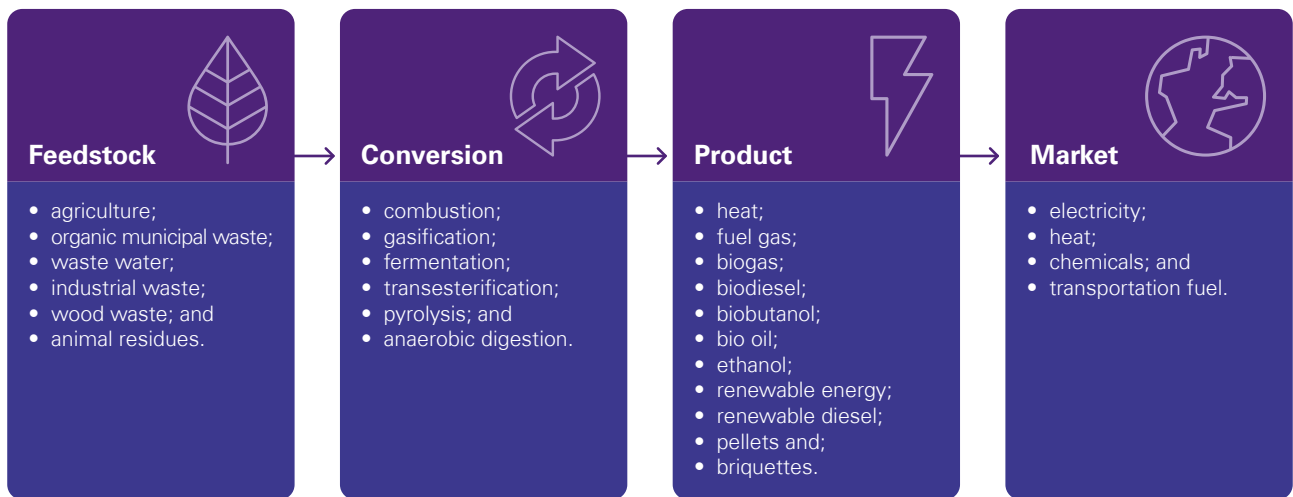


In order to achieve these outcomes, it is important to assess the current status of the industry’s development. Policies can then be developed or adjusted to continue the growth of this important sector.

It is within this context that Bioenergy Australia has asked KPMG to prepare a report on bioenergy activity within Australia, and to highlight the benefits of growing the bioenergy sector in Australia.

Bioenergy is generated from the conversion of solid and liquid biomass products for use as dispatchable electricity, heat, gas, liquid fuels and bio-based products. Figure 1 shows the biomass to bioenergy process, where biomass feedstock is converted to end-use products using different types of conversion technologies, such as combustion, anaerobic digestion and gasification.

Figure 1: Biomass to bioenergy process



The benefits of bioenergy are multi-faceted and cover the following four key areas:



Bioenergy state of the nation assessment

The aim of the state of the nation assessment is to assist Australian governments and industry stakeholders to build an understanding of gaps in the development of the bioenergy sector.

In order to rank bioenergy performance across each state and territory, we have developed five evaluation criteria and a high-level ranking system, which is shown in Table 2.

Table 1 shows the five evaluation criteria. All evaluation criteria have been weighted equally. The equal rating reflects that high performance

across all criteria is required for the development of a bioenergy sector that is economically and environmentally sustainable, and maintains its social licence to operate.

While all states and territories have room to improve across the evaluation criteria, Queensland leads, followed by South Australia and Victoria. What differentiates these jurisdictions is their policy objectives are better defined and more aligned to the bioenergy sector compared to other states and territories, and there is evidence of advocacy of

the benefits and opportunities from bioenergy.

While the Federal Government has implemented mechanisms to reduce carbon emissions, such as the Renewable Energy Target and Emissions Reduction Fund, there does not appear to be a national vision, policy objectives and/or policy levers implemented to directly support the development of Australia's bio-economy.

More detail on the assessment can be found in Chapter 3 and Appendix A.

Table 1: Preliminary bioenergy evaluation

Evaluation criteria	QLD	NSW	VIC	SA	WA	ACT	TAS	NT
Criteria 1 Policy development and effectiveness	✓✓	–	✓✓	✓✓	–	✓	✓	✓
Criteria 2 Bioenergy project development	✓	✓	✓	✓	✓	✓	✓	–
Criteria 3 Technology and feedstock diversity	✓	✓	✓	✓	✓	–	✓	–
Criteria 4 Sustainability guidance	✓	–	–	–	–	–	–	–
Criteria 5 Advocacy and education	✓✓	–	✓✓	✓✓	–	–	–	–
Relative ranking between jurisdictions:	1	4	2	2	4	4	3	5

Table 2: Rating system

Bioenergy evaluation description	
✓✓✓	Meets all requirements.
✓✓	Meets the majority of requirements.
✓	Meets some of the requirements.
–	Most requirements are not being met.

International comparison

Australia is in the bottom quartile of Organisation for Economic Co-operation and Development countries with respect to bioenergy as a proportion of total energy supply.¹

In Australia, biomass for energy purposes makes up around four per cent of total energy consumption.² This stands in contrast to the European Union (EU), where 10 per cent of energy consumption is derived from biomass.³ Over the period 2021 to

2030, the EU expects bioenergy projects to generate €58.7 billion per annum in economic activity and 550,000 direct and indirect jobs.⁴

Sustainable bioenergy is playing a key role in helping the EU to increase energy security and meet ambitious emissions reduction targets.⁵ A significant level of global investment is focussed on the development of biofuels to service the aviation, marine and heavy haulage sector.

Bioenergy Australia participate in five International Energy Agency Bioenergy tasks, and will be increasing to seven tasks in 2019.

Growing Australia's bio-economy

Bioenergy and bioproducts have the potential to be a significant growth sector for the Australian economy, in conjunction with growing the agricultural sector and regional communities. As with any emerging sector, government support plays an important role in removing barriers and accelerating the development of new projects.

The Australian Government, in conjunction with the states and territories, can help grow the Australian bio-economy through:

- establishing a national vision for the bio sector in Australia, with a corresponding set of policy objectives and targets informed by cost benefit analyses
- developing a national roadmap to achieve the vision, including recommended policy levers (see section 1.5) for all levels of government to implement and
- monitoring performance of achieving the roadmap through regular reporting.

A national roadmap reflecting the unique attributes of each state and territory will allow the identification of their respective needs and comparative advantages. Some jurisdictions may have feedstock that allows them to become a leader in biofuel refining or generating dispatchable electricity from biomass or producing biochemicals.

Policy levers can be tailored to the specific circumstances of each jurisdiction, as part of one congruent approach to establish a strong Australian bio-economy.

Section references

- 0 Clean Energy Finance Corporation, The Australian bioenergy and energy from waste market, November 2015, p. 6.
- 1a O'Hara, I., Robins, K. & Melssen, B., *Biofuels to bioproducts: a growth industry for Australia*, 2018
- 1 Total primary energy supply describes the sum of production and imports, subtracting exports and storage changes.
- 2 Department of the Environment and Energy, Australian Energy Update 2017, August 2017.
- 3 European Commission, Sustainable and optimal use of biomass for energy in the EU beyond 2020 — May 2017, page 13.
- 4 *Ibid*, p. 87-88.
- 5 *Ibid*, p. 15.
- 6 IEA Bioenergy Countries' Report — update 2018 Bioenergy policies and status of implementation, Figure 1.

1

Introduction to bioenergy

Bioenergy is generated from the conversion of solid, liquid and gaseous products derived from biomass. Biomass is organic material available on a renewable basis, such as wood, agricultural products and waste from local councils and industrial sources.⁷ Typical forms of bioenergy are electricity, heat, liquid fuels and chemicals.

Bioenergy delivers a range of economic, social and environmental benefits, including:

Employment and economic development of rural/agricultural communities:

The feedstock used for bioenergy often stems from rural and agricultural activities and can be associated with existing or new manufacturing processes. Development of bioenergy can provide skilled employment opportunities to these regions and stimulate economic development through the delivery of revenue streams outside of traditional sources.

Energy security:

Domestic production of biofuels results in less reliance on imported oil and petroleum products, promoting energy security. Further, electricity and heat produced from bioenergy can often be dispatchable and ramped up and down to support variable renewable energy.

Utilisation of waste streams:

Bioenergy is typically produced from the utilisation of waste materials such as agricultural and animal residues as well as municipal waste. This delivers economic benefit to resources that would generally be considered as end-of-life products, and can contribute towards a reduction in landfill and other waste product storage.

Reduction in greenhouse gas emissions:

Sustainable management of biomass and conversion to bioenergy ensures that most carbon emissions produced in the process are re-absorbed into the feedstock supply chain. This supports a transition to a low-carbon economy through a reduction in greenhouse gas emissions and results in a range of positive environmental and social impacts by alleviating demand for petroleum-based products.⁸

1.1 Scope and purpose of the report

Bioenergy Australia has asked KPMG to prepare a state of the nation report on the Australian bioenergy sector. The purpose of the report is to:

- provide an overview of bioenergy and its benefits to the Australian economy
- develop criteria to assess the bioenergy performance of each state and territory and
- undertake a high level evaluation and prepare an indicative scorecard of each state and territory's performance.

KPMG used data on Australian bioenergy projects provided by Bioenergy Australia to undertake the evaluation. The data was captured through a questionnaire, with the data compiled by Bioenergy Australia and provided to KPMG. In some instances this data was supplemented by desktop research.

Bioenergy is a multifaceted sector and this report is not a comprehensive overview of feedstock type and availability, conversion technologies or end-uses. It also does not provide specific policy recommendations on developing the bioenergy sector.

The report is designed to provide an accessible introduction to biomass and bioenergy, including a high-level assessment of the performance of the states and territories based on desktop research and data provided by Bioenergy Australia.

1.2 Converting biomass to bioenergy

Bioenergy is produced from a range of biomass sources, including agricultural products⁹, local council (municipal) waste and landfill gas, as shown in Figure 2.¹⁰

Biomass is converted to end-use products through the use of conversion technologies. These technologies can be categorised as follows:

Direct combustion processes:

Biomass such as wood products, bagasse and municipal solid waste is combusted in boilers to produce direct heat or steam for industrial processes and electricity production. Direct combustion also includes co-firing, where biomass and a fossil fuel (generally coal) is combusted together in a boiler.

Thermo-chemical processes:

Feedstock is converted into gas, oils, hydrogen or methanol under controlled temperature and oxygen conditions. Gasification (heating solid biomass to over 800 °C), hydrothermal liquefaction (decomposition of biomass using water, heat and pressure) and pyrolysis (decomposition from high temperatures with zero oxygen) are examples of thermo-chemical processes.

Biochemical processes:

Micro-organisms are used in the treatment and conversion of organic waste. Biochemical processes encompass anaerobic digestion (biological breakdown of biomass to

produce gas), methane production in landfills to produce electricity, and ethanol fermentation for use as a liquid fuel.

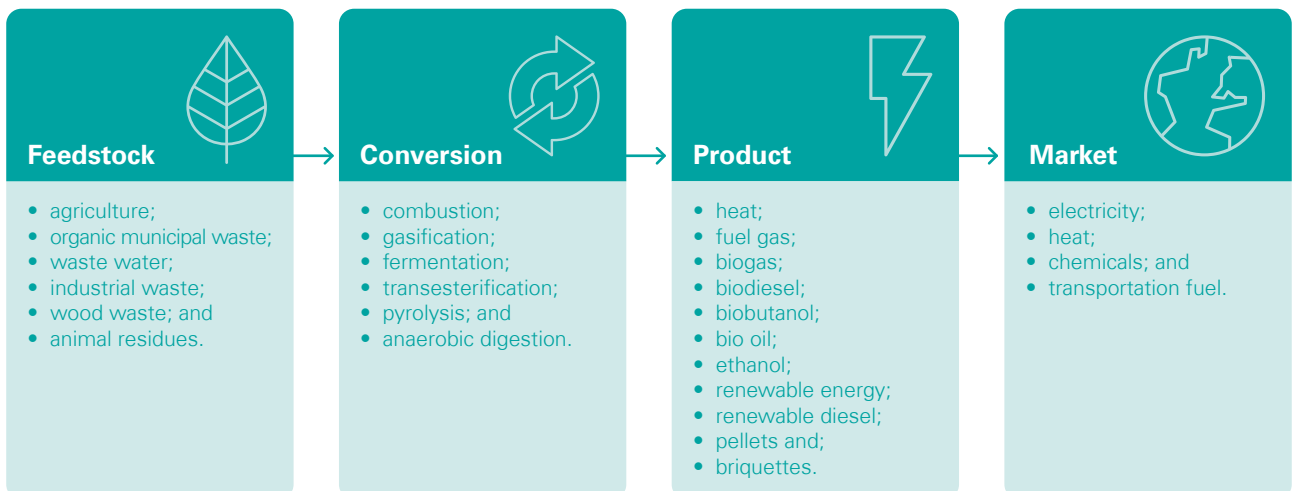
Decisions on the type of feedstock and conversion technologies used depend on the individual project. Availability of feedstock, capital expenditure, technology risk, utility costs, the level of energy production, and type of the end-use market drive the economics of individual projects.

Figure 3 illustrates the supply chain of biomass to market across feedstock, technology and end-use products.

Figure 2: Biomass fuel sources



Figure 3: Biomass to bioenergy process



1.3 End use markets for bioenergy

The bio-economy consists of the following end use market categories:

Electricity: to directly supply businesses or exported into the grid

Direct heat: used for residential and industrial heating purposes

Transport fuels: for use in the transportation sector such as passenger vehicles, medium and long haul trucks, rail, off road, aviation and maritime and

Bioproducts: chemicals for use in polyester fibres for clothing, detergents, oils and other products.

1.3.1 Electricity

Bioenergy is a dispatchable source of electricity generation that can be used to support reliability and security of the grid.¹¹ The Australian Energy Market Operator (AEMO) has noted that maintaining energy security in the National Electricity Market will require significant new dispatchable capacity as coal-fired power stations retire.¹²

Bioenergy can play a significant role in the energy transition by providing flexible and dispatchable generation capacity to support and complement variable wind and solar. Table 3 sets out types of bioenergy technologies that can be used for electricity generation.

In 2017, biomass was estimated to make up only 1.4 per cent of Australia's total electricity production.¹³

Table 3: Bioenergy technologies for electricity generation

Technology	Description	Dispatchable
Biomass combustion	<ul style="list-style-type: none"> Heat produced by direct combustion of biomass material in a boiler is used to produce electricity via a steam turbine or reciprocating engine. Most types of biomass feedstock can be used in the process. If waste heat is also utilised the efficiency can be 80 %-90%. 	✓
Co-firing	<ul style="list-style-type: none"> Co-firing is the combustion of biomass materials with fossil fuels, such as in coal-fired generators. Co-firing of solid biomass, such as wood pellets, has become common in European and Asian countries. Co-firing is relatively low cost compared to a new power station, and emissions of an existing coal-fired plant can be reduced. 	✓
Gasification	<ul style="list-style-type: none"> Gasification is a process where biomass is transformed into biogas at high temperatures without combustion. Syngas is used in internal combustion engines or gas-fired generators to produce electricity. 	✓
Anaerobic digestion	<ul style="list-style-type: none"> Anaerobic digestion is the biological degradation of biomass in oxygen-free conditions. Anaerobic digestion produces a methane-rich biogas that can be used as fuel for a gas-fired generator or (gas converted) internal combustion engine. Biogas can be upgraded to biomethane in the form of gas (at near ambient pressure, compressed natural gas (CNG), or liquified natural gas (LNG)). It can then be used for peak power production. 	✓

1.3.2 Heat

The generation of thermal energy (heat) from biomass is a simple and effective way of extracting energy from a solid biomass material, and thermal energy represents a compelling case for the utilisation of bioenergy in Australian manufacturing.

Heat generated from bioenergy can be used to deliver the thermal energy required in places like food processing facilities, abattoirs and dairy producers (all of whom need steam and hot water for their manufacturing); commercial glasshouses, hospitals and aquatic centres (for space and water heating); and industrial manufacturers such as plywood and MDF manufacturers, and cement producers (who require steam and hot air).

Occasionally, waste heat is used to generate electricity as well. These are known as combined heat and power (CHP) or co-generation facilities and can deliver cost-effective power for facilities with poor grid connections or unusually high electricity charges. In a true co-generation situation (where both all heat and all electricity is consumed), this can substantially improve the thermal efficiency of the plant, using up to 80 per cent of the potential energy in the feedstock.¹⁴

The combustion of a solid biomass fuel in a boiler can deliver the same quality of thermal energy as is generated by a natural gas boiler, but normally at a significantly lower cost per unit of energy delivered. In this way, bioenergy offers part of the solution to the pressure mounting on manufacturers using natural gas in Australia today.

1.3.3 Transport fuel

Biofuels derived from biomass can be used in the transport sector as a replacement for conventional fuels. The transport sector includes emissions from the direct combustion of fuels in transportation by road, rail, domestic aviation and domestic shipping. In the year to March 2018, transport accounted for 18.7 per cent of Australia's national emissions inventory.^{14B}

Biofuels can be produced through a range of sources including oil-based residues such as cooking and waste crop oils, as well as the more typical organic wastes and agricultural and forest residues. Similar to electricity production, conversion technologies are used to convert the biomass into intermediate products. Examples of the biofuel production process are shown in Figure 4.

In 2017, biofuels made up 3 per cent of the transport fuel demand worldwide, with 70 per cent of this usage coming from the US (47 per cent) and Brazil (23 per cent).¹⁵ This equates to 140 billion litres globally, which is expected to grow in the future as more sustainable fuel sources are sought by the market.

While the biofuels industry has not experienced the same growth in Australia, production is expected to increase due to mandates for ethanol-blended petrol in both New South Wales and Queensland and a growth in the global demand for biofuels specifically for the aviation and marine sector.¹⁶

Road

In Australia the vast majority of petrol cars can use ethanol blended fuel — in the same way that virtually all trucks and cars can take biodiesel blended fuel. Ethanol lifts the octane of fuel in the same way that cetane is lifted by the use of biodiesel; both are an oxygenate, which reduces carbon monoxide, and also contribute to lowering the sulphur in the fuel simply because it is almost a pure single molecule fuel.

Ethanol blended fuels are easy to incorporate in the supply chain and cost effective to produce. Increasing the use of biofuels by only 10 per cent in petrol and diesel in Australia can reduce total greenhouse gas emissions by 8.9 million tonnes of CO₂-eq per year, with subsequent health benefits. A study by QUT identified that the growth of biorefinery industries in Queensland alone could result in an increase to the Gross State Product of more than A\$1.8 billion per year, and the creation of around 6,640 jobs, most of which would be in regional communities.

Another example of a transport fuel is renewable diesel, which is created by the thermal and hydro processing of renewable biomass and waste. These fuels must meet Australian Fuel Quality Standards Acts and Regulation. Renewable diesel is considered a drop-in fuel and requires no blending with traditional diesel.¹⁷

Aviation

As part of the global decarbonisation process, the international aviation industry has committed to reducing its greenhouse gas emissions. In 2009 the International Air Transport Association set the following ambitious targets of carbon neutral growth from 2020 and a 50 per cent reduction in net emissions by 2050 compared to 2005 levels.

Unlike the land transport sector, airlines have limited options to materially reduce emissions other than through the use of aviation biofuels. From one flight in 2008, the threshold of 100,000 flights has been passed in 2017. A number of airlines, including Cathay Pacific, FedEx Express, JetBlue, Lufthansa, Qantas, and United, have made investments by forward purchasing 1.5 billion gallons of Sustainable Aviation Fuel (SAF). Airports in Oslo, Stockholm, Brisbane and Los Angeles are currently mixing SAF with the general fuel supply.

Maritime

The maritime industry is facing a similar transformation. LSF2020 refers to the new 'Low Sulphur Fuel' regulations, which will come into effect on 1 January 2020. These regulations are the biggest of a series of steps by the International Maritime Organisation to reduce marine pollution (MARPOL) in response to the threat of climate change. The LSF2020 emission regulations mean ships will have to significantly reduce emissions on the high seas as well as in coastal areas, which is a significant opportunity for the biofuels sector.

1.3.4 Bioproducts, chemicals and co-products

Biofuels and biomass can be utilised to produce chemical and pelletised products across several sectors, contributing towards a sustainable bio-economy. Chemical production currently forms an integral part of bioproducts created worldwide, with large-scale biorefineries established in Europe, North America, and Asia.¹⁸

Bioproducts are derived through the formation of various chemicals, which are then used in a range of products and sectors. Chemicals, including lactic and succinic acids, formed using biomass feedstocks can be used across food, nutraceuticals and pharmaceutical applications. Other chemicals, such as polyethylene and monoethylene glycol, can be used across a range of products including polyester fibres for clothing, detergents, and other cleaning products¹⁹, while phosphorus can contribute to the production of biodiesel as well as renewable fertiliser.²⁰

In Australia, a biorefinery project in Queensland from chemical company Amyris is planning to utilise sugarcane to produce 23,000 tonnes of farnesene before exporting into high demand markets in South East Asia for various vitamins and cosmetics.²¹ The global market for bioproducts is expected to reach over \$1 billion by 2022 as biomass is increasingly utilised in the production of a range of chemical and industrial applications.²²

As with the conversion of all biomass, there are a range of technologies that can be employed to form bioproducts, depending on the feedstock and the end-use. Chemicals such as ethanol and butanol can be produced through fermentation processes, while other common chemicals such as ammonia and methanol can be produced through higher temperature processes including gasification.²³

In addition to the above, wood pellets, briquettes and digestate produced from biomass are able to be used as co products, such as co-firing in coal-fired power stations for pellets and briquettes to reduce emissions, or using digestate as a nutrient rich fertiliser.

Figure 4: Biofuel production process

Feedstock	Conversion	Intermediary	Upgrading	Biofuel
Organic wastes	Anaerobic digestion	Biogas	Upgrading and compression	Biomethane, Biohydrogen, Hythane
		Biohydrogen	Purification and compression	
Oil-based residues	Extraction and purification	Lipids	Transesterification	Biodiesels and bio-gasoline
			Hydrotreating and refining	
Agricultural or forest residues	Pyrolysis	Bio-crude	Hydrotreating and refining	Bioethanol
	Hydrothermal liquefaction	Sugars	Fermentation	Renewable Diesel
	Enzymatic hydrolysis	Syngas		
	Gasification			

1.4 Sustainability

One of the key benefits of utilising biomass as an energy source is the potential to improve sustainability outcomes, emissions and air quality versus traditional fossil fuel use. However, the absence of appropriate sustainability measures for the use of biomass could lead to potential concerns that production is non-sustainable and has a negative effect on food security and the environment.²⁴ There are three potential concerns related to the development of the bioenergy sector:²⁵

1. food security, where growth in demand for agricultural feedstock for bioenergy may result in land used for both animal feed and food being converted into land solely used for the production of biomass products
2. risks that land use and land use change from bioenergy expansion may increase carbon emissions or reduce biodiversity and
3. challenges in achieving economic competitiveness and providing high quality and affordable energy services.

Systems and processes are available to mitigate the risks of these negative effects. Once they have been implemented, an enabling environment for bioenergy production is created that allows the benefits to be captured and risks minimised.

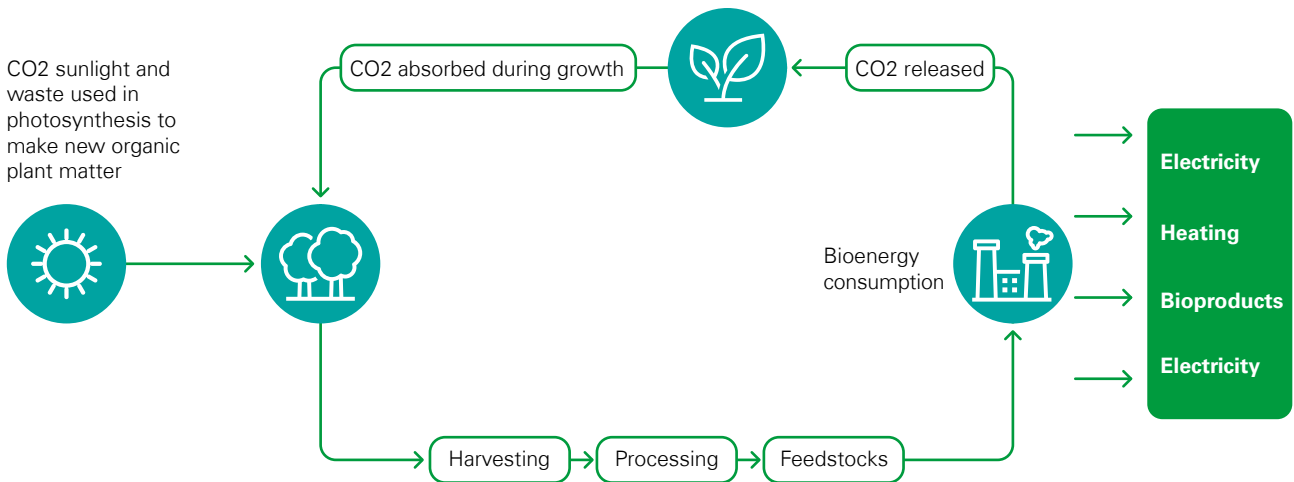
Bioenergy, if sustainably produced, is a renewable and carbon-neutral form of energy. However, it is unique (when compared to other forms of renewable energy) in that it releases carbon dioxide (CO₂) during the production process. Living biomass, such as wood residue from forests takes in carbon as it grows, offsetting the carbon that is released when it is converted into energy. This results in a carbon-neutral cycle that does not increase the atmospheric concentration of greenhouse gases, as shown in Figure 5.²⁶

To maintain this carbon-neutral lifecycle, biomass feedstock must be harvested in a sustainable manner to ensure the same amount of carbon is being absorbed as is being released.

Some of the international certification schemes applicable to bioenergy include:²⁷

- International Organisation for Standardisation Sustainability Criteria for bioenergy
- The International Sustainability and Carbon Certification Scheme
- The Roundtable on Sustainable Biofuels
- Forest Stewardship Council
- The Programme for the Endorsement of Forest Certification and
- The European Commission's Landfill Directive²⁸.

Figure 5: Carbon neutral lifecycle





1.5 Policy levers that encourage bioenergy use

Different policy levers can be used to support the development of the bioenergy sector. These range from explicit targets on the use of bioenergy, such as the E10 biofuel mandate in Queensland and New South Wales, to government grants to reduce project capital costs, and contracts-for-difference which guarantee a price for electricity generated over a defined time period.

Understanding the available levers to the market is an important step towards identifying strategies for the development of the bioenergy sector in Australia, as each will have different impacts not only on the bioenergy industry, but related industries as well.

An overview of potential bioenergy policy levers is in Table 4. Some of these, such as gate fees and capital grants, have been implemented in some Australian jurisdictions. However, there is currently not a consistent, national approach to using these policy levers to grow the bioenergy industry.

Table 4: Policy levers to support bioenergy uptake²⁹

Policy levers	Description	End use applicability
Bioenergy target/mandate	<p>A target provides the market with a firm level of demand for the uptake of bioenergy. These can be incorporated as part of a larger renewable energy target or designed in isolation for the uptake of bioenergy.</p> <p>Targets can also span across end-use markets for bioenergy, including a target on electricity generation or a fuel-switching target such as the E10 mandate.</p>	<ul style="list-style-type: none"> • electricity • heat • transport fuels • bioproducts
Contract-for-difference	<p>Bioenergy projects can be supported by the government through a contract-for-difference (CfD). These contracts ensure the bioenergy project receives a minimum price per MWh of electricity, through funding the difference between the contract price and the market price.</p>	<ul style="list-style-type: none"> • electricity
Feed-in-Tariff	<p>Feed-in tariffs (FiTs) guarantee a project a certain price for their electricity and/or heat over a period of time. This is different from a CfD in that the payment amount is fixed and not linked to a hedge structure.</p>	<ul style="list-style-type: none"> • electricity • heat
Capital grants	<p>Capital grants provide a means to reduce the upfront investment required for a project. Governments typically run a tender process and then provide direct funding to the winning project.</p>	<ul style="list-style-type: none"> • electricity • heat • transport fuels • bioproducts
Soft loans and guarantees	<p>Loans provide an alternative means to reduce the cost of capital for a project through government providing access to low-rate financing.</p> <p>Governments can conversely encourage private-sector loans through subsidising rates offered by banks or other proponents, in what is known as a “stapled financing” product.</p>	<ul style="list-style-type: none"> • electricity • heat • transport fuels • bioproducts
Gate-fee	<p>Gate-fees require a fee to be paid for the disposal of waste product from a project, providing an incentive for the utilisation of waste in bioenergy products. A gate fee provides certainty to the bioenergy project over the value of each tonne of waste produced.</p>	<ul style="list-style-type: none"> • electricity • heat • transport fuels
Fuel tax exemption	<p>The Australian Government allows eligible businesses that acquire fuel to use in their operations, for example machinery, heavy vehicles, plants and equipment, to claim credits for the fuel tax included in the fuel price.</p> <p>Eligible fuel can be acquired, manufactured, imported or used in the business includes biodiesel (including B5 and B20³⁰, and other blend ratios), ethanol (including E10 and E85³¹, and other blend ratios) and other products such as petrol, diesel, kerosene or heating oil.³²</p>	<ul style="list-style-type: none"> • transport fuels

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- 9 Agricultural waste products which are used directly and indirectly for bioenergy production in Australia include (but are not limited to): corn, banana, vegetables, cotton gin, macadamia and nut shells, grape marc and pruning's, sugarcane (bagasse), sorghum, wheat/barley/rice straw and oils.
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- 27 Definitions sourced from: IEA 2017, Bioenergy Roadmap Development and Implementation, page 54.
- 28 Definition sourced from European Commission 2016, Waste Introduction, last accessed 28 September 2018 from http://ec.europa.eu/environment/waste/landfill_index.htm
- 29 Definitions sourced from: IEA 2017, Bioenergy Roadmap Development and Implementation, page 58.
- 30 Biodiesel is diesel fuel made from vegetable oils, animal fats or recycled greases and common blends include B5 and B20 (5% or 20% biodiesel).
- 31 Ethanol is a colourless alcohol that can be used as an alternative fuel and is considered a renewable fuel when produced from agricultural sources. E10 is regular unleaded petrol blended with 10 per cent ethanol.
- 32 Bioenergy Australia, "Fuel Tax Credits" (2016), accessed 28 September 2018, <http://biofuelsassociation.com.au/policy/policy-and-excite-framework/fuel-tax-credits/>



2

Snapshot of Australian bioenergy activity

Bioenergy Australia undertook a survey to quantify activity in the Australian bioenergy sector. The survey asked for information including type of project, status, location, technology and feedstock. Bioenergy Australia provided the data to KPMG and KPMG refined the data through desktop research, where possible.

Bioenergy Australia issued a number of communications to members and the wider industry and individually contacted over 250 projects to obtain this data. Bioenergy Australia do acknowledge that not all projects were comfortable with providing information, and as such the data included represents what could be obtained from the industry.

The data provided to KPMG has 222 operating bioenergy plants and an additional 55 projects are either under construction or within the feasibility stage of development.³³ Table 5 outlines the definitions we have used to categorise projects according to development status.

Based on these classifications, Table 6 illustrates the development stage of each bioenergy project, sorted by whether the project generates electricity or produces a bioproduct.

The data shows there are 222 operating projects, of which 165 produce electricity. From these 165, 40 generate over five MW and 62 generate between one to five MW. There are 14 projects that produce bioproducts (fuel, wood pellets for export, chemicals etc.) and 43 we have categorised as 'other', which include flaring projects and biogas to support behind the meter operations.³⁴

Table 5: Project development timeline

Project development stage	
Feasibility stage	Projects are being assessed to determine whether they are economically and technically feasible.
Under construction	All development approvals received and a final investment decision has been made.
Commissioned	Bioenergy projects that are commissioned or fully operational.

Table 6: Bioenergy projects by development stage, as of 2018³⁵

Project development stage	Project development stage		
	Feasibility stage	Under construction	Commissioned
Bioproducts (fuels, wood pellets chemicals etc.)	11 projects	0 projects	14 projects
Electricity projects generating less than 1 MW	3 projects	3 projects	63 projects
Electricity projects generating more than 1 MW	13 projects	9 projects	102 projects
Other	11 projects	5 projects	43 projects

We note that most of the commissioned projects categorised as 'other' are flaring methane from municipal waste sites. Including these projects within the other data categories and Figure 6 would have made the data less informative in terms of understanding Australian bioenergy trends.

Figure 6 shows the number of operational bioenergy projects throughout Australia (excluding projects classified as 'other'), and the breakdown of biomass feedstock which has been categorised as either municipal waste, animal residues, agricultural residues or wood waste.

The majority of the 179 operational bioenergy projects are in Queensland, New South Wales and Victoria (77 per cent).

Figure 7 shows the proportion of commissioned bioenergy projects classified by technology, feedstock, and end use type.

Figure 6: Operating bioenergy projects by state and feedstock, as at September 2018³⁶

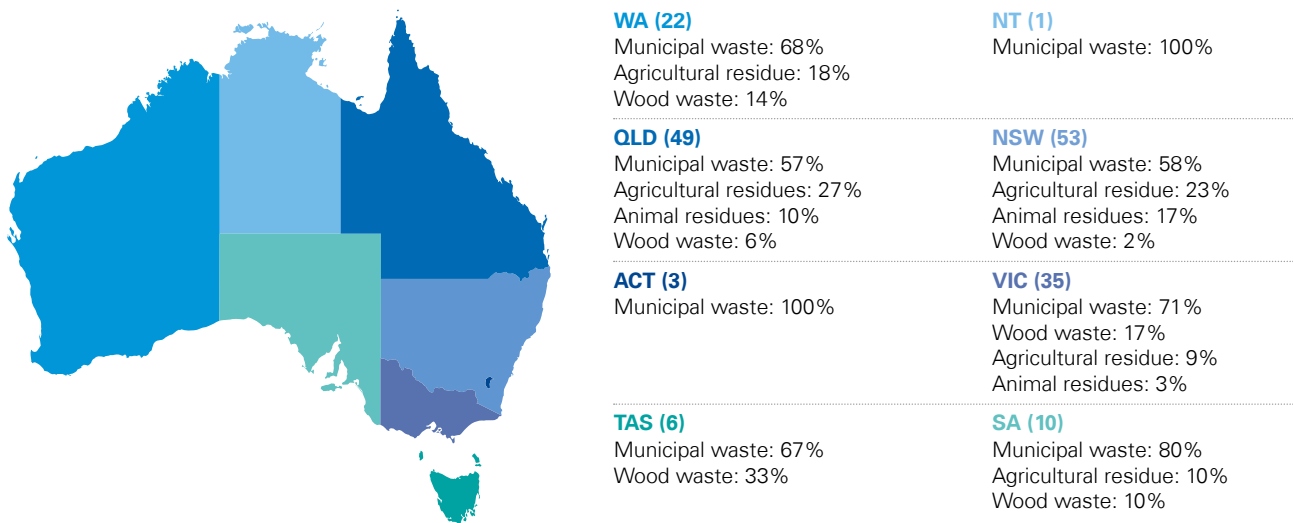
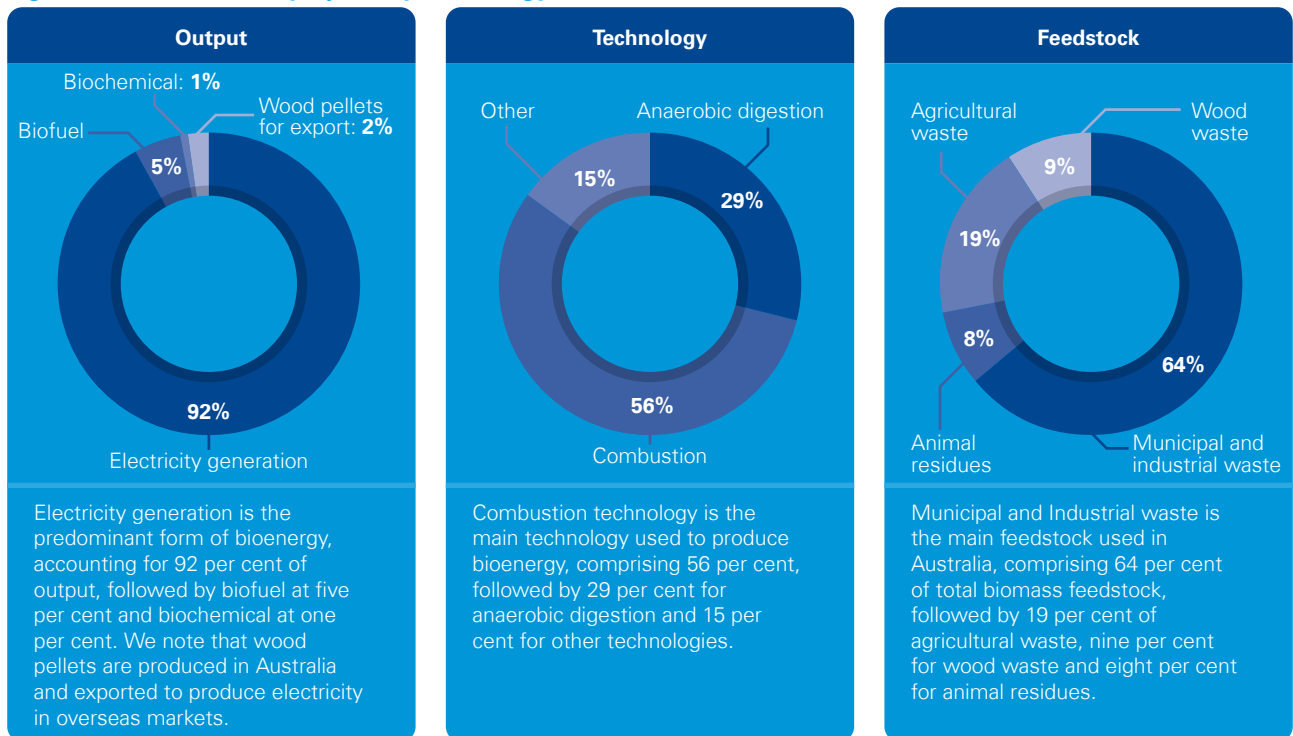


Figure 7: Commissioned projects by technology, feedstock and end-use, 2018³⁷



Section references

- 33 Bioenergy Australia data.
- 34 "Other" projects include waste water for treatment, behind the meter gas produced by anaerobic digestion and used for on-site operations, and project that minimise the release of greenhouse gas emissions through flaring. These were characterised as other because they do not produce a market output, such as exporting electricity to the grid or a bioproduct.
- 35 Bioenergy Australia data; KPMG analysis.
- 36 Bioenergy Australia data; KPMG analysis.
- 37 Bioenergy Australia data; KPMG analysis.



3

Evaluating Australia's bioenergy performance

Bioenergy Australia's vision is to see bioenergy recognised and widely-adopted as a sustainable resource within Australia to unlock the substantial regional development and energy security benefits. To do this, it is important to assess the current state of the industry's development. Policies can then be developed or adjusted to continue the growth of this important sector.

KPMG, in conjunction with Bioenergy Australia, has developed evaluation criteria in Table 7 as a way to measure the bioenergy sector's development. The evaluation will measure bioenergy performance across Australia and highlight opportunities for both federal and state governments to help grow the sector in Australia.

We have developed a high-level system to rank bioenergy performance in each state and territory against the evaluation criteria. The rating system is set out in Table 8. All evaluation criteria have been weighted equally, because all criteria are equally required for an economically and environmentally sustainable bioenergy sector.

To undertake the assessment, KPMG used data provided by Bioenergy Australia, supplemented by desktop research. Data provided by Bioenergy Australia included a spreadsheet of projects from the Bioenergy Australia questionnaire. Desktop research included International Energy Agency (IEA) bioenergy reports and state and federal government websites.

Table 7: Bioenergy evaluation criteria

Evaluation Criteria	Assessment
Criteria 1: Policy development and effectiveness	<ul style="list-style-type: none"> • Appropriate and well-defined bioenergy strategy / policy objectives. • Policies have been developed and implemented. • Policies are aligned with the needs of the bioenergy industry to support its development. • Consultation undertaken during the policy development process to build support and address any community misconceptions.
Criteria 2: Bioenergy project development	<ul style="list-style-type: none"> • Bioenergy projects supported through private investment. • Regulatory frameworks provide clear guidelines and certainty on development approval processes. • Where government policies have been implemented, these have driven growth across the sector and led to new projects.
Criteria 3: Technology and feedstock diversity	<ul style="list-style-type: none"> • Data is available on feedstock type and volumes. • A diverse range of bioenergy technologies and feedstock classes have been successfully developed. • A diverse range of end users, including power, gas and fuels, use bioenergy.
Criteria 4: Sustainability guidance	<ul style="list-style-type: none"> • Guidance is in place for the industry which encourages the sustainable management of feedstock from domestic and international supply chains.
Criteria 5: Advocacy and education	<ul style="list-style-type: none"> • Bioenergy has been promoted within the industry and general public. • Advocacy includes a focus on bioenergy's key strengths of economic development in regional areas, energy security, and sustainability. • Community has been adequately educated on the myths of bioenergy.

Table 8: Rating system

Bioenergy evaluation description	
✓✓✓	Meets all requirements.
✓✓	Meets the majority of requirements.
✓	Meets some of the requirements.
—	Most requirements are not being met.

3.1 Bioenergy assessment summary

This section sets out our state of the nation assessment on bioenergy performance in Australia, undertaken in conjunction with Bioenergy Australia. The aim of the evaluation is to assist Australian governments and industry stakeholders to build an understanding of the gaps in the development of the bioenergy sector.

A summary of our assessment for each evaluation criteria is below, with more detailed assessments set out in Appendix A.

Criteria 1: Policy development and effectiveness:

Queensland, Victoria and South Australia have developed defined policy objectives that align to the bioenergy industry.

The Australian Capital Territory (ACT) has a number of policies that may indirectly support the growth of the bioenergy industry, while Tasmania is working with the private sector through grant programs. New South Wales, Western Australia and Northern Territory have set objectives for renewable targets, but did not align them with the use of bioenergy technology or feedstock.

We note the New South Wales ethanol mandate is currently ineffective due to exemptions granted to fuel retailers and there is no indication the six per cent state ethanol target is being met.^{37B}

Criteria 2: Bioenergy project development:

The majority of the 179 commissioned bioenergy projects are in Queensland, New South Wales and Victoria (77 per cent). There is little diversification across feedstock and technology, and most projects produce electricity as an output.

Bioenergy projects in most jurisdictions have been completed without direct government incentives or grants, although some have received grants from the Australian Renewable Energy Agency (ARENA). Northern Territory policies and regulatory frameworks do not appear to have supported the growth of the bioenergy sector.

Criteria 3: Technology and feedstock:

Most projects utilise combustion technology, followed by anaerobic digestion. The predominant feedstock is municipal waste and agricultural waste.

Criteria 4: Sustainability guidance:

Queensland has developed a biomass data and mapping tool to demonstrate the traceability of biomass feedstocks and to provide an opportunity for biomass purchasers to link with suppliers.³⁸ Further, Queensland requires bio based petrol and bio-based diesel sold under the biofuels mandate to meet the sustainability criteria for biofuels. The criteria includes a 20 per cent minimum greenhouse gas saving threshold and certification under the relevant environmental standard for the feedstock used.

Queensland, Victoria, South Australia, New South Wales, Western Australia and Tasmania have endorsed and are carrying out the Australian Biomass for Bioenergy Assessment (ABBA) project. ABBA is a database of biomass that enables better links between biomass suppliers.

Criteria 5: Advocacy and education:

Queensland and South Australia most actively advocate for and provide information on the bioenergy sector, followed by Victoria; however, further actions could be taken in this area. New South Wales, Western Australia, the ACT, Tasmania and the Northern Territory do not appear to actively educate or promote bioenergy opportunities.

Based on our high level assessment in Appendix A, the ranking of each state jurisdiction against each of the bioenergy evaluation criteria is summarised in Table 9.

Table 9: High-level bioenergy evaluation

Evaluation criteria	QLD	NSW	VIC	SA	WA	ACT	TAS	NT
Criteria 1 Policy development and effectiveness	✓✓	–	✓✓	✓✓	–	✓	✓	✓
Criteria 2 Bioenergy project development	✓	✓	✓	✓	✓	✓	✓	–
Criteria 3 Technology and feedstock diversity	✓	✓	✓	✓	✓	–	✓	–
Criteria 4 Sustainability guidance	✓	–	–	–	–	–	–	–
Criteria 5 Advocacy and education	✓✓	–	✓✓	✓✓	–	–	–	–
Relative ranking between jurisdictions:	1	4	2	2	4	4	3	5

3.2 Federal Government

While the Federal Government has implemented mechanisms to reduce carbon emissions, such as the Renewable Energy Target and Emissions Reduction Fund, there does not appear to be a national vision, policy objectives and/or policy levers implemented to directly support the bioenergy or bio-economy sector.

Notwithstanding this, various programs administered by federal agencies, such as the Australian Renewable Energy Agency (ARENA) and Clean Energy Finance Corporation (CEFC), have supported bioenergy projects.

In the 2014-15 Budget, the Federal Government removed the Ethanol Production Grants Scheme and the Cleaner Fuels Grant Scheme under the Biofuel Excise Policy (2011) — which initially provided taxation benefits for renewable fuels.³⁹

Bioenergy Australia notes that financial support for the development of the bio producer website is due to expire in January 2019.⁴⁰

Section references

37b IPART, Ethanol mandate – options to increase the uptake of ethanol blended petrol, Final Report, May 2015, p. 1.

38 We understand the ARENA Lifecycle Assessment Guidelines helped inform the Queensland approach, see: <https://arena.gov.au/funding/programs/advancing-renewables-program/life-cycle-assessment-guidelines-for-bioenergy-projects/>

39 Australian National Audit Office, The Ethanol Production Grants Program, Table Performance Audit Report, January 2015; Australian Tax Office, Cleaner Fuels Grants Scheme < <https://www.ato.gov.au/Business/Fuel-schemes/Cleaner-fuels-grants-scheme/>>, accessed 4 October 2018.

40 See: http://biomassproducer.com.au/about/about-the-industry/#.W7Z_qmgzZPY

4

International examples

On a number of metrics the development of the Australian bioenergy sector is substantially lagging other Organisation for Economic Co-operation and Development (OECD) and IEA member countries.

In Australia, biomass for energy purposes makes up around four per cent of energy consumption.⁴¹ This stands in contrast to the European Union (EU), where 10 per cent of energy consumption is derived from biomass.⁴² Over the period 2021 to 2030, the EU expects bioenergy projects to generate €58.7 billion per annum in economic activity and 550,000 direct and indirect jobs.⁴³

Figure 8 compares total primary energy supply from bioenergy on a per capita basis for OECD and IEA member countries in 2016.⁴⁴ Australia produced less than 10 GJ of bioenergy per capita, placing in the bottom third of countries. We note Australia has less demand for heating than European countries, and a greater range of energy

supply options, and this could therefore contribute to lower levels of bioenergy used on a per gigajoule (GJ) basis.

This chapter sets out examples of bioenergy projects and policies internationally to demonstrate the opportunities available for Australia if development of the industry is actively supported by the Australian and state and territory governments.

The United Kingdom, Europe and Scandinavia are developing their bioenergy sectors to help meet challenges around energy security and reducing greenhouse gas emissions. Within the EU, energy from biomass contributes over 60 per cent of primary renewable energy production.⁴⁶ Sustainable bioenergy

is playing a key role in helping to meet ambitious climate and energy targets for 2030, including an EU-wide target for renewable energy of at least 27 per cent of final energy consumption.⁴⁷

A snapshot of international bioenergy examples is shown in Table 10 alongside the government policies that are promoting the uptake of bioenergy. These policies can range from renewable energy targets to feed-in tariff schemes, each providing a different incentive for projects. A detailed list of international bioenergy policies has been compiled by the International Energy Agency (IEA).⁴⁸

Figure 8: Total primary energy source from bioenergy, per capita 2016⁴⁵

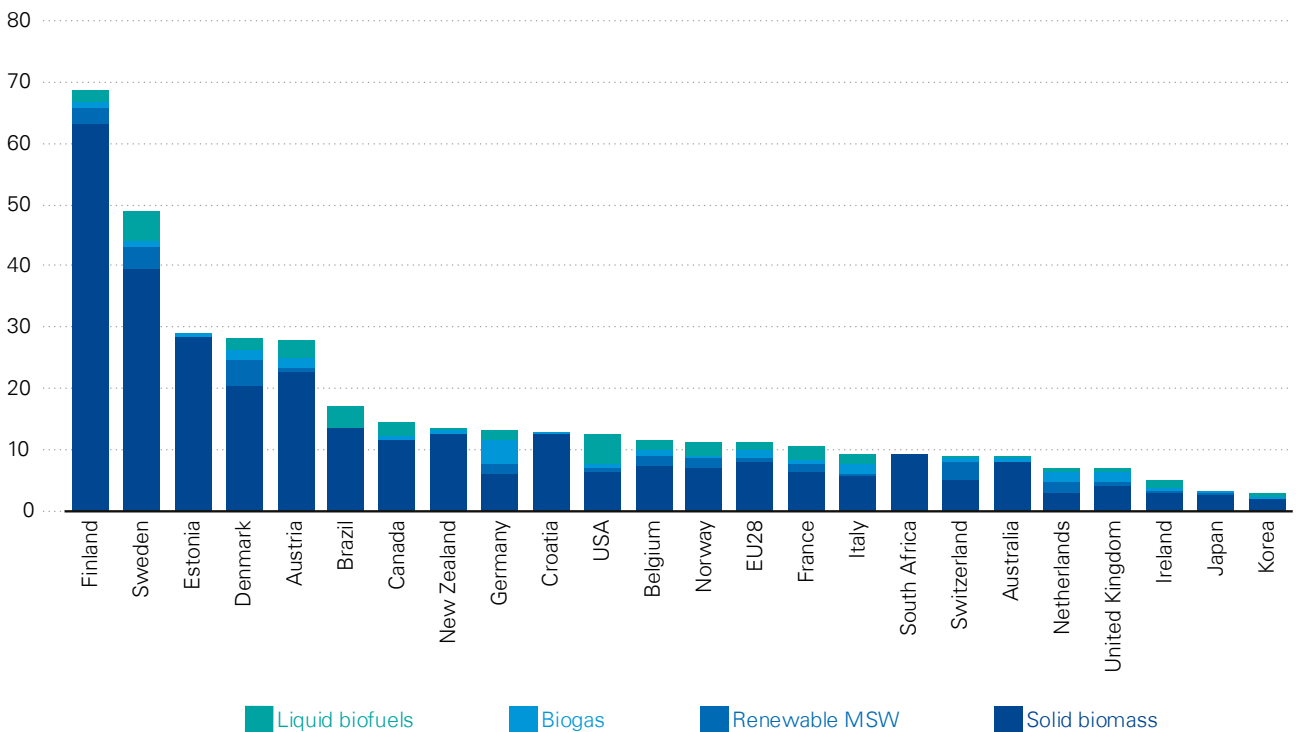


Table 10: Snapshot of international bioenergy projects and policies.

Project	In-country policies
<p>Finland</p> <p>The City of Helsinki in Finland has a vision to become carbon neutral by 2050. One innovative element of the city's strategy is the Katri Vala integrated heating and cooling plant. The plant operates the world's largest heat pump system based on heat from purified sewage and sea water.</p>	<ul style="list-style-type: none"> • Renewable energy target of 38 per cent by 2020. • Feed-in premium of 60 per cent for electricity from wind, biogas, and forest residues. • Investment support for high risk projects. • Carbon tax for fossil fuels in heating. • Landfill ban for organic waste.
<p>United Kingdom</p> <p>Tees Renewable Energy Plant in the United Kingdom is a 299 MW biomass-fired combined heat and power plant. Currently under construction, the plant will cost around £650m to build and power around 600,000 homes. The power plant will consume 2.4 million tonnes of wood pellets and wood chips per annum sourced from sustainable forestry operations. Tees qualifies for a subsidy under the United Kingdom's contract for difference scheme.</p>	<ul style="list-style-type: none"> • Renewable energy target of 15 per cent by 2020. • 15 year contract-for-difference to support large scale renewable projects. • Feed-in tariff scheme. • Renewable Transport Fuel Obligation (RTF) for biofuels in transport. • Renewable Heat Incentive to increase renewable heat usage including biomass.
<p>Switzerland</p> <p>In Switzerland, the Renergia plant is proving an innovative way to redistribute 220,000 tonnes of municipal waste that would otherwise be landfill. The plant is located next to a highway and in direct proximity to a paper factory and district heating connection point, which provides for minimal interruption to nearby residents and maximum export of steam and heat. The nearby paper mill, which uses large amounts of steam, is able to lower their CO2 levels.</p>	<ul style="list-style-type: none"> • Renewable energy target of 24 per cent by 2020. • Feed-in remuneration scheme, covering difference between production and market price. • Carbon tax on fuels for stationary applications. • Phase-out plan for nuclear power through promotion of renewable measures. • Target to recycle 50 per cent of Municipal Solid Waste.
<p>USA</p> <p>In the US state of Nevada, Fulcrum Bioenergy has begun construction of the 65,000 square foot Sierra Biorefinery. The biorefinery converts municipal solid waste (MSW) produced from the adjacent feedstock processing facility into low-carbon synthetic crude oil (syncrude). The syncrude product will be further processed into transportation fuel.</p> <p>When completed in 2020, the Sierra project will process approximately 175,000 tonnes of MSW feedstock annually, creating 40 million litres per year of renewable syncrude.⁴⁹</p>	<ul style="list-style-type: none"> • Loan guarantees for up to US\$ 4 billion established in 2014 for renewable projects. • Renewable Fuel Standard (RFS) for biofuel usage. • Loan guarantees for establishment of biorefineries.
<p>Sweden</p> <p>Under their new sustainability program, Danish-owned Carlsberg Group aims to eliminate all carbon emissions from their breweries. In doing so, the Groups brewery in Falkenberg, Sweden is now 100 per cent fuelled by biogas and green electricity which reduces their carbon emissions from thermal energy to zero.</p>	<ul style="list-style-type: none"> • Renewable energy target of 50.2 per cent by 2020. • Declaration of a fossil independent vehicle fleet by 2030. • Carbon taxing predominately on heating and service sectors. • Landfill ban for organic waste. • Electricity certificates to increase renewable electricity usage.

Section references

- 41 Department of the Environment and Energy, Australian Energy Update 2017, August 2017.
- 42 European Commission, Sustainable and optimal use of biomass for energy in the EU beyond 2020 – May 2017, page 13.
- 43 Ibid, p. 87-88.
- 44 Total primary energy supply describes the sum of production and imports, subtracting exports and storage changes.
- 45 IEA Bioenergy Countries' Report – update 2018 Bioenergy policies and status of implementation, Figure 2.
- 46 European Commission, Sustainable and optimal use of biomass for energy in the EU beyond 2020 – May 2017, page 15.
- 47 Ibid.
- 48 IEA Bioenergy, IEA Bioenergy Countries' Report – Bioenergy policies and status of implementation (2016)
- 49 Fulcrum Bioenergy, "Sierra Biofuels Plant – Bright Future" (2018), <http://fulcrum-bioenergy.com/facilities/>



Appendix A: Jurisdictional evaluations

A.1 Queensland

Policy Criteria	Assessment	Grade
Criteria 1: Policy development and effectiveness	<ul style="list-style-type: none"> The Planning Act 2016⁵⁰ and Waste Reduction and Recycling Act 2011⁵¹ have been implemented by the QLD government to support waste management and recovery, and ecological sustainability of agricultural areas. The QLD government partnered with agricultural and waste industry leaders to develop the 10-year Biofutures Roadmap and Biofutures Program. The QLD Biofuel Mandate has been implemented to achieve the objectives of the above and target \$1 billion of investment. Funding of almost \$20 million over three years has been approved to implement Queensland's Biofutures plan including: <ul style="list-style-type: none"> Industry Development Fund - \$5 million fund offering an interest free source of repayable risk capital to help well-advanced large-scale projects; Commercialisation Program - provides grants ranging from \$250,000 to \$1,000,000 for pilot-scale and demonstration projects; and Acceleration Program - aims to attract and support the development of new or the expansion commercial-scale bio-refinery projects in Queensland. The Queensland government has committed \$100m over three years to the Resource Recovery Industry Development Program. A key objective of the fund is to grow Queensland's biofutures and resource recovery industries and attract investment in new infrastructure.⁵² 	✓✓
Criteria 2: Bioenergy project development	<ul style="list-style-type: none"> Of the 87 bioenergy projects in QLD, there are 28 operating projects and nine either under construction or feasibility which generate over one MW of electricity. While 11 projects commissioned or under development will produce bioproducts, 19 generate less than one MW of electricity, and another 20 are considered 'other' projects (flaring, waste water for treatment or biogas for behind the meter) — this is the most of any state or territory in Australia. The Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) has clear guidelines for renewable energy project development.^{53 54} Of the 87 QLD project responses to the bioenergy questionnaire, none indicated they had received Queensland Government support or grants.⁵⁵ QLD project responses to the Bioenergy Australia survey did not disclose information about job creation. 	✓
Criteria 3: Technology and feedstock diversity	<ul style="list-style-type: none"> QLD's application of bioenergy technology is predominately combustion, followed by anaerobic digestion.⁵⁶ Of those projects, the commonly used feedstocks are agricultural residues (including bagasse) and municipal waste.⁵⁷ 	✓
Criteria 4: Sustainability guidance	<ul style="list-style-type: none"> The Planning Act 2016 was legislated to establish a transparent system of land use planning, and to support this, the QLD government has developed the QLD biomass mapping and data to enable links between biomass suppliers and end users in QLD.⁵⁸ The QLD government supports the Australian Biomass for Bioenergy Assessment (ABBA). ABBA is the provision of detailed information (projects, types, volumes, location etc.) of potential bioenergy feedstocks, on a state-by-state basis.⁵⁹ The project is funded through the Australian Renewable Energy Agency (ARENA). The QLD's forestry operations are independently certified by the Program for the Endorsement of Forest Certification (PEFC)⁶⁰ and Forest Stewardship Council (FSC).⁶¹ Queensland requires biobased petrol and biobased diesel sold under the biofuels mandate to meet the sustainability criteria for biofuels. The criteria includes a 20 per cent minimum greenhouse gas saving threshold and certification under the relevant environmental standard for the feedstock used.⁶² 	✓
Criteria 5: Advocacy and education	<ul style="list-style-type: none"> In 2016 QLD government released the 10-year Roadmap and Action Plan for Biofutures with a focus on economic development in regional and rural areas and a sustainable option to produce biofuels, biochemicals, bioplastics and other biomaterials. We note the Roadmap could better highlight bioenergy as a reliable, dispatchable source of electricity, which can potentially increase energy security. DSDMIP website offers several links to data and information to QLD's biofutures strategies and initiatives, although it is difficult to determine whether the community is offered adequate information regarding competition with food crops, lifecycle carbon balance or compliance on incineration⁶³. 	✓✓

A.2 NSW

Policy Criteria	Assessment	Grade
<p>Criteria 1: Policy development and effectiveness</p>	<ul style="list-style-type: none"> • Protection of the Environment Operations Act 1997⁶⁴ and the Waste Avoidance and Resource Recovery Act 2001⁶⁵ are defined policies with objectives that are aligned to support the development of the bioenergy industry. • The Environmental Planning and Assessment Amendment Act 2017⁶⁶, the State Environmental Planning Policy (State and Regional Development) 2011⁶⁷, and the State Environment Planning Policy (Infrastructure) 2007⁶⁸ do not specifically align with the bioenergy sector, but offer some support to industry needs. • The Office of Environment & Heritage (OEH) introduced The Climate Change Fund in 2007⁶⁹ under the Energy and Utilities Administration Act 1987 which encourages energy and water saving activities and contributes to over 28 grant and research & development programs that directly support the application of biomass production for bioenergy.⁷⁰ The grants aim to contribute over \$80 million in funding. • In 2007, NSW introduced the first biofuels mandate in Australia, which required fuel wholesalers to ensure that ethanol made up a minimum of 2 per cent of petrol sold in NSW. As of 2017, the mandate has been re-focused towards 'volume fuel retailers' – a service station which sells three or more types of petrol or diesel and sells in excess of 900,000 litres per quarter of petrol and diesel combined, in two consecutive quarters.⁷¹ 	–
<p>Criteria 2: Bioenergy project development</p>	<ul style="list-style-type: none"> • Of the 80 bioenergy projects in NSW, there are 23 operating projects and 4 either under construction or feasibility which generate over one MW of electricity. While six produce bioproducts, 26 generate less than one MW of electricity and another 21 are considered 'other' projects (flaring, waste water for treatment or biogas for behind the meter). • The Department of Planning and Environment (DPE) is responsible for NSW's State significant developments under the State Environmental Planning Policy 2005⁷² which consider wider social, economic or environmental significance to the community. • Of the 80 NSW project responses to the bioenergy questionnaire, 25 have received federal or state government grants or support.⁷³ • Survey responses indicate that direct and indirect jobs will be created from the commissioning of at least 30 additional bioenergy projects in NSW.⁷⁴ 	✓
<p>Criteria 3: Technology and feedstock diversity</p>	<ul style="list-style-type: none"> • NSW's application of bioenergy technology is predominately combustion, followed by anaerobic technologies across the 80 projects either proposed, under construction or commissioned.⁷⁵ • Of those projects, the commonly used feedstocks are municipal waste and agricultural residues. Wood waste and animal residues are yet to be fully adopted throughout the state.⁷⁶ 	✓
<p>Criteria 4: Sustainability guidance</p>	<ul style="list-style-type: none"> • Based on our research we could find no evidence of sustainability guidance in place. • NSW participates in ABBA (see Queensland for background). 	–
<p>Criteria 5: Advocacy and education</p>	<ul style="list-style-type: none"> • The NSW Renewable Energy Action Plan and the Renewable Energy Advocate promote renewable energy within the industry and general public, with limited emphasis on bioenergy.⁷⁷ • DPE website provides some details on sustainable energy, including bioenergy.⁷⁸ 	–

A.3 Victoria

Policy Criteria	Assessment	Grade
<p>Criteria 1: Policy development and effectiveness</p>	<ul style="list-style-type: none"> • The Victorian Waste and Resource Recovery Policy⁷⁹ under the Environment Protection Act 1970 provides a guideline which outlines all the processes and technologies that recover energy or fuel from biological processing and details well-defined policy objectives. • The Environmental Protection Agency (EPA) Victoria released the siting, design, operation and rehabilitation of landfill guidelines to provide a clear statement of performance and objectives which are aligned to support the development of the bioenergy industry.⁸⁰ • In support of the above mentioned policies and guidelines, the Victorian government also established the \$500 million Sustainability Fund⁸¹ which receives funds from Victorian landfill levies and redistributes as grants. • 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.⁸² • The Climate Change Act 2017⁸³ drives Victoria's transition to a net zero emissions state, which provides general support to the development of the bioenergy industry. • The New Energy Technology Sector Strategy sets out the need to implement an industry development plan for the bioenergy sector.⁸⁴ 	✓✓
<p>Criteria 2: Bioenergy project development</p>	<ul style="list-style-type: none"> • Of the 45 bioenergy projects in Victoria, there are 23 operating projects and two either under construction or feasibility which generate over one MW of electricity. While according to the Bioenergy Australia data, none produce bioproducts, 16 generate less than one MW of electricity, and another four are considered 'other' projects (flaring, waste water for treatment or biogas for behind the meter). • The Environmental Protection Authority Victoria coordinates approval assessments but no evidence was found regarding the duration or certainty or the project development approval process. • VIC project responses to the Bioenergy Australia survey did not disclose information about job creation. • Of the 45 VIC project responses to the bioenergy questionnaire, six have received grants or support from either federal or state jurisdiction.⁸⁵ 	✓
<p>Criteria 3: Technology and feedstock diversity</p>	<ul style="list-style-type: none"> • VIC's application of bioenergy technology is predominately combustion technologies across 45 projects either proposed, under construction or commissioned.⁸⁶ • Of those projects, the commonly used feedstocks are municipal waste, followed by wood waste. There are few agricultural and animal residues feedstocks being used throughout the state.⁸⁷ 	✓
<p>Criteria 4: Sustainability guidance</p>	<ul style="list-style-type: none"> • Based on our research we could find no evidence of sustainability guidance in place. • Victoria participates in ABBA (see Queensland for background). • VicForests' operations are certified to the Australian Forestry Standard which is endorsed by PEFC.⁸⁸ VicForests' is also a member of the FSC. 	—
<p>Criteria 5: Advocacy and education</p>	<ul style="list-style-type: none"> • The Renewable Energy Roadmap⁸⁹ promotes bioenergy to industry and the general public. It focuses on the bioenergy's three strengths of economic development, energy security and sustainability. • Turning waste to energy discussion paper seeks to engage the community in a discussion on best practices and highlights the role of waste to energy technologies.⁹⁰ 	✓✓

A.4 South Australia

Policy Criteria	Assessment	Grade
<p>Criteria 1: Policy development and effectiveness</p>	<ul style="list-style-type: none"> The SA government has funded the Bioenergy Roadmap⁹¹ to provide a foundation of research and help businesses and industry groups to identify and develop bioenergy projects in SA. The SA Energy Plan directly supports the \$150 million Regional Growth Fund⁹², which has a focus on enhancing regional infrastructure (inclusive of waste-to-power plants) and the \$150 million Renewable Technology Fund⁹³ which aims to catalyse private investment to support further integration of bioenergy technologies. In March 2015, Renewables SA commissioned Jacobs Group (Australia) to analyse South Australia's bioenergy potential in a step towards creating a sustainable bioenergy industry. 	✓✓
<p>Criteria 2: Bioenergy project development</p>	<ul style="list-style-type: none"> Of the 20 bioenergy projects in South Australia, there are six operating projects and three either under construction or feasibility which generate over one MW of electricity. While two produce bioproducts, four generate less than one MW of electricity, and another five are considered 'other' projects (flaring, waste water for treatment or biogas for behind the meter). Renewables SA provides guidelines and certainty for obtaining development approvals as well as the processes through the South Australian Development Act 1993⁹⁴ and Development Regulations 2008.⁹⁵ Of the 20 SA project responses to the bioenergy questionnaire, three have received state or federal grants or support.⁹⁶ 	✓
<p>Criteria 3: Technology and feedstock diversity</p>	<ul style="list-style-type: none"> SA's application of bioenergy technology is predominately anaerobic digestion, followed by combustion technologies across the 20 projects either proposed, under construction or commissioned.⁹⁷ Of those projects, the commonly used feedstocks are municipal waste and agricultural residues, followed by forest residues.⁹⁸ 	✓
<p>Criteria 4: Sustainability guidance</p>	<ul style="list-style-type: none"> Based on our research we could find no evidence of sustainability guidance in place. South Australia participates in ABBA (see Queensland for background). 	—
<p>Criteria 5: Advocacy and education</p>	<ul style="list-style-type: none"> Two Bioenergy Roadmap Forums have been held by Renewables SA which focused on a business case for bioenergy, advocated economic development in rural areas, and educated the community on the myths concerning bioenergy.⁹⁹ This information can be found online through the Renewables SA bioenergy website, while the site also offers several links to other bioenergy knowledge sharing portals. Renewables SA bioenergy website promotes the bioenergy industry with a clear focus on energy security and sustainability.¹⁰⁰ Moreover, the website offers links to bioenergy news, resource maps and events, as well as investment portals. 	✓✓

A.5 Western Australia

Policy Criteria	Assessment	Grade
Criteria 1: Policy development and effectiveness	<ul style="list-style-type: none"> In 2007, the Western Australian Government created a BioFuels taskforce to examine Biofuel opportunities.¹⁰¹ The taskforce made 22 recommendations, but due to a change in government priorities, none appear to have been implemented. In 2014, a Biomass scoping study¹⁰² - Bulletin 4862 was published by the Department of Agriculture and Food which also outline Bioenergy opportunities. There is no update on whether any findings have been implemented. Based on our research, there were no state government grants or incentives identified which offer support to the development of the bioenergy sector in Western Australia. 	—
Criteria 2: Bioenergy project development	<ul style="list-style-type: none"> Of the 29 bioenergy projects in Western Australia, there are 14 operating projects and three either under construction or feasibility which generate over one MW of electricity. three projects produce bioproducts, one wood pellets for export, six generate less than one MW of electricity and another two are considered 'other' projects (flaring, waste water for treatment or biogas for behind the meter). Of the 29 WA project responses to the bioenergy questionnaire, three have received grants or support from ARENA.¹⁰³ Of the 29 projects currently listed, 1,344 jobs are expected to be created which is predominately due to the 1,000 construction jobs needed for the Phoenix Energy Waste-to-energy facility.¹⁰⁴ The project is worth over \$400 million and Phoenix Energy has signed a 20 year resource recovery agreement with seven Regional Local Government Authorities. 	✓
Criteria 3: Technology and feedstock diversity	<ul style="list-style-type: none"> WA's application of bioenergy technology is combustion and anaerobic technologies across the 29 projects either proposed, under construction or commissioned.¹⁰⁵ Of those projects the commonly used feedstocks are municipal waste and agricultural residue.¹⁰⁶ 	✓
Criteria 4: Sustainability guidance	<ul style="list-style-type: none"> Based on our research we could find no evidence of sustainability guidance in place. Western Australia has endorsed ABBA (see Queensland for background). 	—
Criteria 5: Advocacy and education	<ul style="list-style-type: none"> Many external websites link to the Department of Finance for Bioenergy reports, however, these links no longer work. The only established government repository for bioenergy information is a sub-section of the climate-land-water page of the Department of Primary Industries and Regional Development website¹⁰⁷, for which no link is actually provided 	—

A.6 Australian Capital Territory

Policy Criteria	Assessment	Grade
Criteria 1: Policy development and effectiveness	<ul style="list-style-type: none"> The ACT Waste Management Strategy 2011–2025¹⁰⁸ sets objectives for achieving no waste to landfill and was a result of community consultation. The strategy also supports the potential of innovative bioenergy technologies. The ACT Sustainable Energy Policy¹⁰⁹ highlights the ACT Government’s goal to reach 100 per cent renewable generation by 2020, although does not explicitly outline objectives to drive the development of the bioenergy sector. The Electricity Feed-in-Tariff (Large-scale Renewable Energy Generation) Act 2011¹¹⁰ provides a mechanism to stimulate investment in large-scale renewable energy in the ACT, however, it has not directly aligned with the bioenergy sector. 	✓
Criteria 2: Bioenergy project development	<ul style="list-style-type: none"> There are three bioenergy projects which operate in the ACT which generate for a combined total of 4.4 MW. In addition, according to the data, there are no plants producing bioproducts. While, it is expected the ACT would not have as many operating projects when compared to the other major states – according to the Bioenergy Australia data there are no projects in the development pipeline The ACT Waste Management Strategy supports the bioenergy industry. 	✓
Criteria 3: Technology and feedstock diversity	<ul style="list-style-type: none"> There is no technology or feedstock diversification. According to the Bioenergy Australia survey data, ACT has three municipal waste facilities that use anaerobic digestion.¹¹¹ 	–
Criteria 4: Sustainability guidance	<ul style="list-style-type: none"> Based on our research we could find no evidence of sustainability guidance in place. The ACT Government’s Sustainability Policy 2009¹¹² identifies sustainable procurement principles to be incorporated into the ACT’s procurement processes. Although, it does not demonstrate whether systems are in place for the sustainable traceability of bioenergy feedstock. 	–
Criteria 5: Advocacy and education	<ul style="list-style-type: none"> Limited advocacy other than the ACT Waste Management Strategy 2011-2025, which notes the importance of bioenergy as a source of energy security and sustainability as well as promoting bioenergy within industry and the general public. 	–

A.7 Tasmania

Policy Criteria	Assessment	Grade
Criteria 1: Policy development and effectiveness	<ul style="list-style-type: none"> The Tasmania Energy Strategy was released in 2015 and included \$200,000 funding for biofuels, \$550,000 in funding for forest residues¹¹³ and \$1.25 million in funding for Wood and Fibre processing.¹¹⁴ In their 2017 report, the Tasmanian Energy Security Taskforce, a committee implemented under the <i>Energy Co-Ordination and Planning Act 1995</i>¹¹⁵, deemed bioenergy (biomass) technology too costly in the short-term, however, given more government support it may be viable in the long term.¹¹⁶ 	✓
Criteria 2: Bioenergy project development	<ul style="list-style-type: none"> Of the 12 bioenergy projects in Tasmania, there are four operating projects and one project proposed which generate over one MW of electricity. While two bioenergy projects are or would produce wood pellets, another five are considered 'other' projects (flaring, waste water for treatment or biogas for behind the meter). Of the 12 project responses to the bioenergy questionnaire, three have received grants or support from either federal or state jurisdiction.¹¹⁷ Several commissioned projects have employed 345 people nationally, while the \$50 million Valley Central Industrial Precinct - Bioenergy Hub is expected to create 82 full-time positions during construction and 30 full-time positions during operation.¹¹⁸ 	✓
Criteria 3: Technology and feedstock diversity	<ul style="list-style-type: none"> Tasmania's application of bioenergy technology is predominately combustion technologies across the bioenergy projects either proposed, under construction or commissioned.¹¹⁹ Of those projects, the commonly used feedstocks are municipal waste and wood waste.¹²⁰ 	✓
Criteria 4: Sustainability guidance	<ul style="list-style-type: none"> Based on our research we could find no evidence of sustainability guidance in place. Tasmania has endorsed ABBA (see Queensland for background). Information pertaining to Tasmanian Forest Agreement (AFA) and FSC certification for sustainable timber can be found on the Department of State Growth website as well as other information relating to the states strategic plans for timber. 	—
Criteria 5: Advocacy and education	<ul style="list-style-type: none"> Information pertaining to forestry / timber in Tasmania is easily accessible through the www.stategrowth.tas.gov.au website which includes information on regulation, funding, industry bodies and planning. Although, through our research it is difficult to identify suitable information relating to bioenergy and other biomass sources. Community groups in the south (Huon region) and the north east (Dorset region) have been specifically established for the commercialisation of wood residue opportunities that can benefit regional communities. 	—

A.8 Northern Territory

Policy Criteria	Assessment	Grade
Criteria 1: Policy development and effectiveness	<ul style="list-style-type: none"> The NT government has developed the Roadmap to Renewables¹²¹, however, it was identified that a challenge for NT will be to develop sufficient biomass feedstock to support the development of the bioenergy industry. 	✓
Criteria 2: Bioenergy project development	<ul style="list-style-type: none"> According to the Bioenergy Australia survey data, NT has only one operating bioenergy facility, which was commissioned in 2005¹²² and there is no evidence to suggest there are bioenergy projects in the development pipeline. It is difficult to assess whether government policies have driven growth in the bioenergy sector. 	—
Criteria 3: Technology and feedstock diversity	<ul style="list-style-type: none"> The Shoal Bay Renewable Energy Facility use combustion technologies and municipal waste as a feedstock. 	—
Criteria 4: Sustainability guidance	<ul style="list-style-type: none"> Based on our research we could find no evidence of sustainability guidance in place. 	—
Criteria 5: Advocacy and education	<ul style="list-style-type: none"> The Roadmap to Renewables states that due to a lack of data through the NT, it is challenging to assess biomass as a resource and advocate to industry and the general public. No action has been taken to rectify this. 	—

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