Energising resource recovery: the Australian opportunity

Investment Outlook

ARUP

About this report

Energising resource recovery: the Australian opportunity investigates the exciting potential and considerable benefits of resource recovery and bioenergy.

In developing our Investment Outlook to 2025 we worked together with global engineering and consultancy leader Arup in addressing some of the big questions:

1. How can our modern day systems for managing waste and resources play a valuable role in the vital transition to cleaner, cheaper and more reliable energy?

2. Where are the economic, environmental, social and energy benefits?

3. How can we convert this potential into an energy and economic benefit for Australia?

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Energising resource recovery: the Australian opportunity

Australia's recycling and resource recovery sector is undergoing considerable transformation, driven by global market pressures, evolving consumer preferences and an increasing focus on cutting our carbon footprint.

As an experienced investor in the bioenergy and thermal energy from waste sectors, the Clean Energy Finance Corporation (CEFC) sees immediate and important investment opportunities in recycling and resource recovery, drawing on proven technologies with the potential to deliver long term economic and environmental benefits.

We also recognise the critical importance of the circular economy, in supporting the development of new industries and jobs while cutting greenhouse gas emissions and making more efficient use of finite natural resources.

In this Investment Outlook, we examine the investment and employment benefits that can be gained from strengthening our recycling, organics, bioenergy and thermal energy from waste sectors. We discuss the key factors influencing market developments and examine the very considerable potential for emissions reduction.

Positive impact

Our analysis points to an exciting future, with the sector capable of delivering a positive impact in reaching Australia's economic, employment and emissions goals:

- New and expanded infrastructure requirements for waste, recycling and bioenergy projects in Australia have the potential to generate between $4 billion and $7.8 billion in new investments in the period to 2025.
- The employment benefits include the potential for the creation of up to 9,000 construction jobs, 2,600 indirect jobs and as many as 1,400 direct and ongoing jobs, including in regional and rural areas.
- From an emissions reduction perspective, the benefits are also substantial, with the potential to reduce landfill emissions by as much as 60 per cent based on current forecasts.

Our strong track record

The CEFC has been an active investor in the bioenergy and waste sectors since we began investing and we have a strong pipeline of projects ahead. Our goal is to increase the flow of investment in projects and opportunities to support Australia's transition to a low emissions economy. Bioenergy and waste have a big role to play here, including through the Australian Recycling Investment Fund.

The bioenergy and waste sectors are particularly diverse, encompassing a broad range of feedstocks, technologies and end uses. All have the potential to cut Australia's emissions, contribute to the circular economy and drive investment. While this complexity poses challenges for potential investors and project proponents, international experiences give us confidence that these challenges do not outweigh the opportunities.

This comprehensive Investment Outlook, developed alongside Arup, builds on our previous market research into bioenergy and waste. We trust it will give investors and policy makers a richer understanding of this exciting market and the very real opportunities for new investment and accelerated emissions reduction.

I encourage you to contact the CEFC and our specialist waste and bioenergy team to explore these opportunities further.

Ian Learmonth
Chief Executive Officer, CEFC

1. Investment Outlook

Triple impact: economy, employment and lower emissions

The five-year infrastructure investment outlook in Australia's waste, bioenergy, recycling and resource recovery sectors is robust. Australia-wide, we see a potential infrastructure pipeline of $4–$7.8 billion in investment opportunities.

These investments have the potential to deliver 9,000 construction jobs and as many as 1,400 ongoing operational roles in metropolitan and regional communities. Of equal significance, these investments have the potential to avoid more than three million tonnes CO_2-equivalent (CO_2-e) of methane emissions from landfills every year.

Investment Outlook to 2025

~$4b – $7.8b

new investment

~3 Mt CO_2-e

avoided

~9,000

construction jobs

Source: Arup analysis

Pathway to delivery: five principles

The pathway to realising the potential of this infrastructure pipeline requires investors and decision makers to focus on five key principles:

1. The adoption of mature and proven technologies, adapted to meet Australian markets and contexts.

2. Development of a robust strategy for securing suitable waste and feedstock materials and supplying recovered products or energy to market.

3. Implementation of a mature commercial approach to infrastructure delivery and operation for long term performance.

4. A clear commitment to community engagement, delivering a social licence to operate.

5. An informed approach to site selection, balancing transport and energy efficiency considerations alongside land use and community expectations.

Factors driving investment: top 10

In considering the Investment Outlook to 2025, we examined the investment and employment benefits that can be gained from strengthening our recycling, organics, bioenergy and thermal energy from waste sectors. The key factors influencing investment and market developments are summarised here.

1. Circular economy

Significant momentum is building to move towards a circular economy. Australians are ready to take greater responsibility for the better management of wasted resources, while also realising value for businesses and Australian communities in the process.

2. Policy drivers

Policy implementation has the ability to heavily drive investment and employment. Recent impactful policies include the application and increasing of landfill levies in certain states, Council of Australian Governments (COAG) waste export bans, increased source separation and an ambitious 80 per cent resource recovery target and 50 per cent reduction of organic waste to landfill by 2030 under the National Waste Policy Action Plan.

3. Landfill levies

Landfill levies remain one of the strongest drivers of investment through to 2025. If implemented appropriately, landfill levies encourage the diversion of valuable resources from landfill to higher order uses, creating significant infrastructure investment and employment opportunities.

4. Resource recovery market development

There is renewed focus on development and regulation of markets for recycled materials and by-products from other resource recovery operations, including leveraging government procurement. This will drive demand for recovered materials and reduce the commercial risk for resource recovery project investments.

5. Bioenergy as a flexible energy source

Higher value must be placed on renewable energy to fully realise the opportunities in this sector. Bioenergy is a flexible energy source capable of producing renewable electricity, renewable heat, renewable gas and renewable transportation fuels, whilst also having the ability to regenerate natural systems and is able to support decarbonisation of harder to abate sectors such as industry and manufacturing.

6. Resilient supply chains

The COVID-19 pandemic has shone a spotlight on the need for Australia to build more resilient and sustainable supply chains. The Australian Government $1.3 billion Modern Manufacturing Initiative will provide a catalyst to support infrastructure investment and create employment opportunities, including rural and regional job creation.

7. Source separation of waste streams

Increased focus on the source separation of waste streams will result in lower sorting costs, lower contamination rates leading to less residual waste to landfill, and a wider array of available end uses and markets. Recent examples in Australia include the proliferation of Container Deposit Schemes and implementation of improved kerbside collection systems.

8. The international experience

The relative immaturity of Australia's waste management and resource recovery sector means there is a significant opportunity to take international learnings and commercially proven technologies and apply that to the Australian context. For example, following the successful financing of the first two thermal Energy from Waste (EfW) projects only in the last two years, a significant project pipeline has already emerged in this sector. This approach can be applied to other commercially proven technologies like anaerobic digestion and food-grade plastics recycling.

9. Advanced processing infrastructure

Increasing waste streams, primarily due to population growth, that must be dealt with locally will necessitate increased investment in more advanced processing infrastructure. This not only delivers investment and job benefits but will also deliver better quality recycled material for a wider range of applications.

10. Reducing organic waste

Increasing attention on reducing organic waste to landfill by 50 per cent by 2030 will create opportunities for composting and anaerobic digestion investments using high quality organic feedstocks. It will also provide significant decarbonisation benefits by preventing methane release that would otherwise occur when organics are landfilled. Methane has 28 times greater global warming potential than an equivalent amount of carbon dioxide.[1]

National Waste Policy Action Plan targets:

80%
resource recovery

50%
reduction of organic waste to landfill

2. Circular economy sets the framework

A commitment to the principles of the circular economy set the framework for developing **Energising resource recovery: the Australian opportunity.**

The World Sustainable Business Council describes the circular economy as one that moves away from the traditional "take-make-dispose" economic model to one that is regenerative by design. The goal is to retain as much value as possible from resources, products, parts and materials to create a system that allows for long life, optimal reuse, refurbishment, remanufacturing and recycling.[2] The United Nations has recognised the importance of this approach under Sustainable Development Goal 12: Responsible Consumption and Production.

The circular economy has been identified as a major commercial opportunity by the World Economic Forum, supporting the development of new industries and jobs, reducing greenhouse gas emissions and increasing the efficient use of natural resources (including energy, water and materials). Globally, the circular economy transition could offer up to US $4.5 trillion in economic benefits to 2030. However, in 2020, only 8.6 per cent of the world's systems of consumption and production were associated with the circular economy.[3]

In Australia, the transition to a circular economy is well underway. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is exploring research pathways in support of a circular economy, with an objective of reducing total waste generated in Australia by 10 per cent per person by 2030 and aiming to achieve an 80 per cent average resource recovery rate from all waste streams applying the waste hierarchy by 2030.[4]

The CSIRO also published its circular economy roadmap in January 2021, reviewing four materials that are common waste streams in the economy: plastics, tyres (automotive and mining), glass and paper. The roadmap notes that all participants in the circular economy have a shared responsibility to make it efficient and effective, including government, industry, the community and research organisations. It identifies a range of priority areas for action, including procurement, harmonised standards, infrastructure investment, technology innovation, reduced contamination and disposal bans.[4]

Case study

IKEA, Australia[5]

IKEA has identified the consumption of materials as a key environmental impact related to its furniture and homewares businesses. Progress towards its 2030 vision of having 100 per cent circular and climate-positive operations began with 100 per cent sustainable certification of all wood and paper products.

IKEA is now tackling the challenge of phasing out virgin plastics and developing circular business models, adjusting operations within IKEA factories and supply chains, and developing take-back and leasing models for customers.

100%

sustainable certification of all wood and paper products by 2030

10 stores

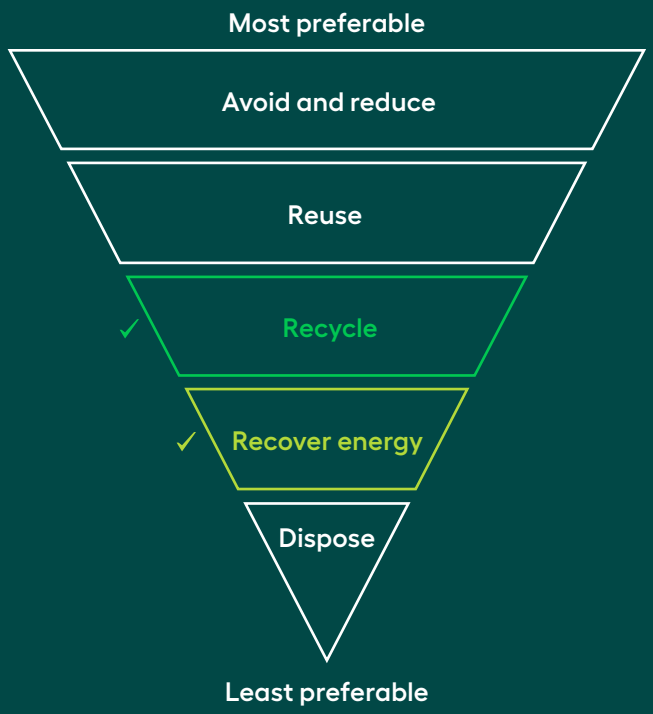
Australian IKEA stores offer furniture buy-back since 2020

Guiding principles of waste management

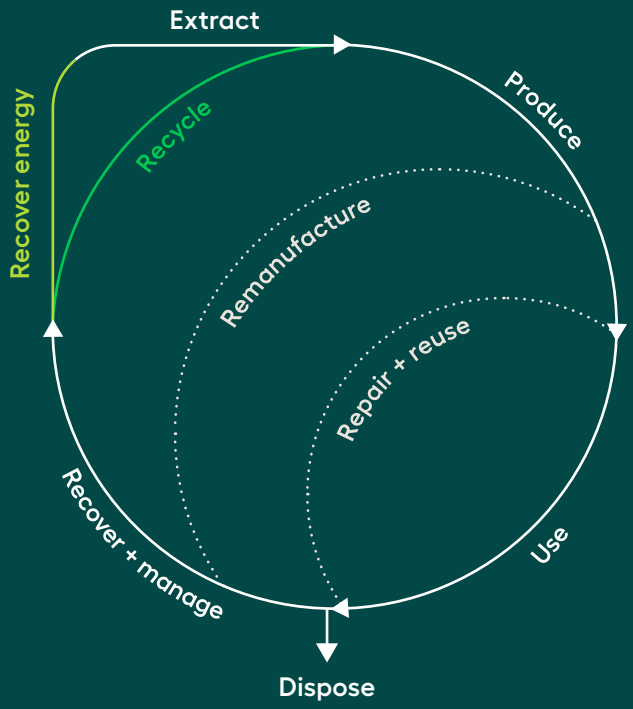
The waste hierarchy outlines a preferential ranking for management of waste materials. Avoidance and reduction of waste are the most preferable outcomes and disposal of waste to landfill is the least desirable outcome. Infrastructure opportunities within Australia are moving up the waste hierarchy, beyond a reliance on landfill disposal. Australia's investment opportunity spans multiple levels of the waste hierarchy, acknowledging the varied and complementary roles of different technologies.

This report focuses on infrastructure investments to recycle and recover energy from waste.

Waste hierarchy



Circular economy



✓ Recycling: paper, plastics, glass and tyres
Composting
Anerobic Digestion

✓ Processed engineered fuel (PEF) Production
Thermal energy from waste

The waste hierarchy principle is widely accepted globally and in Australia and is reflected in waste management legislation.

Cutting through the complexity

The bioenergy and waste sectors are particularly diverse, encompassing a broad range of feedstocks, technologies and end uses.
All have the potential to cut Australia's emissions, contribute to the circular economy and drive investment.

Diversifying Australia's infrastructure portfolio:

1. Recycling

Renewed focus on domestic opportunities to take greater responsibility for wasted resources is driving recycling infrastructure investment opportunities, creating jobs and recovering more value for Australia. This will ultimately support a circular economy onshore. Paper, plastics, tyres and glass are a priority focus for new investment due to impending bans on the export of this waste.

2. Organics

Increasing focus on source-separation of organic waste creates opportunities for high quality recycling and emissions reduction through new and expanded composting and anaerobic digestion infrastructure. Returning recovered organic waste to agricultural land has soil health and productivity benefits.

3. Bioenergy

Bioenergy technologies can provide flexible, renewable energy from organic feedstocks and can support significant emissions reduction by diverting organic waste from landfills. When landfilled, organic waste forms methane, which is a greenhouse gas 28 times more potent than carbon dioxide.[1] Proven technologies are beginning to find commercial applications in Australia and could achieve widespread expansion with the right policy and incentives.

4. Thermal energy from waste

Thermal energy from waste is a mature infrastructure and technology option for the treatment of both mixed and residual waste. There is a strong pipeline of proposals that can relieve pressures on metropolitan landfill capacity, provide reliable heating and electricity and reduce emissions by diverting waste from landfill.

Australian Recycling Investment Fund

The Australian Recycling Investment Fund, with access to $100 million in CEFC finance, was created in December 2019 to invest in projects which use clean energy technologies to support recycling and resource recovery operations and the broader circular economy.[6]

Investing in a cleaner future:

The Fund has a particular focus on large-scale commercial projects which support the recycling of waste plastics, paper, glass and tyres, consistent with the National Waste Policy Action Plan.

The CEFC is working with project sponsors on a range of innovative solutions to increase resource recovery, recycling, and diversion of waste from landfill. In line with the CEFC Act, eligible projects are required to draw on renewable energy, energy efficiency and low emissions technologies and to contribute to emissions reduction.

The CEFC expects to provide either debt or equity finance to eligible larger-scale commercial projects through the Fund – typically requiring $10 million or more of CEFC capital. Smaller-scale projects, from $10,000 to $5 million, may be eligible for debt finance through the specialist CEFC asset finance programs.

3. Market and policy context

The global view

In July 2017, the Chinese Government announced its National Sword policy, dramatically reducing the contamination thresholds for imported solid waste from five per cent impurities to 0.5 per cent impurities for both scrap paper and scrap plastics. This policy was enacted in January 2018 and effectively banned the import of mixed scrap material. Prior to these restrictions, Australia sent 1.25 million tonnes of recyclable material to China each year.[7]

This disruption highlighted Australia's reliance on international commodity markets as part of its waste management practices. It galvanised a push for a more circular approach to resource recovery, with responsibility for waste materials and resource recovery moving to the domestic economy.

More recently, industry news reports suggest that the Chinese Government will ban all imports of solid waste from 2021 and will no longer accept or approve import applications for solid waste. In addition, three of the five largest global shipping lines (MSC, Hapag Lloyd and Maersk Line subsidiary Hamburg Süd) have announced they will cease receiving recovered materials for shipment to China.

1.25m tonnes

of recyclables can no longer be exported to China [7]

The Australian view

In response to international market disruptions, the COAG announced national packaging targets, export bans on specific materials and funding for recycling infrastructure to address the shortfall in domestic recycling capacity.

All levels of Government play a role in generating demand for high quality recycled products via direct Government procurement processes, or conditions imposed on Government funded projects. This may include mandating the minimum use for recycled product in infrastructure projects such as roads, as is currently being considered by the Australian Government.

In December 2019, the Australian Government directed the CEFC to create a $100 million Australian Recycling Investment Fund to encourage increased investment in clean energy technologies which support recycling, leading to lower landfill related emissions. The federal government has also provided matched grant funding for recycling infrastructure upgrades through the $190 million Recycling Modernisation Fund (RMF) to help the recycling sector adapt to the waste export bans.[8] By March 2021, state government partnerships under the RMF reached a total co-funded commitment of $193 million to increase the capacity of recycling infrastructure and support the manufacture of recycled goods around Australia.

In March 2020, the Australian Government announced its intention to introduce new procurement guidelines to encourage the uptake of secondary resources during the National Plastics Summit. In addition, the Victorian Government announced a Recycled First policy for major transport infrastructure construction projects, which has the potential to mobilise the use of recycled glass, rubber, aggregate and plastics throughout Victoria's Big Build program.

The targets, policies, funding and changes to Government procurement processes that have been announced in the past five years, and the plans to achieve various initiatives by 2030, send clear market signals to the recycling and resource recovery industry.

The combination of supply drivers, such as the export bans and recycling targets, and demand drivers, such as procurement, create investment opportunities to increase recycling capacity, particularly those focusing on national priority materials including plastic, paper, glass, tyres and organics.

Australian export of waste for recycling[7,9]

4.4m
tonnes each year in both 2016-17 and 2018-19

$3.2b
value in 2018-19

Plastics

0.3m tonnes recycled

54% exported[10] | 46% recycled in Australia

Paper and cardboard

3.4m tonnes recycled

30–40% exported | 60–70% recycled in Australia

Metals

5m tonnes recycled

50% exported | 50% recycled in Australia

Tyres

0.3m tonnes recycled

40% exported whole | 40% processed + exported | 20% recycled in Australia

Exported waste
Recycled in Australia

Building momentum for resource recovery

Since 2018, government policy and funding announcements at a federal and state level have accelerated. This unlocks new resource recovery infrastructure opportunities.

Policy announcements

2015
- Waste management strategy, NT
- Waste strategy, SA
- Organics resource recovery strategy, VIC

2016
- Market development strategy for recovered resources, VIC
- Biofutures roadmap, QLD

2017
- Food waste strategy, National
- ✓ Yarra Valley Water anaerobic digestion plant commences operations, VIC

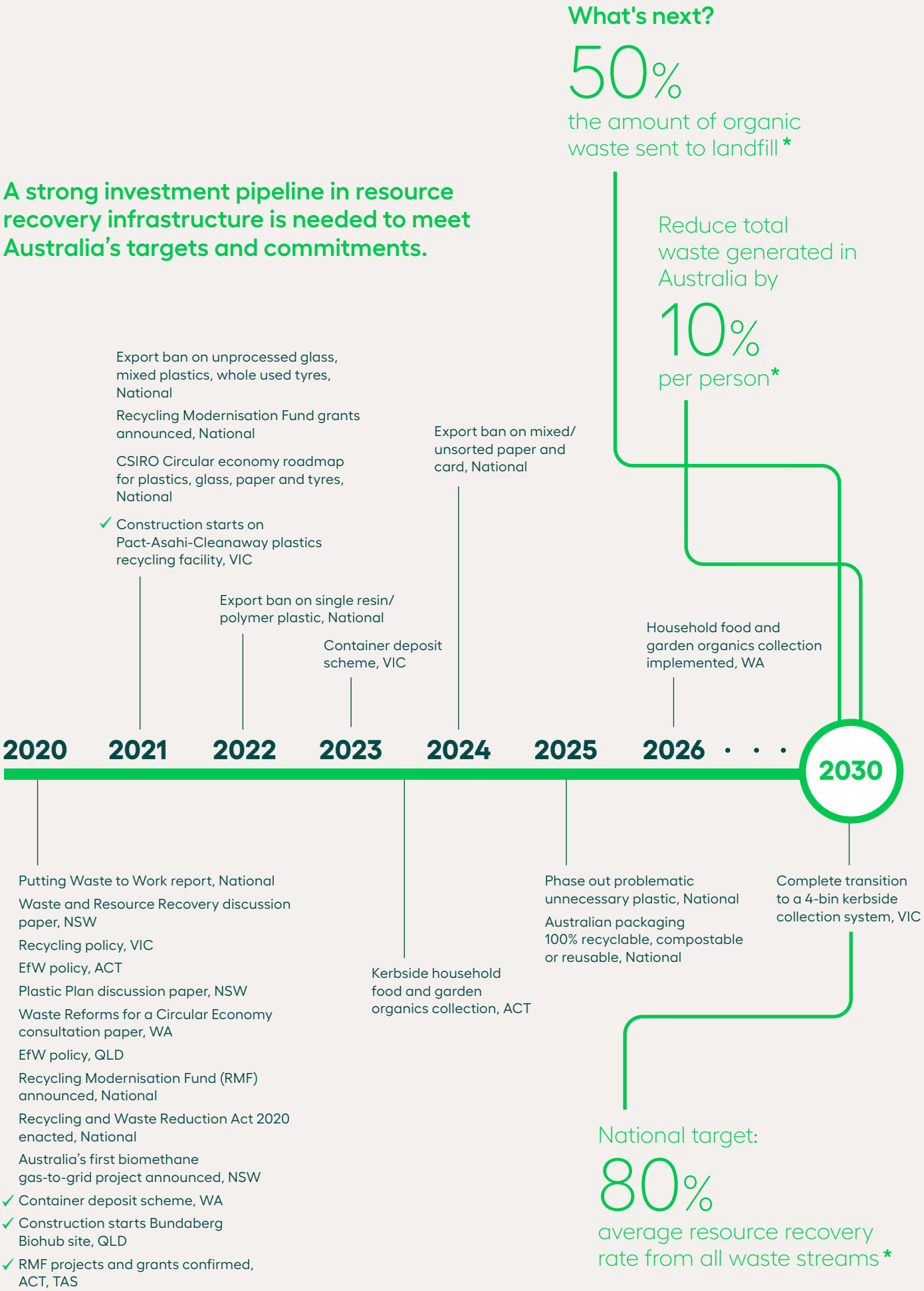
2018
- China import restrictions, National
- Waste and resource recovery infrastructure plan, SA
- Waste feasibility study, ACT
- Container deposit scheme, NSW, ACT, QLD
- Waste Strategy, QLD
- Waste and resource recovery infrastructure plan, VIC
- ✓ Avertas thermal EfW plant begins construction, WA
- ✓ ResourceCo Wetherill Park waste to fuel plant opens, NSW
- ✓ Boral Berrima cement kiln begins co-firing waste-derived fuel, NSW

2019
- Waste policy action plan, National
- $167 million Australian Recycling Investment Plan, National
- CEFC Australian Recycling Investment Fund created, National
- Thermal EfW position statement, SA
- Circular economy policy statement, NSW
- Landfill levy commences, QLD
- Waste avoidance and resource recovery strategy, WA
- Circular economy in action, SA
- ✓ East Rockingham thermal EfW plant begins construction, WA
- ✓ Sacyr organics recovery plant opens in Melbourne, VIC
- ✓ Advanced Circular Polymers recycling facility opens, VIC

✓ Resource recovery infrastructure

✱ All targets will be measured against baselines in the 2018 National Waste Report

A strong investment pipeline in resource recovery infrastructure is needed to meet Australia's targets and commitments.



State context influences investment opportunity

The Australian resource recovery and bioenergy sectors are complex, in terms of technology, feedstocks, end uses and policy levers. While investment decisions are influenced by a range of factors, the market impact of a selection of policy settings is discussed here.

The current market for the recycling and resource recovery industry is significantly shaped by landfill levy values and impending export bans. These factors are translating strategic objectives for landfill diversion and improved recycling directly into commercial decision-making.

Waste will most often be directed to the lowest-cost available outlet, unless there are other inhibitors or incentives in place, such as bans, feed-in tariffs (FiT), levies or corporate responsibility schemes to disincentivise this behaviour. Gate fees for recycling and EfW facilities must be competitive with landfill charges to secure feedstock.

Landfill levies are set through State-based legislation and vary around the country. Australian jurisdictions are not consistent on the application of a levy, the levy value, exemptions to the levy, or hypothecation of the levy funds. However, there is a general trend towards implementation of levies and levy increases, providing greater opportunity for the deployment of recycling and resource recovery facilities and the development of other end markets for materials.

Between 2015-2020, landfill levy settings supported a pipeline of proposals for thermal energy from waste projects. However, they have been less successful in driving recycling and bioenergy projects, which are more heavily reliant on the quality of input material and on the market value of recovered products to achieve viable commercial operations.

EfW policy approaches

There is no national EfW policy guidance in Australia but there is convergence in the adoption of a policy position for each State and Territory. Commonly, the policy approach limits thermal recovery of energy to residual waste streams which have no viable alternative to landfilling. To achieve this, a majority of Australian EfW policy documents outline eligibility criteria. This not only highlights the opportunity for EfW development in Australia but also the additional sorting and recycling infrastructure required to respect the waste hierarchy and safeguard an appropriate role for EfW within the wider waste and recycling system.

EfW eligibility criteria vary between States

SA	Landfill levy liability for councils is determined based on kerbside source separation performance. For councils with food and garden organics (FOGO) collection systems, up to 40 per cent (by weight) of municipal solid waste (MSW) total kerbside collection is eligible for levy-free use in EfW. All C&I and C&D waste must go through sorting for resource recovery prior to EfW.
NSW	Residual waste from MSW FOGO collection systems and C&I generators with effective source separation is eligible for EfW. FOGO is encouraged but not mandated. For other collection systems, resource recovery criteria prescribe the percentage of residual waste eligible for energy recovery. Ineligible waste may be recycled or landfilled. Organic waste cannot be recovered for land application following a regulation change in 2018.
VIC	One million tonne annual limit on residual waste feedstock to thermal EfW until 2040. Works approvals have been granted for prospective projects totalling approximately 950,000 tpa capacity.
QLD	EfW can only accept residual waste which is technically, environmentally or economically impractical to recycle. This will be further defined in a guideline in 2021. 2050 waste targets suggest that 15 per cent of waste generated could be potential EfW feedstock.
WA	Moving towards a three-bin FOGO collection system for MSW in metropolitan areas. Only residual waste is eligible for EfW.
TAS	No policy. Insufficient scale to support thermal EfW for mixed residual waste.
ACT	Thermal EfW will not be permitted in the ACT. PEF production for use in other jurisdictions may be accepted.
NT	No policy. Insufficient scale to support thermal EfW for mixed residual waste.

Landfill levy rates – January 2021

Commercial and industrial levy rate presented in jurisdictions where levy rate varies by waste stream.

SA

metropolitan
$143/tonne
no scheduled increases

regional
$71.50/tonne
no scheduled increases

NSW

metropolitan
$146/tonne
indexed annually

regional
$84.10/tonne

VIC

metropolitan
$65.90/tonne
indexed annually

regional
$57.76/tonnes

QLD

$80/tonne
increases by $5/tonne each year

WA

$70/tonne
no scheduled increases

TAS

$0/tonne levy
proposed $20 in 2021 and $60 by 2024

Landfill levies are set through State-based legislation and vary around the country.

$1.5b

landfill levy collected in 2019-20[11]

- Metropolitan levy
- Regional levy
- No levy

Victoria: Scheduled increase to $125.90 (metro) and $110.79 (rural) by FY 22-23. Indexed annually (to fee units).

4. Trends in bioenergy and thermal energy from waste

Bioenergy from organics

Bioenergy technologies using 100 per cent organic feedstocks can produce renewable energy in various forms, including heat, electricity, gas and transport fuels. Food and organic liquid wastes are suited to biogas production through anaerobic digestion. Biomass either in the form of dedicated energy crops, forestry waste or woody agricultural waste could be utilised within existing energy generation infrastructure or stand-alone combustion plants. In 2018, the International Energy Agency (IEA) identified modern bioenergy as the "overlooked giant" of the renewables sector.[12]

IEA reported that bioenergy was responsible for half of all global renewable energy in 2017, predominantly providing heat for buildings and industry and biodiesel and ethanol-blended transport fuels. IEA expects bioenergy will have the biggest growth in renewable resources between 2018 and 2023, but also notes the right policies and rigorous sustainability regulations will be essential to meet its full potential. A separate IEA report also found that net-zero targets, which now cover half of global GDP, will not be met without major acceleration of innovation in a number of key sectors, including bioenergy. In Australia, the combustion of sugar cane bagasse and wood waste biomass provided 44.8 per cent of all renewable energy in 2018-19, while bioenergy from biogas and biofuels contributed a further 6 per cent.[13]

While Australia has lower heating demands than cold climate countries, 29.7 per cent of Australia's energy consumption is attributable to manufacturing and residential and commercial gas supply.[13] Bioenergy for heating presents a clear decarbonisation opportunity in these hard-to-abate sectors.

Delivering successful projects

Successful bioenergy projects must align feedstock supply, energy offtake and outlets for organics residues within a commercially viable framework. This remains challenging in the Australian market, and the 2021-2025 project pipeline is constrained by the lack of policy support and inadequate valuation of flexible, renewable energy. Active government support to overcome these barriers could unlock significant expansions in bioenergy projects. However, the 2021-2025 investment pipeline is focused on anaerobic digestion for behind-the meter energy applications in intensive agriculture, food processing and wastewater treatment.

Case study

Richgro Bioenergy Plant, WA[14]

Project cost	$6 million
CEFC commitment	$2.2 million
Technology	Anaerobic digestion (CHP engines)
Throughput capacity	50,000 tonnes p.a. (~35,000 tonnes p.a. actual throughput)
Power capacity	2 MWe
Feedstocks	C&I (pre-consumer food waste)
Carbon abatement	~68 $ktCO_2$-e p.a.
Offtake agreements	Richgro uses behind the meter power to operate off-grid, exporting excess energy to the SWIS Digestate used in Richgro horticultural production
Operation and maintenance	Biogass Renewables

Processes food organics waste stream
Diverting organics from landfill where they would otherwise decay in an anaerobic environment and produce methane (28 times greater global warming potential than carbon dioxide).[1]

Supports a circular economy
The nutrient rich digestate output from the facility is used in Richgro's range of garden products, resulting in nutrient cycling.

Improves grid stability
Provides dispatchable/baseload renewable energy into the WA South West Interconnected System (SWIS).

Case study

Hot water keeps cucumbers cool

The 5 MW bioenergy boiler installed at the Family Fresh Farms facility at Peats Ridge in NSW is delivering the heat that the crops need at a fraction of the cost of gas. It uses plantation wood chips as a carbon-neutral energy source for the facility, which produces Qukes – baby cucumbers.[15] Justsen Pacific installed the system on schedule and on budget, and has arranged for both the fuel supply for the boiler and the EPA and local council approvals that the operation requires. The state-of-the-art emissions control system installed with the boiler means that the emissions from the system are well within acceptable limits, and the remote monitoring/activation of the system means that Justsen Pacific engineers are able to check in with the operation of the boiler 24/7 to make sure it is performing optimally.[16]

Biomass powers regional timber kilns

Timber processor Dongwha Australia is using biomass to heat timber kilns at its large sawmill in southern NSW, where it can use its own waste to fuel a boiler. Justsen Pacific delivered the turn-key system that encompassed the boiler, the emissions control system, the fuel-handling system and the connection of the new system to Dongwha's existing infrastructure. The state-of-the-art emissions control system installed with the boiler means that the emissions from the system are well below what regulations require.
The remote monitoring/activation of the system means that Justsen Pacific engineers are able to check in with the operation of the boiler 24/7 to make sure it is performing at optimum levels.[17]

Case study

MSM Milling, NSW

MSM Milling is a 100 per cent Australian family owned company based in Manildra in the heart of NSW. The company transforms canola seed, bought directly from more than 1,000 local farmers, into value added oil, meal and stockfeed products at its fully integrated oilseed crushing, oil refining, packaging and stockfeed manufacturing operation in regional NSW's farming belt.[18]

In 2019, MSM Milling commissioned a $5.38 million cornerstone project for the Australian food processing industry, making it the country's first low carbon canola oil producer.[19]

The biomass-fuelled boiler was funded by MSM Milling, in conjunction with a $2 million grant from the Australian Renewable Energy Agency (ARENA), under the Advancing Renewables Program.

The 4.88 MW boiler is fuelled by locally sourced renewable wood waste, forestry thinnings, offcuts and sawmill by-products, to generate the steam needed for the canola processing operation. The biomass boiler replaces three LPG boilers, with the vast majority of heat and steam requirements now coming from renewables.

The company's commitment to sustainability and adoption of renewable energy, helps to ensure the future of the business, and is in line with consumers' demands for environmentally friendly products, production, supply chains and businesses. The boiler is delivering a 70 per cent reduction in MSM's thermal energy costs, reducing greenhouse emissions, fossil fuel energy use and depletion, while increasing NSW's renewable energy generation.

MSM Milling's switch from LPG to biomass will result in net emissions reductions of more than 80,000 tonnes of CO_2-e during the life of the project, removing the CO_2-e of 1,500 cars from the road each year, or the carbon footprint of 4,444 Australian households over the life of the project.

Looking to the future

There has been interest in feasibility-stage assessment of bio-hub models for anaerobic digestion in various states, which seek to bring together multiple players such as food and beverage producers, intensive horticulture and wastewater treatment to secure both organic feedstock and energy offtake at a viable scale and pricing.

If successful, this bio-hub model could be replicated in many regional areas. The inherent complexity of multiple, site-specific stakeholders required to secure supply and demand for these facilities continues to constrain the 2021-2025 investment outlook.

The Recycling Organics Network has committed to a bio-hub project in Colac. Another is planned for Geelong, while private company Utilitas is progressing its flagship Bundaberg Biohub, with site preparation works now underway for the first phase of construction.

Another opportunity is to co-fire biomass within existing fossil fuel energy plants as we move to reduce our long term dependency on fossil fuel energy generation. This approach is being promoted by Japan and is resulting in an attractive export market for Australian biomass products. In the UK, conversion of coal fired power generation to 100 per cent biomass fuels has been implemented successfully, driven by a policy decision to phase out coal by 2024.[20,21]

Global examples

Bold commitments drive international progress in bioenergy

EU landfill constraints drive investment

A push towards energy security and limited space available for landfill disposal has driven an extensive uptake of bioenergy technologies in the European Union (EU). The EU member states have implemented targets and financial mechanisms to enable industry action and support the transition towards bioenergy. Key financial levers include FiTs, capital grants and fuel tax exemptions. In Germany, generous FiTs in the decade to 2014 supported rapid expansion of the biogas sector, with over 9,000 biogas plants processing a range of organic waste and energy crop feedstocks.[22] The German biogas fleet includes numerous small-to-medium scale anaerobic digestion facilities, typically with links to agricultural activities. Since the removal of the FiTs, construction of new biogas facilities in Germany stalled, but the nation reached 360 PJ of biogas production capacity.[23]

Diversified energy shapes Japan investment

Japan has set 2030 targets to diversify its energy supply mix following the Fukushima nuclear disaster and increase renewable energy generation. This includes a target of 3.7-4.6 per cent of total power generation from biomass sources.[24] In 2012, a FiT for bioenergy was introduced. The FiT offers a stable energy price over 20 years, and has led to investor interest in biomass projects targeting a range of woody feedstocks, including wood pellets, crop residue, forestry waste and construction waste.
By 2019, Japan had 411 operational biomass energy projects, including dedicated biomass boilers and co-firing of biomass in existing coal-fired power stations.[25] Approved bioenergy capacity under the FiT scheme exceeded 12 GW – nearly double the bioenergy target. However, not all approved projects are expected to be realised, due to grid connection and fuel supply constraints.[26]

Biomass fuel replaces coal in UK energy transition

In the UK, the Drax power station is being progressively upgraded to transition from coal to sustainably sourced biomass fuel. Four of its six 660 MW generation units have been upgraded to use compressed wood pellets, and the power station now supplies 12 per cent of the UK's renewable power, with the Drax power station providing renewable energy to more than six million British homes. Fossil fuels will be completely phased out at Drax by 2021, three years ahead of the UK's proposed 2024 deadline for the phase-out of coal-fired power.[20,21]

50% of global GDP now covered by

net-zero

emissions targets

Shaping the bioenergy investment pathway

Bioenergy investment in Australia has remained constrained by low fossil fuel prices and limited appetite from government or the private sector to offer a price-premium for renewable alternatives, particularly outside the electricity sector. However, there is growing recognition of the importance of bioenergy for decarbonisation and regional growth, with substantial research and planning underway.

Notable examples include:

Bioenergy roadmap

ARENA is developing a bioenergy roadmap to demonstrate the role bioenergy can play in meeting Australia's emission reduction targets and identify efficient policy and funding levers to accelerate Australia's energy transition while stimulating regional development and enhancing energy security.

Biogas opportunities

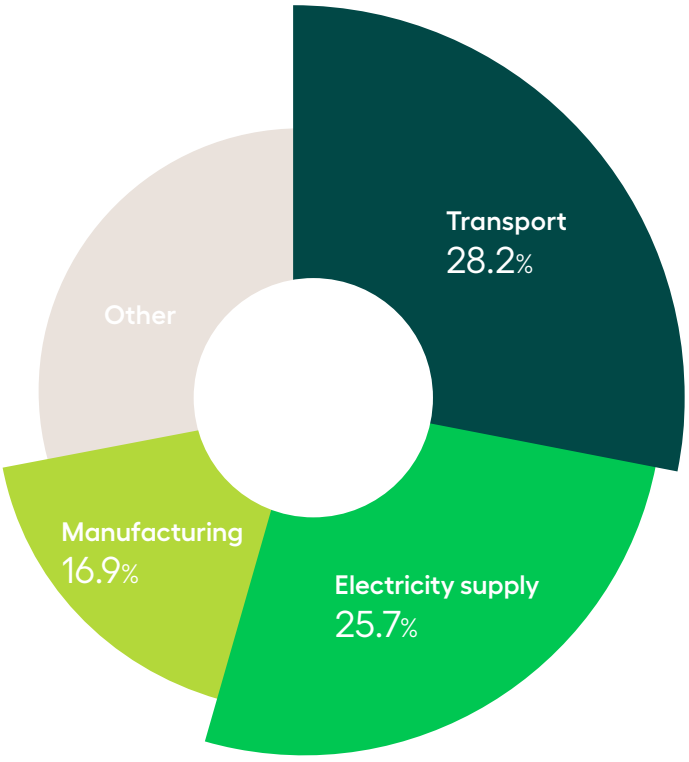
In 2019, Bioenergy Australia, supported by the CEFC, ARENA, Energy Networks Australia and International Energy Agency (IEA) Bioenergy, published a report on biogas opportunities in Australia, which identified up to 371 PJ of potential bioenergy feedstock. It presented seven recommendations to unlock this opportunity, including setting renewable gas targets, supporting feedstock quality through waste policy and strategy, maximising energy recovery at existing landfills, exploring opportunities in the transport sector, simplifying the approvals process and providing regulatory clarity for agricultural reuse of nutrient-rich digestate.[23]

Biofuels and transport

Additional analysis from the CEFC and ARENA[27], found that Australia's existing skills and experience in agriculture, forestry and engineering give us the tools to develop a thriving biofuel industry. To build an industry at the required scale, Australia needs early investment in construction of "first-of-their-kind" facilities.

Biofutures and bioproducts

Queensland released its Biofutures 10 Year Roadmap and Action Plan in 2016 and in 2019 committed $5 million to provide support for infrastructure that uses conventional waste streams or biomass to produce bioenergy, biofuels and high value bioproducts.



Source: Department of the Environment and Energy (2020)

Australian energy consumption by sector:

Bioenergy is a flexible fuel suitable to decarbonise multiple sectors.

Recovering industrial heat from wasted materials

Waste materials which have been mixed or contaminated have no viable recycling option. These residual waste materials can be a suitable energy resource for industrial furnaces, displacing fossil fuel consumption and diverting waste from landfill.

Processed engineered fuel (PEF), has the potential to address constrained and increasingly expensive landfill, and growing demand for lower carbon waste derived fuels by industrial facilities both in Australia and internationally. Energy generated through the combustion of PEF is partially renewable, due to the inclusion of fossil-based materials such as plastics and synthetic textiles in the fuel mix. However, it is a lower carbon alternative when used to offset industrial heat demand which would otherwise have been met using coal or gas. PEF production involves the extraction of some saleable, recyclable materials from mixed waste and preparation of a combustion fuel with relatively consistent energy content and physical properties from the non-recyclable fraction. Manufactured PEF typically has a higher calorific value than mixed residual waste and can be prepared to meet specifications or regulatory requirements.

There are several waste combustion infrastructure proposals within the planning system which propose the use of PEF, indicating an opportunity for expansion of production capacity to service this future market. PEF is also well-suited to combustion in existing industrial facilities, providing partial decarbonisation for industrial heat. The Boral Berrima and Adelaide Brighton cement kilns both successfully use PEF.

Additional investment in new infrastructure for sorting mixed waste and the production of PEF for combustion is expected in some States, driven by a combination of landfill levy increases and policy requirements on some large-scale EfW proposals. New infrastructure for waste sorting and fuel production is likely to be located in metropolitan centres and could create approximately 200 full-time operational jobs.

200 FTE jobs

in metropolitan centres[13]

Case study

Cleanaway ResourceCo Resource Recovery Facility, NSW[28]

Project cost	$15 million
CEFC commitment	$10 million
Technology	PEF production
Throughput capacity	250,000 tonnes p.a. (licensed throughput)
Feedstocks	C&I
Carbon abatement	~288 $ktCO_2$-e p.a.
Jobs	50[30]
Offtake agreements	Boral Berrima Cement Works (partial)
Strategic equity owners	Cleanaway, ResourceCo
Operation and maintenance	ResourceCo

Partially renewable fuel
Can help reduce the carbon intensity of its end users (e.g. cement kilns) which generally rely on fossil fuels.

Highly flexible fuel
Can be made to different specifications for different customers and end uses.

Substantial landfill diversion
For organic waste, including paper and carboard.

Industrial heating alternative
Can be used to decarbonise hard-to-abate sectors like manufacturing because of its strong scope for providing industrial heating.

Powering up the EfW sector

New infrastructure for thermal EfW using mixed residual waste feedstocks has gained momentum in Australia, with a strong pipeline of projects and proposals.

~700

operational jobs in EfW to 2025

Emerging constraints on landfill capacity around Australia's metropolitan centres and increasing landfill levies are beginning to create clear commercial drivers for thermal energy recovery infrastructure, as the sector seeks alternatives for managing mixed residual waste.

Thermal energy recovery technologies are suitable for mixed waste when it is not technically or economically viable to extract materials for recycling. For this mixed and contaminated waste, thermal technologies capture an energy resource and significantly reduce reliance on landfill, as well as enabling the recycling of by-products such as bottom ash into aggregates for construction.

Thermal EfW requires significant scale, typically upwards of 200,000 tpa, to be competitive in the market. Consequently, this investment is expected to be concentrated in metropolitan centres, or regions with efficient transport connection to metropolitan centres for waste supply. Social licence to operate is also essential to successful development of thermal EfW.

Thermal EfW from mixed waste does not generate 100 per cent renewable energy, due to the presence of fossil-derived plastics in the feedstock. However, it offers the opportunity to contribute to supporting a more diverse energy network in Australia by providing stable and reliable baseload energy. It also has the ability to reduce the reliance on gas by providing heat, and ultimately results in significant emissions reduction compared to landfill.

Full realisation of the identified opportunity for large-scale thermal EfW in Australia in the period to 2025 could create almost 700 operational jobs and deliver a net reduction in greenhouse gas emissions of approximately 1.7 million tonnes CO_2-e per year.

The renewable biomass fraction of EfW feedstock could contribute renewable electricity equivalent to about one per cent of Australia's 2017-18 energy demand. The EfW opportunity to 2025 would provide around 500 MW of reliable baseload electricity generation, supporting grid strength and reliability as Australia's network transitions to a more diversified and renewable generation mix.

Co-location of thermal EfW capacity with industrial heat users could greatly support decarbonisation of hard to abate sectors, delivering up to 45 PJ to displace heating from natural gas. This would replace approximately three per cent of Australia's natural gas consumption while diverting non-recyclable waste from landfill.[29] The current pipeline of thermal EfW proposals includes two projects at existing paper mills, as well as facilities which have designed in heat offtake connections to support ongoing heating requirements.

Case study

Avertas Energy, Perth

Project cost	$700 million
CEFC commitment	$90 million
Technology	Moving grate (thermal)
Throughput capacity	400,000 tonnes p.a.
Power capacity	38 MWe
Feedstocks	MSW and C&I waste
Carbon abatement	~400 $ktCO_2$-e p.a.
Jobs	Construction: 800 Operations: 60
Waste supply agreements	MSW take or pay contracts with Rivers Regional Council and City of Kwinana
Strategic equity investors	Macquarie Capital, DIF
Engineering, procurement and construction	Acciona
Operation and maintenance	Veolia
Tech provider	Keppel Seghers
ARENA grant	$23m non-recoupable

Australian first
Australia's first large-scale EfW project to reach financial close. Setting a strong precedent for the bankability of an EfW, particularly with merchant exposure.

International recognition
Asia Pacific's Clean Energy Deal of the Year at the 2018 Project Finance International (PFI) Awards.

Case study

East Rockingham Waste to Energy Facility, Perth

Project cost	$511 million
CEFC commitment	$57.5 million
Technology	Moving grate (thermal)
Throughput capacity	300,000 tonnes p.a
Power capacity	29 MWe
Feedstocks	MSW and C&I
Carbon abatement	~300 $ktCO_2$-e p.a.
Jobs	Construction: 300 Operations: 50
Waste supply agreements	MSW and C&I contracts
Strategic equity investors	John Laing, Masdar Tribe, Acciona, HZI
Engineering, procurement and construction	Acciona, HZI
Operation and maintenance	Suez, HZI
Tech provider	HZI

Australian first
Australia's first subordinated debt tranche to an EfW and first EfW project to reach financial close with "waste arising" waste supply agreements.

International recognition
2019 IJ GlobalAwards Asia Pacific Waste Deal of the Year and Renewable Energy Waste-to-Energy deal of the year by The Asset magazine.

5. Trends in recycling and resource recovery

Investment in infrastructure and the development of output markets are key elements that will allow Australia to take responsibility for its waste, reduce reliance on the export of waste and decrease reliance on landfill. This will also allow a higher proportion of waste to be processed domestically, promote jobs and keep materials circulating in the Australian economy at their highest possible value for as long as possible.

Quality and price influence recycling

With international import restrictions and the upcoming implementation of material export bans, recyclable feedstock is more readily available in Australia. Investments in sorting and processing infrastructure will be needed during this transition period, as well as policy and funding support to ensure that recyclable materials are actually recycled rather than being sent to landfill or used for energy recovery alternatives.

High quality recycled material can replace the need for "raw" or "virgin" materials. This can achieve greenhouse gas emission reductions through the offset of the more energy-intensive mining, manufacturing or the importation of virgin materials.

The method of material collection, sorting and processing influences the stream quality and ultimate end use for the material. Significant amounts of energy, labour and logistics are required to sort co-mingled recycling streams (sometimes referred to as "unscrambling the egg"). There is also often a low-quality "residual" material that is not suitable for recycling or reuse but which may be suitable for energy recovery.

Trends towards increased source separation support more cost-effective resource recovery and higher value recycled products. Commitments to FOGO separation for households across Victoria, metropolitan WA and the ACT since 2018 will make new organic material available for processing. Similarly, all States and Territories now either operate a container deposit scheme (CDS) for beverage containers or have committed to introducing a CDS and these schemes are beginning to provide a source of cleaner materials available for more reliable recycling. People across NSW now return an average of seven million drink containers per day through Return and Earn refund points. The scheme reached five billion containers collected in Febraury 2021, after 3 years of operation.[30]

These structural changes recognise the role of producers and consumers in material supply chains, reduce the costs of sorting and support investments in materials reprocessing. The recycling sector is realigning its offering to meet the price and quality expectations of changing and emerging markets.

Positive signs for renewed demand

Use of recycled material must grow significantly to support increased reprocessing, and there are signals that Corporate Responsibility Schemes and targets are beginning to generate this demand. Consumers have become more aware of waste issues through platforms such as the War on Waste ABC television series and campaigns tackling the ocean plastic crisis. This is prompting corporations to re-examine their material supply chains and publicly commit to more recycled and recyclable products. Recent announcements by major brand owners provide promising market signals for renewed investment in higher value recycling and reprocessing.

Australia's first Plastics Summit, in 2020, was another indicator of the changing landscape of recycling in Australia. The Summit convened a cross-sector group of more than 200 senior representatives from Government, industry and the community to mobilise further action around plastic waste. Ideas and solutions generated at the Summit will inform the National Plastic Plan, which the Australian Government released in 2021.

Infrastructure gap for paper and cardboard

Recovery of paper and cardboard through kerbside recycling in Australia is at approximately 60 per cent. Along with plastics, paper and cardboard waste volumes were most impacted by the China National Sword policy. While these material streams have been predominantly redirected to other export markets, waste contamination levels have not markedly improved and prices for mixed paper remain close to zero.[31] This is not viewed as a sustainable long-term solution.

With the export of unprocessed waste materials banned from 2024, there is an opportunity for increased infrastructure to recycle a greater proportion of paper and cardboard waste onshore. The Australian Government has announced it will co-invest with State and Territory governments to secure new paper and pulp processing infrastructure, with State governments seeking partnerships with industry to develop proposals during and beyond 2020.[32] A new pulp mill for Western Australia will be built with support through the Recycling Modernisation Fund.

$190m invested

by the Australian Government into the Recycling Modernisation Fund (RMF)

$600m

in total to be leveraged for recycling infrastructure investment

10,000 jobs

will be created in the industry

10m tonnes

of waste will be diverted from landfill

Supply chain solutions to plastics challenge

Cooperation between major players across the plastics supply chain is reducing project risks, unlocking infrastructure investment and closing the loop on plastics in Australia.

Significant expansion needed to address plastic waste

In Australia, nearly 3.5 million tonnes of plastic is consumed annually. However, the Australian plastics recycling rate in 2017-18 was just 9.4 per cent or 319,000 tonnes, with a high reliance on plastic waste being exported for recycling (approximately 174,000 tonnes) rather than being recycled onshore.[10] Plastics flow through global supply chains, with around 58 per cent of the plastic consumed in Australia imported as finished or semi-finished goods, and just four per cent locally manufactured from domestically recycled resins.[10] The domestic plastics recycling industry processes around 145,000 tonnes[10] of plastic annually, with capacity constrained by the limited availability of end-markets.

Significant expansion will be needed to absorb around 174,000 tonnes of waste plastic that can no longer be exported with additional capacity needed to support higher recycling rates.[10] PET and HDPE material presents the biggest opportunity in this sector, while the most established value chains are for recovered material.[31]

The phase out of non-recyclable packaging materials and single use plastics by 2025 will help simplify the plastic waste stream. However, investment in upgrades to sorting infrastructure remains essential to separate clean polymer streams for high quality recycling. Investment in washing, flaking and pelletising recyclable plastic may enable export markets to be re-established for higher-quality products. Funding support for capital upgrades is likely to be needed to achieve this at a competitive price-point. Infrastructure investments for new domestic plastics manufacturing capacity using recycled material will rely on the establishment of end markets, both through brand owners and public procurement policies, to secure a viable, closed-loop business model.

28,000 tonnes

PET bottles recycled each year once operational[33]

Circular Plastics Australia

In 2020, Cleanaway, Pact and Asahi – major players in the waste management, packaging manufacturing and consumer beverages sectors, respectively – formed the Circular Plastics Australia joint venture to close the loop on plastic packaging. The parties plan to establish a new facility at the Nexus industrial precinct in Albury-Wodonga to recycle 28,000 tonnes, equivalent to approximately 1 billion 600 ml PET bottles, of plastic into food grade packaging each year. As a practical example of the circular economy, Asahi will purchase beverage containers using the recycled material, to meet its internal sustainability commitments of 30 per cent recycled content across its packaging portfolio by 2025. The plant is anticipated to commence operations in late 2021 and create 300 direct and indirect jobs during construction and 35 ongoing local jobs.[33,34]

Collaboration for soft plastics solution

Closed-loop recycling for food grade soft plastic packaging is not yet available, posing a challenge for the National Packaging Targets and sustainability commitments by major brands. A proposal for chemical recycling of soft plastics aims to develop a local solution. In 2021, Nestlé, Coles, technology developer Licella, recycler iQ Renew and polymer[35] manufacturer LyondellBasell jointly announced a feasibility study into potential processing sites in Victoria. By turning soft plastics back into oil, the proposed facility aims to supply food grade soft plastics from Australian recycled content.

Source diagram: Cleanaway

Composting and anaerobic digestion offer organics solution

The 2020 National Waste Report estimates that in 2018-19 Australia generated 14.3 million tonnes of organic waste. With only 60 per cent of organic material recycled, nearly seven million tonnes of valuable organic material waste is disposed to landfill, presenting a clear opportunity for recycling and energy recovery through composting or anaerobic digestion.[36]

Australia will need to avoid, reuse or recycle an additional two million tonnes of food waste per year to meet the National Waste Target of halving food waste to landfill by 2030. Food waste alone costs the Australian economy an estimated $20 billion per year in wasted resources.[37]

When organic material decomposes within a landfill it produces methane, a greenhouse gas 28 times more potent than carbon dioxide.[1] Diversion of organics from landfill, organics separation and high-quality recycling through new and expanded composting or anaerobic digestion facilities could avoid 1.4 million tonnes CO_2-e in landfill emissions, reducing Australia's 2019 greenhouse gas emissions from landfill by 18 per cent. It also provides the potential to recycle valuable nutrients for use in agriculture and other land applications. However, contamination of recovered organics remains a critical concern, to protect the safety of food supply chains and the environment.

The roll out of FOGO bins for households is increasingly prevalent in metropolitan areas and regional population centres. Composting remains the cheapest and most common processing option, but household organics could also provide feedstock for bioenergy projects in the future. Significant investment in more than 880,000 tpa capacity of new composting or anaerobic digestion infrastructure will be needed to support the full transition of metropolitan populations to FOGO collections.

In jurisdictions which are more mature in their policy settings, separate collections and organics processing can make further gains through improvements in food waste capture rates and transition from garden organics (GO) to FOGO collection by some local governments. Increased processing capacity is likely to be delivered through the expansion of existing facilities, repurposing of infrastructure for mixed waste organics, or a combination of expansion and investment in new-build organics infrastructure totalling around 560,000 tpa capacity.

Organics recovery is appropriate for both metropolitan and regional areas and could create around 400 direct operational jobs and 750 indirect jobs around the country. However, investment figures are dominated by metropolitan infrastructure due to land availability pressures and the need for more capital-intensive enclosed operations to enable organics processing in a smaller footprint and closer proximity to sensitive land uses.

Case study

South Eastern Organics Facility, Melbourne[38]

Project cost	$65 million
CEFC commitment	Up to $38 million
Technology	In-vessel composting (mechanical biological treatment)
Throughput capacity	120,000 tonnes p.a.
Power capacity	2 MWe
Feedstocks	FOGO
Carbon abatement	~65 kt CO_2-e p.a.
Jobs	~5 direct jobs
Waste supply agreements	MSW – 8 Melbourne councils (FOGO)
Strategic equity investors	Sacyr
Engineering, procurement and construction	Sacyr
Operation and maintenance	Sacyr

Innovative structure was an industry first
Providing councils with access to a project financing structure that is rarely able to be leveraged at local government level.

Processes household FOGO waste
Diverting organics from landfill where they would otherwise decay in an anaerobic environment and produce methane (28 times greater global warming potential).[1]

State-of-the-art technology
Sacyr Group uses a fully-enclosed in-vessel composting process, with completely closed plant storage reservoirs and the use of efficient and reliable deodorisation systems.

Circular economy
Councils supply the facility with their FOGO waste and some of the facility's compost output is given back to those councils for use in community parks and gardens.

7m tonnes

of organic waste to landfill in 2018-19[36]

Local processing could make full use of glass

Approximately 84 per cent of Australia's glass packaging is recovered for recycling, collected primarily through co-mingled kerbside bins.[36]

The majority of this stream has the potential to be diverted into source-separated collection systems, with container deposit/refund schemes now operating or committed to in all States and Territories, and the introduction of a separate bin for kerbside glass in Victoria. Source separation of glass helps reduce losses through breakage and sorting and avoids contamination of paper and cardboard with glass fines. Higher quality glass recovery increases the opportunity to recycle glass into packaging at existing glass furnaces.

In South Australia, Orora processes 80 per cent of the glass collected through the state CDS at its Gawler plant.[39] However, this represents less than 10 per cent of the plant capacity. Orora has previously investigated sourcing recycled glass from interstate, but the quality and price-point of glass from co-mingled collections was not considered commercially viable.

In 2020, recycler and packaging manufacturer Visy acquired the dominant glass manufacturing business in Australia from Owen-Illinois, including is four furnaces across Sydney, Melbourne, Brisbane and Adelaide. This strengthened the vertical integration of Visy's recycling and packaging business. Visy Glass has stated that it aims to increase the use of recycled content from current level of around one-third of glass inputs up to two-thirds of glass inputs, requiring an additional 280,000 tonnes in recyclable materials each year, based on 2020 levels.[40, 41]

In Melbourne, construction contractor and C&D recycler Alex Fraser Group has developed a new 150,000 tpa facility to recover clean construction sand from previously unusable glass fines.[42] Some expansion is expected in this space in the period to 2025, supported by more active procurement into infrastructure.

ACT recycling facility upgrades funded under the RMF include glass washing processes to improve the quality of glass sand recovered from kerbside recycling. There is also increased interest in recycling glass products into infrastructure projects, such as pavement, roads and piping bedding. This can be a useful avenue for lower quality mixed glass outputs, while also enabling local use of glass in regions where transport to glass kilns is cost-prohibitive.

27% recycled

content in Australian-made glass packaging in 2018-19[36]

$70b program

of Victorian transport infrastructure projects are pushing forward recycled content trials under the Recycled First policy

Alternative transport role for tyres

A lack of domestic markets for tyre derived product and high demand internationally for tyre derived fuel has resulted in export-dominated supply chains, with exports accounting for 80 per cent of used tyres collected.[43]

These markets will remain available, requiring modest upgrades to handling and shredding equipment, in response to the export ban on whole baled tyres from 2021. Tyre Stewardship Australia estimates that in 2018-19, 50 per cent of Australia's tyre exports were whole bale tyres, with the balance exported as shredded tyre-derived fuel.[43]

Tyres are subject to an industry-run voluntary product stewardship scheme which supports collection for recovery. Tyres are also subject to landfill bans in a number of jurisdictions.

There is a growing market opportunity for tyre derived products in Australia in road, rail and non-structural civil projects. National standards or specifications are available for bitumen-crumb rubber asphalt, bitumen-modified spray seals and soft-fall matting.

In addition, around 123,000 tonnes of used tyres are sent to mining sites for disposal each year.[43] High-value products and mobile processing equipment are required to offset the transportation costs associated with recovering this waste stream.

Energy recovery remains less desirable than recycling but may become a viable pathway as energy recovery capacity for mixed waste and for dedicated tyre processes is established. The renewable content of this energy depends on the blend of natural and synthetic rubber in tyres. All waste rubber has a high energy content and poses a fire risk if inappropriately stockpiled.

Processing of waste tyres using pyrolysis has also made progress towards commercial scale operations. However, the technological and commercial risk concerns continue to constrain the opportunity for pyrolysis in the period to 2025.

Case study

Turning truck tyres into asphalt

Transurban is taking old truck tyres and turning them into road asphalt. In a first for the business, it has used gap crumbed rubber asphalt as part of an upgrade to a Gateway Motorway on-ramp in south-east Queensland. Transurban[44] said the gap crumbed rubber asphalt is made partially from recycled truck tyres. In a trial project, Transurban said it had diverted about 250 truck tyres that were destined for landfill and recycled them into asphalt. While the asphalt looks the same as a normal road, it happens to be more durable in addition to being better for the environment.

Tyres reused to make safer and smoother local roads

In Queensland, almost 5,700 old tyres have been recycled as part of a Fraser Coast Regional Council bitumen resealing program aimed at making local roads safer.[45] The reseal program used a bitumen blended with crumb rubber produced from old tyres, to produce a more durable product less prone to cracking. Some 362,000 litres of crumb rubber bitumen was sprayed on roads in 54 locations throughout Hervey Bay, Maryborough and rural areas of the Fraser Coast region. The council said the bitumen reseal program prevented the equivalent of almost 5,700 old tyres ending up in landfill.

Glossary

AD	Anaerobic digestion technology, which converts organic waste into renewable biogas.
ARENA	Australian Renewable Energy Agency.
CDS	Container deposit scheme.
C&D	Construction and demolition waste. This waste is generated by construction and demolition activities and typically consists of high tonnages of inert materials such as soil, concrete, masonry and metals. It currently has a higher recycling rate than other waste streams and is largely unsuitable for energy recovery.
C&I	Commercial and industrial waste. This waste is generated by businesses and typically serviced through various commercial waste collection, recycling and disposal services. It is a diverse and highly price-sensitive waste stream.
EfW	Energy from waste.
FOGO	Food and garden organics. Household food and garden organics collection.
FiT	Feed-in tariff. An agreed, fixed-term price for supplying energy from specific renewable sources into the grid, used to support investment in new generation infrastructure.
FTE	Full time employees.
GO	Garden organics. Household garden organics collection.
HDPE	A common plastic used in consumer packaging, labelled number two in the plastics identification code. Clean, sorted HDPE retains good value in recycling markets.
MSW	Municipal solid waste. This waste is generated by households and typically controlled by local government.
Residual waste	Mixed waste which remains after source-separation of recyclables or mechanical sorting to recover recyclable materials. Residual waste is typically directed to landfill.
RMF	Recycling modernisation fund. $190 million Australian Government funding to be allocated to projects with co-investment from State Governments and industry, leveraging a total of $600 million in new and upgraded recycling infrastructure investment.
PEF	Processed engineered fuel is a combustion fuel derived from waste materials, typically the dry fraction of C&I waste. Waste materials are sorted, shredded and blended to create a fuel with more consistent physical properties and energy content than unprocessed waste.
PET	A common plastic used in consumer packaging, labelled number one in the plastics identification code. Clean, sorted PET retains good value in recycling markets.
Thermal EfW	Thermal energy recovery technology, suitable for woody material or, with more stringent handling and emissions controls, for mixed residual waste.
TPA	Tonnes per annum.

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About the CEFC

The CEFC has a unique role to increase investment in Australia's transition to lower emissions. With the backing of the Australian Government, we invest to lead the market, operating with commercial rigour to address some of Australia's toughest emissions challenges – in agriculture, energy generation and storage, infrastructure, property, transport and waste. We're also proud to back Australia's cleantech entrepreneurs through the Clean Energy Innovation Fund and invest in the development of Australia's hydrogen potential through the Advancing Hydrogen Fund. With $10 billion to invest on behalf of the Australian Government, we work to deliver a positive return for taxpayers across our portfolio.

info@cefc.com.au

Clean Energy Finance Corporation
ABN: 43 669 904 352

cefc.com.au