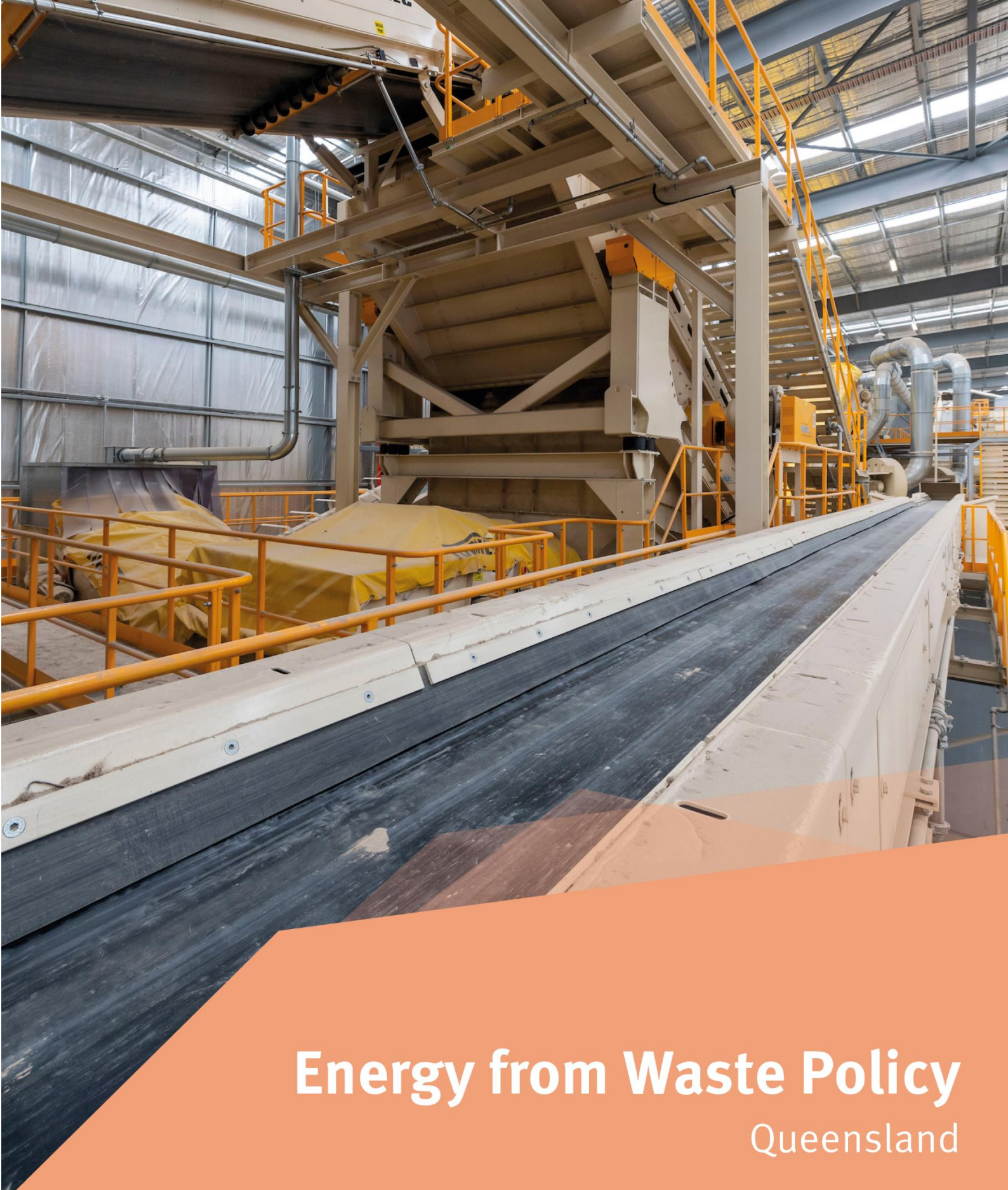

Energy from Waste Policy

Queensland

Queensland Government

Prepared by: Office of Resource Recovery, Department of Environment and Science

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Contents

Purpose

This non-statutory policy has been developed to support implementation of Queensland's *Waste Management and Resource Recovery Strategy* (the waste strategy), by providing a high-level outline of the following matters related to energy-from-waste (EfW) activities in Queensland:

- expectations for proponents to undertake appropriate stakeholder engagement in the EfW sector
- information required to support an environmental authority (EA) application for an EfW facility
- the environmental regulation of EfW facilities.

This policy does not incentivise or promote EfW, rather it provides a framework that aims to provide certainty to EfW proponents around the requirements identified above, to help ensure that any EfW facilities developed in Queensland meet technical, environmental, regulatory and community expectations and are in the best interest of Queenslanders. This policy operates in conjunction with other key strategic documents under the waste strategy as described further below.

Context

Energy from waste

EfW refers to the recovery of energy from residual waste materials. The energy can be recovered as solid, liquid or gaseous fuels, or as heat. Fuels can be combusted (e.g. in a power plant) to generate electricity, or used as a replacement for fossil fuels in vehicles, equipment and machinery, while the heat produced can be used to produce hot water or steam to feed industrial heating systems, or drive cooling and air conditioning systems. The steam can also be converted into electricity using a turbine.

Waste Management and Resource Recovery Strategy (waste strategy)

The waste strategy envisions Queensland as a zero-waste society, where waste is avoided, reused and recycled as much as possible, as part of a transition to a circular economy. This vision is supported by 2050 targets to reduce household waste by 25 percent; recycle 75 percent of all waste; and divert 90 percent of all waste from landfill (Table 1). This policy is an action of the waste strategy, under Strategic Priority 2 – Transitioning to a circular economy.

Table 1: Waste strategy targets

Description of target	**Waste stream**	**2017-18 Baseline**	**2025**	**2030**	**2040**	**2050**
Reduce household waste generation (as percentage of 2017-18 baseline)	MSW	0.54 tonnes per capita	10%	15%	20%	25%
Landfill diversion rate (amount diverted as percentage of total waste generated in 2017-18)	MSW	32.4%	55%	70%	90%	95%
	C&I	47.3%	65%	80%	90%	95%
	C&D	50.9%	75%	85%	85%	85%
	All streams	**45.4%**	**65%**	**80%**	**85%**	**90%**
Recycling rate (amount recycled as percentage of total waste generated in 2017-18)	MSW	31.1%	50%	60%	65%	70%
	C&I	46.5%	55%	60%	65%	>65%
	C&D	50.9%	75%	80%	>80%	>80%
	All streams	**44.9**%	**60**%	**65**%	**70**%	**75**%

C&D = Construction and demolition waste; C&I = Commercial and industrial waste; MSW = Municipal solid waste.

Based on these targets, it is estimated that by 2050, up to 15 per cent of municipal solid waste (MSW), commercial and industrial (C&I) waste, and construction and demolition (C&D) waste (together, 'headline wastes') may be unsuitable for reuse or recycling, and therefore may be suitable feedstock for EfW. A further 10 per cent of waste is estimated to still require disposal to landfill as energy recovery is unlikely to be feasible. Table 2 shows how the potential EfW feedstock quantity is distributed across the headline waste streams over the waste strategy's horizon.

Table 2: Estimated amount of waste potentially available for EfW based on 2017-18 baseline data

Waste stream	**2025**	**2030**	**2040**	**2050**
MSW (% of all MSW)	5%	10%	25%	25%
C&I (% of all C&I)	10%	20%	25%	30%
C&D (% of all C&D)	0%	5%	5%	5%
Overall (% of all headline waste)	**5%**	**15%**	**15%**	**15%**
Waste stream	**2025**	**2030**	**2040**	**2050**
MSW (tonnes)	134,300	268,500	671,200	671,200
C&I (tonnes)	292,500	585,000	731,300	877,600
C&D (tonnes)	0	264,100	264,100	264,100
Overall (tonnes)	**426,800**	**1,117,600**	**1,666,600**	**1,812,900**

This policy is just one of several strategic actions that support implementation of the waste strategy (Figure 1). Other key actions include the following:

- The *Queensland Waste and Resource Recovery Infrastructure Report* provides a review of existing infrastructure capacity on a regional basis and identify opportunities for investment to fill current and future infrastructure gaps to support implementation of the waste strategy.
- The *Queensland Resource Recovery Industries 10-year Roadmap and Action Plan* sets out a framework to accelerate the transition to a circular economy and develop Queensland’s resource recovery industries. The Roadmap is administered by the Department of State Development, Infrastructure, Local Government and Planning (DSDILGP).
- The *Resource Recovery Industry Development Program*, also administered by DSDILGP, provided grant funding to local governments, established businesses and not-for-profit organisations to improve existing operations or bring new facilities at all stages of the supply chain to Queensland.
- The *Plastic Pollution Reduction Plan,* released 7 November 2019, identifies and prioritises actions, at every step in the supply chain, to help reduce plastic waste and reduce the amount of plastic in and entering the environment, and also looks for economic opportunities to create a plastic circular economy through investment in plastic reprocessing, remanufacturing, market development and new products as alternatives to plastic.
- The *Respecting Country – A sustainable waste strategy for First Nation communities* sets out a path to improve waste management and resource recovery in Aboriginal and Torres Strait Islander communities.

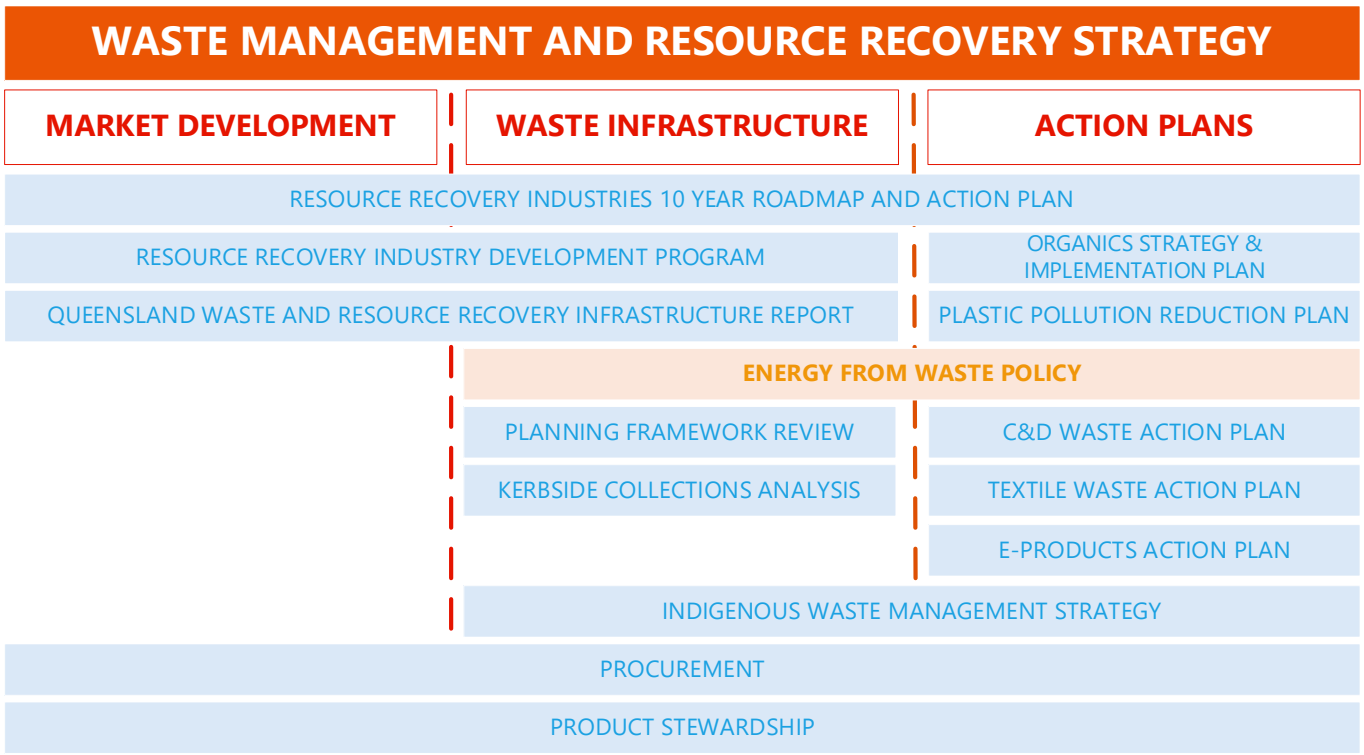

Figure 1: Key actions in implementing the Waste Management and Resource Recovery Strategy

Queensland's renewable energy target

The path to achieving a zero net emissions future includes a commitment to generate 50 per cent of Queensland's energy from renewable sources by 2030. Under the Commonwealth *Renewable Energy (Electricity) Act 2000*, energy derived from organic wastes may be regarded as renewable energy. This includes energy derived from wood waste, agricultural waste, food and food processing waste, biomass-based components of municipal waste, landfill gas, sewage gas, and biomass-based components of sewage. This type of energy is also referred to as 'bioenergy'. To the extent that electricity generated from waste meets this definition, it will contribute to the Queensland Government's commitment to reach 50 per cent renewable electricity generation by 2030. Energy derived from waste products made from fossil fuels (e.g. traditional plastics) does not count as renewable energy or bioenergy and would not contribute to the renewable energy target.

Underlying principles and values

Recognising the role that EfW facilities will play in managing Queensland's residual waste during the transition to a circular economy, and simultaneously acknowledging the need to account for community sentiment, the growing urban footprint in Queensland, evolving innovation in and understanding of emerging technologies, this policy is guided by the following underlying principles.

Waste and resource management hierarchy

This policy is underpinned by the Queensland Waste and Resource Management Hierarchy (the waste hierarchy), which is a framework that guides the order of preference for managing waste (Figure 3). The waste hierarchy is enshrined in the *Waste Reduction and Recycling Act 2011* and supported by the vision, targets and actions in the waste strategy.

Waste should be avoided as a first priority, after which options to reduce, reuse and recycle waste should be pursued. The options for fuel production, energy production, and disposal should be reserved for residual waste that is unsuitable for higher order options. This policy prioritises liquid fuel production over other forms of energy (electricity, heat and cooling) in line with the vision of developing a $1 billion sustainable and export-oriented industrial biotechnology and bioproducts sector under the *Queensland Biofutures 10-year Roadmap and Action Plan* (Biofutures Roadmap), which includes bioenergy.

Options for fuel and energy production are preferable to landfill because they recover value from the waste, reduce greenhouse gas emissions from organic wastes, and lessen the legacy impacts of landfills.

Circular economy

Making the transition to a circular economy is a priority under the waste strategy. A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (Figure 2). Transitioning from the current linear 'take-make-use-dispose' model to a truly circular economy will take time. During this transitional period, EfW provides an opportunity to capture the embodied energy in residual waste materials that would otherwise be lost if disposed to landfill. This policy applies circular economy principles to guide EfW activities as described below.

- **Design out waste/pollution**: This policy requires the application of best available techniques that help to minimise waste and pollution arising from EfW activities.
- **Keep products and materials in use**: To support this policy, end of waste codes will be developed where appropriate to guide and encourage environmentally-sound recovery and use of by-products, residues and wastes from EfW processes.
- **Regenerate natural systems**: The EfW hierarchy (discussed further below) has been developed, and will be applied under this policy, to prioritise EfW processes (e.g. biological EfW) that promote this principle.

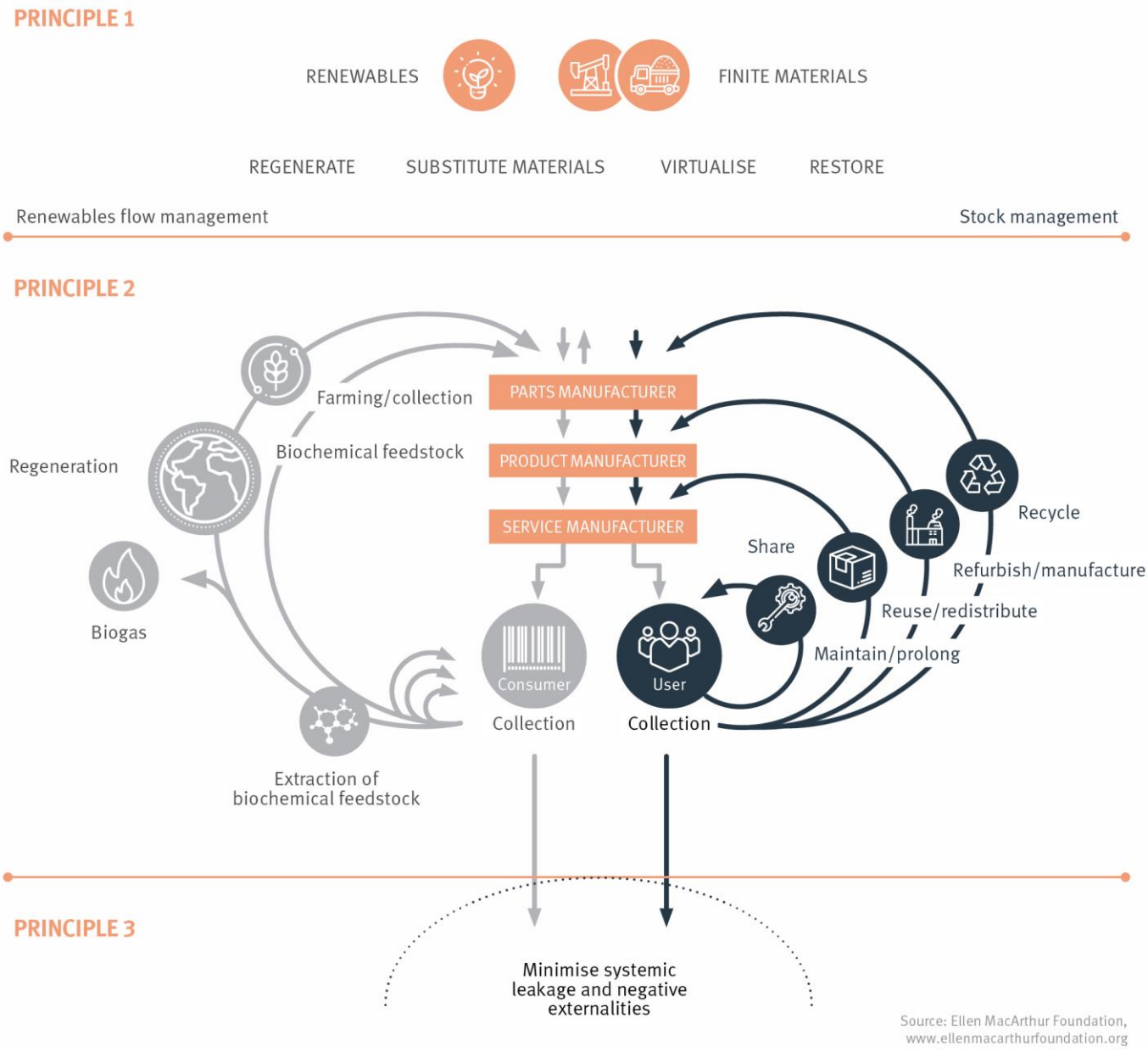

Figure 2: Circular economy (source: Ellen MacArthur Foundation, https://www.ellenmacarthurfoundation.org)

EfW hierarchy

The EfW hierarchy (Figure 3) has been developed to support the overarching waste hierarchy by providing greater clarity on energy recovery priorities. The EfW hierarchy ensures that development of the EfW sector aligns with other strategic priorities for waste management, resource recovery, economic development, and environmental protection, while providing the best outcomes for Queensland.

Biological EfW processes such as anaerobic digestion and fermentation are prioritised because, in addition to producing fuel, they preserve nutrients and organic matter, which can be returned to the soil to help improve soil quality and carbon sequestration. Importantly, biological EfW processes are aligned with the circular economy principle of regenerating natural systems, which promotes returning nutrients to soils and ecosystems to enhance natural resources.

The second preference is for EfW technologies that convert homogenous or single-source residual waste streams (e.g. agricultural wastes) into solid or liquid fuels that comply with an Australian, Queensland or international standard. This includes chemical EfW processes, such as the conversion of waste fats and oils into biodiesel using chemical catalysts. These processes align with the Queensland Government's priority to develop the biotechnology and bioproducts sector (including bioenergy) under the Biofutures Roadmap.

Thermal EfW (such as combustion with energy recovery) is preferred to landfill gas capture and combustion, because the latter relies on the continued disposal of organic waste to landfill, which is inconsistent with the waste hierarchy.

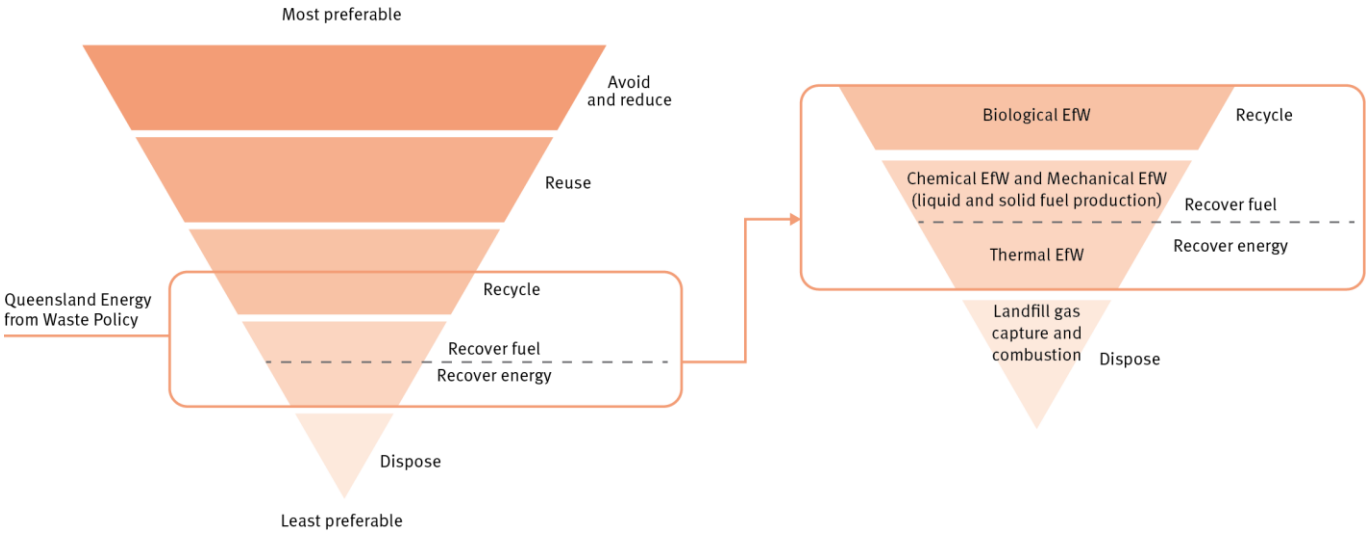

Figure 3: Waste and Resource Management Hierarchy (left), and EfW Hierarchy for residual waste (right) for Queensland

Precautionary principle

The Precautionary Principle as set out in the *Intergovernmental Agreement on the Environment*[1] requires that, where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

While respecting the Proximity Principle, EfW facilities must also adhere to the **Precautionary Principle**, to limit the risk of harm to the environment or human health as a result of air emissions or other environmental releases. Industrial growth and the emergence of new technologies and materials necessitate the use of a precautionary

1 Department of the Environment and Energy 1992, Intergovernmental agreement on the environment. Available at: https://www.environment.gov.au/about-us/esd/publications/intergovernmental-agreement.

approach to avoid unintended impacts from current and emerging contaminants for all communities.

Populations can still experience health impacts when emissions are below established national standards and thresholds and, for some common air pollutants, there is no safe threshold. While air quality impacts can be managed through effective regulation, tighter national air quality standards, the impacts of climate change and increasing community expectations mean greater monitoring and compliance challenges. **Consequently, EfW facilities cannot be located within or near sensitive land uses in the urban footprint such as (but not limited to) residential, aged care or child care facilities**.

Facility location guiding principles

Queensland is moving towards the circular economy and the waste management industry is progressively evolving its role in it. The Queensland Government is committed to a modern and sustainable resource recovery industry – one that encompasses waste management, collection and logistics, innovation, energy recovery, reprocessing and remanufacturing materials, and creating secondary markets. The waste hierarchy provides guidance to industry on preferences for resource recovery activities with avoid, reduce, reuse and recycle preferred. This EfW policy supports the waste hierarchy by ensuring only residual waste is used for EfW, such that EfW does not undermine higher order resource recovery.

An important strategy to reduce the risk of harm and unintended impacts is to ensure that, in particular, thermal EfW facilities are located away from sensitive land uses within the urban footprint such as residential dwellings, schools, childcare centres, healthcare and aged care facilities, offices, and public parks. However, strategic placement of EfW facilities in suitable areas that have complementary activities (for example, allowing greater energy recovery through exploiting cogeneration opportunities) with other industrial activities can help to boost the environmental and economic benefits of recovering energy from residual waste.

In time, this may lead to changes to the location of resource recovery industries as co-located businesses, operating in precincts, have greater opportunities to collaborate and innovate and can trade materials (feedstocks and by products) more efficiently, with less transport costs. This can help to catalyse supply chain development opportunities, drive industrial symbiosis, support innovation of waste activities and accelerate a transition to the principles underlying a circular economy. Locating EfW facilities in industrial areas occupied by, or intended for, facilities of similar size, scale and intensity provides certainty to industry as to what will be permitted, but does not necessarily preclude smaller scale, complementary or ancillary activities that are waste related.

The Queensland Government is taking a precautionary approach to the future of resource recovery industries and the relationship with communities. Actions in the *Queensland Resource Recovery Industries 10-Year Roadmap and Action Plan* (Roadmap) include the development of resource recovery precinct guidelines and location strategies. These guidelines will aim to provide certainty to industry on the preferred development of resource recovery precincts, including EfW facilities.

Through the Roadmap, the Queensland Government seeks to provide communities and industry with greater certainty about growth and economic opportunities. As the waste management and resource recovery industries evolve from landfill and waste management to resource recovery and recycling, precinct guidelines and location strategies will provide this certainty. Existing planning and environmental regulations will continue to apply, complemented by the following guiding principles:

- Development of EfW facilities is only supported where the proposal is of a size, scale, and intensity consistent with the intended or planned development for the area as outlined in relevant planning instruments and regional waste and/or resource recovery infrastructure plans (e.g. South East Queensland Waste Management Plan). This provides the opportunity to align developments with current and future economic, community and environmental needs and considerations.
- Development of EfW facilities is only supported where the proposal is situated away from current and future sensitive land uses so as to prevent noise, dust, odour or emissions impacts on these sensitive land uses. The rights of residents are to be protected and the opportunity for urban growth preserved within the regional planning framework.
- Economic benefits are realised through co-location of EfW with resource recovery industries in precincts supported by existing or planned infrastructure (such as road, rail, power, water).

Objective

The objective of this policy is to ensure Queensland's EfW sector is developed in an environmentally- and socially-sound manner that contributes to the vision, objectives, and targets of the waste strategy.

Scope

In scope

This policy applies to all technologies that produce all forms of energy (fuel, electricity, heating, cooling) from waste materials, including those that operate on biological, thermal and chemical or mechanical principles (Table 3).

Table 3: EfW technologies within the scope of this policy

Technology type	Description	Examples
Biological EfW	Breakdown of organic waste by microorganisms and enzymes to produce a combustible gas or liquid fuel	• Anaerobic digestion of organic wastes to produce biogas, and digestate • Fermentation of food processing wastes to produce ethanol
Chemical EfW	Chemical agents are used to convert the waste feedstock into a liquid fuel	• Conversion of waste fats and oils into biodiesel using chemical catalysts
Mechanical EfW	Processing of waste using mechanical and physical processes such as shredding, screening, dehydration and pelletisation, to produce a fuel (often solid)	• Production of refuse derived fuel (RDF)
Thermal EfW	Breakdown of waste using heat (typically greater than 200°C) to release the embodied energy, usually in the form of heat (hot flue gases), a synthesis gas, or liquid fuel	• Combustion with energy recovery of mixed MSW to produce heat and/or electricity • Pyrolysis of end-of-life tyres to produce pyrolysis oil, syngas, heat, electricity

In Queensland, an environmental authority (EA) is required to conduct an environmentally relevant activity (ERA) that has the potential to cause environmental harm. The department administers seven waste-related ERAs (refer to Table 4), which are prescribed in Schedule 2 of the Environmental Protection Regulation 2019. The EfW technology types defined in this policy are regulated under one or more of these ERAs as indicated in Table 4.

This policy applies to the assessment of an application for a waste-related ERA. It forms part of the standard criteria under the *Environmental Protection Act 1994* that must be considered in deciding an application for the ERA.

Table 4: Waste-related ERAs and their application to EfW activities

ERA	Example of EfW activity
ERA 53 - Organic material processing	Biological EfW, e.g. anaerobic digestion of organic waste
ERA 54 - Mechanical waste reprocessing	Mechanical EfW, e.g. production of RDF
ERA 55 - Other waste reprocessing or treatment	Chemical EfW, e.g. Producing biodiesel from waste fats/oils
ERA 57 - Regulated waste transport	Nil
ERA 60 - Waste disposal	Nil
ERA 61 - Thermal waste reprocessing and treatment	Thermal EfW, e.g. combustion for energy recovery
ERA 62 - Resource recovery and transfer facility operation	Nil

Note: The information in this table does not constitute exhaustive or formal guidance on all ERA requirements for all EfW activities.

Out of scope

This policy does not apply to:

- capture and combustion of landfill gas
- energy recovery from non-waste materials, such as sorghum and other crops grown for energy production
- industrial non-waste facilities such as cement kilns and fossil fuel power plants, which use as a fuel a resource under an end of waste (EOW) code.

Approvals required under other legislation have not been included in this policy. Proponents are responsible for determining all of the approvals and permits required for their EfW proposal. Early stakeholder engagement prior to lodgement of any application is however encouraged and may support consideration of related approvals.

Policy outcomes

This chapter of the policy outlines seven policy outcomes to guide proponents on how environmental authority applications for EfW facilities will be assessed, and how EfW facilities will be regulated. However, not all policy outcomes apply to all types of EfW technologies. For example, biological EfW is regarded as recycling and thus there is no requirement to limit feedstock to residual waste. Refer to Table 5 for the specific application of each policy outcome.

An operational guideline will accompany this policy to provide detailed guidance on the application and implementation of this policy.

Table 5: Application of the policy outcomes to EfW technologies

Policy outcomes	Biological EfW	Chemical EfW	Mechanical EfW	Thermal EfW
1. Protect the waste hierarchy	✓	✓	✓	✓
2. Demonstrate operational performance	✓	✓	✓	✓
3. Engage with the community	✓	✓	✓	✓
4. Residual waste as feedstock		✓	✓	✓
5. Adapt to residual waste changes		✓	✓	✓
6. Energy recovery requirements				✓
7. Environmental protection requirements	✓	✓	✓	✓

Protect the waste hierarchy

Policy outcome 1: Energy from waste proposals do not undermine reuse and recycling and the circular economy principles, and disposal does not undermine appropriate energy recovery

Waste should be managed at the highest practical level of the waste hierarchy to support Queensland's transition to a circular economy and to achieve the best outcome for the environment and for future generations.

In assessing and deciding an application for a waste-related ERA, the department must currently consider a range of matters, including any Commonwealth or State government plans, standards, agreements or requirements about environmental protection or ecologically sustainable development. The waste hierarchy forms part of this requirement and will continue to be considered by the department in assessing EfW applications.

To further support the waste hierarchy, the department will also consider the EfW hierarchy (Figure 3) in its decision-making process. Proponents are therefore expected to demonstrate how their proposed project aligns with both the waste hierarchy and the EfW hierarchy.

Demonstrate operational performance

Policy outcome 2: The operational performance of a proposed EfW facility is demonstrated

This policy enables a range of commercial, new, and emerging EfW technologies to be considered, each carrying different risks. It is important to understand the nature and magnitude of these risks to ensure appropriate mitigation, management and regulation. A proponent is expected to be able to characterise the risks to human health and the environment associated with the commissioning and operation of the proposed EfW facility.

Commercial technologies

In this policy, a commercial technology is defined as having been in commercial operation for at least two (2) years. Commercial operation means operation of the technology or facility, in return for financial gain or other valuable consideration, and which is available to the public, or performed under a contract between the technology/facility operator and a customer who has no control over the operator.

A proponent proposing to establish a commercial technology is expected to meet the following requirements:

- Provide data from a reference facility to demonstrate that the proposed facility can function in an environmentally-sound manner in compliance with the requirements of this policy.
    - A reference facility is a facility that has been in commercial operation:
        - at a scale (size and throughput) similar to the facility being proposed
        - with feedstock similar in composition to that proposed
        - for at least two (2) continuous years
        - in Queensland or in a jurisdiction with comparable regulatory governance to Queensland. Further guidance on comparable jurisdictions will be provided in an operational guideline.
- Provide at least two (2) years of operational data from the reference facility to enable the department to assess and validate the potential environmental and human health risks of the proposed facility. Data from the design, modelling or commissioning phases alone is not acceptable to demonstrate operational performance of the proposed facility.
    - The operational data must be no more than five (5) years old and include, but is not limited to:
        - monitoring data for all process parameters, and all (solid, liquid and gaseous) emissions
        - energy and mass balances
        - characterisation of the feedstock, by-products, and wastes.

New and emerging technologies

In this policy, a new technology is a technology that has been in commercial operation for less than 2 years, while an emerging technology is one that is still going through research and development.

By definition, new and emerging technologies would not be able to provide data from a fully operational reference facility to support a proper assessment of the environmental risks, therefore different requirements apply:

- Proponents of new technology are expected to provide:
    - data from the technology development phase corresponding to level 9 on the Technology Readiness Level

(TRL) index[2,3]
    - where available, operational data from the commercial operation of a similar facility that has been operating:
        - at a scale (size and throughput) similar to the facility being proposed
        - with feedstock similar in composition to that proposed
        - in Queensland (or Australia), or in a jurisdiction with comparable regulatory governance to Queensland. Further guidance on comparable jurisdictions will be provided in an operational guideline.

- Proponents of an emerging technology are expected to provide data from the technology development phase to demonstrate a classification at level 7 or higher on the TRL index.

Further information on the TRL index, including information to demonstrate a TRL classification is provided in Appendix A of this policy.

All technologies, whether commercial, new or emerging, would be expected to meet the environmental protection requirements of this policy (policy outcome 7). If approved, new and emerging technologies (compared to commercial technologies) may be subject to more frequent monitoring and reporting requirements, be required to monitor additional parameters, or have other conditions applied to address risks that are specific to those technologies. These conditions would be determined on a case-by-case basis depending on the size/scale, location, and nature of the EfW proposal.

2 Australian Renewable Energy Agency 2014, *Technology readiness levels for renewable energy sectors*, https://arena.gov.au/assets/2014/02/Technology-Readiness-Levels.pdf

3 US Department of Energy, 2009, *Technology readiness assessment guide (DOE G 413.3-4)*, https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04/view

Engage with the community

Policy outcome 3: Communities potentially impacted by proposed EfW facilities are appropriately engaged

EfW can be a particularly contentious topic for communities. Therefore, it is important that communities which may be affected by proposed EfW facilities are appropriately, considerately and authentically engaged early in project decision-making, and provided with appropriate avenues for ongoing engagement with a proponent.

Prior to lodging an application for an EfW facility, a proponent is expected to demonstrate engagement with communities potentially affected by the proposed facility. It is expected this engagement will adhere to the principles of community engagement outlined in Table 6.

Table 6: Principles of community engagement for proponents

Principle	What this means in practice
Community engagement will be authentic and transparent.	It will be clear which decisions can be influenced by community input and which cannot. The results of community engagement will be communicated back to the community – engagement will 'close the loop'. Information will be shared transparently with the community in a manner that encourages mutual trust.
Community engagement will be inclusive.	Engagement and information sharing activities will be as inclusive and accessible as possible and will take into account any specific requirements of community groups, such as cultural and linguistic diversity, First Nations values and traditions, or restricted mobility.
Community engagement will be respectful.	Stakeholders and the community can expect to have their concerns actively listened to. Engagement will acknowledge the expertise, perspective and needs of the community and stakeholders. Stakeholders will be open, trustworthy and respectful when taking part in all engagement processes.
Community engagement will be responsive	Engagement activities and information sharing will be done in a timely manner that allows appropriate time for informed consideration and contributions by those potentially impacted.
People have a right to participate in decisions about matters that affect them.	If a project has the potential (whether real or perceived) to impact on the community, the community has a right to be informed about that project and for their opinions and feedback to be included in decision-making.

Proponents have a role to play in helping to ensure that communities are appropriately engaged in line with the principles of community engagement, including:

- work with local government to identify appropriate stakeholder groups
- prepare and submit a stakeholder engagement plan with the environmental authority application, which demonstrates how the principles of community engagement have been implemented, and are proposed to be implemented over the life of the proposed facility
- prepare and submit a stakeholder engagement report with the environmental authority application, which documents the outcomes of the community engagement undertaken up to the point of making the application
- plan and undertake consultation activities in line with the stakeholder engagement plan
- ensure local and state government are informed throughout the engagement planning and execution process.

The state government also has a role to play in promoting an understanding of state government policies and providing relevant guidance on best practices.

The concept of obtaining a social licence to operate (SLO), which has its origins in the mining and extractive industries, is increasingly becoming important for proponents in other industries, including the waste industry. SLO broadly refers to the informal licence or approval granted by a local community or stakeholders for a project. Once earned, SLO has to be maintained.

Proponents will need to ensure and demonstrate that there is SLO in the impacted communities and subsequently maintain this SLO over the expected life of the facility. EfW operators will need to be ‘good neighbours’ during all phases of a project in accordance with the Good Neighbour Principle. This means taking reasonable care to avoid acts or omissions that are reasonably likely to negatively impact one’s neighbours.

Use only residual waste as feedstock

Policy outcome 4: Only residual wastes is used for energy recovery

This policy outcome helps to safeguard the waste hierarchy and supports Queensland's recycling targets by restricting EfW to residual waste. This helps to ensure that waste materials able to be managed at a higher level of the waste hierarchy are not used for energy recovery but are retained in the economy for as long as possible.

Residual waste is waste that is not technically, environmentally, and economically practical (TEEP) to reuse or recycle. Residual waste may include, for example:

- residues from a waste recycling or remanufacturing process, for which no further recycling process is available
- waste that is too degraded or contaminated to be recycled.

A proponent of an EfW facility must demonstrate that the proposed feedstock is residual waste. The determination of what is TEEP must consider:

- the precautionary principle, intergenerational equity, and conservation of biological diversity and ecological integrity as set out in the *Intergovernmental Agreement on the Environment*
- technical feasibility and economic viability
- protection of resources
- the overall environmental, human health, economic and social impacts.

Examples of non-residual waste include (but are not limited to) uncontaminated comingled recyclables from yellow-lid bins; source-separated green waste; and MSW, C&I and C&D waste that has not been through a resource recovery process.

This policy outcome applies to chemical EfW, mechanical EfW, and thermal EfW. It does not apply to biological EfW, which is regarded as recycling and able to accept materials that can be recycled.

Adapt to residual waste changes over time

Policy outcome 5: EfW facilities are expected to adapt to changes in residual waste over time

The quantity and composition of residual waste in Queensland is expected to change over time as a result of:

- progressively achieving the waste strategy targets to reduce household waste generation by 25 per cent, and recycle 75 per cent of all waste streams by 2050
- industry support programs such as the Resource Recovery Industry Development Program (commenced in 2018-19), and the Waste to Biofutures Fund (2018-19), which both aim to grow capability in the resource recovery sector
- transitioning to a circular economy where waste and pollution are gradually designed out, and where products and materials are kept in circulation for as long as possible.

EfW proponents must clearly demonstrate how the proposed EfW facility will adapt to the expected changes in residual waste, over the facility’s expected lifetime. This may include, for example, conducting a feedstock sensitivity analysis to assess the effect of variations in feedstock composition over time on the performance of the proposed facility, and ability to meet all relevant requirements of this policy.

This policy outcome applies to chemical EfW, mechanical EfW, and thermal EfW. It does not apply to biological EfW, which is regarded as recycling and able to accept materials that can be recycled.

Energy recovery requirements

Policy outcome 6: Facilities combusting waste for energy recovery meet the R1 Energy Efficiency threshold

This policy outcome applies only to facilities proposing to combust waste for energy recovery.

EfW is preferable to landfill partially because, compared to landfill, it extracts energy that can offset the use of non-renewable energy sources. However, this preference diminishes if energy is not recovered and utilised.

The energy recovery efficiency of a proposed EfW facility must be determined using the R1 Energy Efficiency formula (R1 formula) and procedures as set out in the European Union Waste Framework Directive (Directive 2008/98/EC):

$$Energy\ efficiency\ (R1) = \frac{\left(E_p - \left(E_f + E_i\right)\right)}{\left(0.97\ \times\ \left(E_w + \ E_f\right)\right)}$$

In which:

- E_p means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (gigajoules/year)
- E_f means annual energy input to the system from fuels contributing to the production of steam (gigajoules /year)
- E_w means annual net calorific value of the waste (gigajoules /year)
- E_i means annual energy imported excluding E_w and E_f (gigajoules /year)
- 0.97 is a factor accounting for energy losses due to bottom ash and radiation.

Proposals for combustion with energy recovery are expected to demonstrate that the proposed facility can achieve a minimum R1 threshold equal to 0.65.

Facilities lawfully combusting waste for energy recovery when this policy commences, are expected to achieve a minimum R1 threshold equal to 0.60, within 5 years of commencement of this policy. This will help to ensure consistent regulation of similar facilities across Queensland.

To support implementation of this policy, the department will prepare further operational guidance on determining and achieving R1 values. It is widely acknowledged that achievement of the R1 threshold can be affected by the ambient temperature and facility size. These factors will be investigated further to develop correction factors for the R1 formula that take into account Queensland's climate and different facility sizes (e.g. modular facilities suited to regional areas). These correction factors will be included in the operational guideline.

An energy recovery criteria is not required for EfW processes which produce solid, liquid or gaseous fuels, because the business model of waste-to-fuel processes relies more heavily on the value of the fuel product, which serves as the economic incentive to maximise the fuel yield. Consequently, these processes support the waste hierarchy, and energy performance criteria are not required to distinguish them from disposal processes.

Environmental protection requirements

Policy outcome 7: The potential environmental impacts of EfW facilities are expected to be managed in accordance with the Waste Incineration BREF and the Waste Treatment BREF

Best Available Techniques Reference Documents (BREFs) are a series of European reference documents that provide guidance on best available techniques for a range of industrial processes regulated by the Industrial Emissions Directive 2010/75/EU. This policy considers the BREF for Waste Incineration and the BREF for Waste Treatment to be suitable best practice for Queensland. The BREFs are available from the European Commission's website at https://eippcb.jrc.ec.europa.eu/reference/.

The department will apply the BREFs, in particular those parts relating to 'Best Available Techniques Conclusions', to determine appropriate EA conditions for relevant EfW facilities. Detailed guidance will be prepared to complement this policy and help industry proponents predict the core conditions likely to be imposed on an EA, and to tailor the content of EA applications.

Proponents are expected to demonstrate the use of best practices as set out in the following BREFs:

- BREF for Waste Incineration 2019. This BREF covers:
  - Incineration (combustion), pyrolysis, and gasification processes
  - the reception, handling and storage of waste
  - some waste pre-treatment techniques along with their influence on the ensuing incineration process
  - emissions to air and applied techniques for flue-gas cleaning
  - applied techniques for the treatment of, and recovery of useful materials from, incinerator bottom ashes
  - emissions to water and the treatment of wastewater from wet flue-gas cleaning or bottom ash treatment
  - the recovery of energy from the incineration process.
- BREF for Waste Treatment. This BREF covers several waste treatment processes. Relevant proponents will be required to meet those aspects of the BREF concerned with:
  - biological waste treatment such as aerobic/anaerobic treatment and mechanical and biological treatment
  - treatment to produce mainly solid and liquid fuels from hazardous and non-hazardous waste.

To ensure continued protection of Queensland's environment and consistent regulation across Queensland, relevant EfW facilities that are lawfully operating when this policy commences will be expected to demonstrate, within 5 years, that their facilities are operating within the limits and best practices stipulated in the applicable BREF.

Related legislation and regulation

Environmentally relevant activity framework

Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) regulates ERAs that have a potential to impact the environment. The Environmental Protection Regulation 2019 (EP Regulation) prescribes the list of ERAs which are regulated. An EA must be obtained to conduct any of the 53 ERAs prescribed in Schedule 2 of the EP Regulation, including the following seven waste-related ERAs:

- ERA 53 - Organic material processing
- ERA 54 - Mechanical waste reprocessing
- ERA 55 - Other waste reprocessing or treatment
- ERA 57 - Regulated waste transport
- ERA 60 - Waste disposal
- ERA 61 - Thermal waste reprocessing and treatment
- ERA 62 - Resource recovery and transfer facility operation.

Environmental Protection Policies

The environmental impacts to air, water and noise emissions associated with ERAs are also regulated under Environmental Protection Policies, which are:

- **Environmental Protection (Air) Policy 2019**: The purpose of this policy is to achieve the object of the EP Act in relation to the air environment by:
  - identifying environmental values to be enhanced or protected
  - stating indicators and air quality objectives for enhancing or protecting the environmental values
  - providing a framework for making consistent, equitable and informed decisions about the air environment.
- **Environmental Protection (Water and Wetland Biodiversity) Policy 2019**: The purpose of this policy is to achieve the object of the EP Act in relation to water and wetlands by:
  - identifying environmental values for waters and wetlands to be enhanced or protected
  - identifying management goals for waters
  - stating water quality guidelines and quality objectives for enhancing or protecting the environmental values of waters
  - providing a framework for making consistent, equitable and informed decisions about waters
  - monitoring and reporting on the condition of waters.
- **Environmental Protection (Noise) Policy 2019**: The purpose of this policy is to achieve the object of the EP Act in relation to the acoustic environment by:
  - identifying and declaring the environmental values to of the acoustic environment
  - stating acoustic quality objectives that are directed at enhancing or protecting the environmental values
  - providing a framework for making consistent, equitable and informed decisions about the acoustic environment.

End of waste framework

The end of waste (EOW) framework under the *Waste Reduction and Recycling Act 2011*, is Queensland's waste-to-resources framework, which reclassifies waste materials into resources. A waste becomes a resource, and is regulated as a resource, when it meets the quality requirements set out in the applicable EOW code.

To support implementation of this policy, EOW codes for residues and wastes arising from various EfW processes will be evaluated and developed where appropriate.

For example, an EOW code for RDF could help to ensure that only fuels of a stipulated quality are reclassified as resources and used to displace other non-renewable energy sources in industrial non-waste facilities. The quality of the fuel specified under an EOW code could be such that burning it in an industrial facility would result in no worse outcome than the fuel being replaced. Furthermore, because the RDF would be reclassified as a resource, industrial non-waste facilities can use it as a fuel replacement without additional regulation as a waste combustion facility.

A similar practice occurs in Europe, where the European Standard CEN/TC 343 has been developed to ensure consistency in high-quality solid recovered fuels prepared from non-hazardous waste.

Health and safety regulation

Under the *Petroleum and Gas (Production and Safety) Act 2004* and Petroleum and Gas (Safety) Regulation 2018, the Petroleum and Gas Inspectorate within the Resources Safety and Health Queensland (RSHQ), regulates safety and health in relation to exploration, extraction, production, distribution and use of petroleum and fuel gas. This includes facilities that produce or process biogas, landfill gas, and sewage gas, which are also subject to environmental regulation. Proponents of EfW projects that generate fuel gas will need to determine whether the project also requires RSHQ assessment, and comply with any relevant requirements.

Electricity authorities

Under the *Electricity Act 1994*, the Regulator (the Director-General of the Department of Energy and Public Works) issues authorities (licences) for generation, transmission and distribution activities in Queensland's electricity industry, including EfW facilities that produce and export electricity to a transmission grid or supply network. The following authorities may be issued:

- a generation authority allows a generating plant to connect to a transmission grid or supply network
- a transmission authority allows operation of a transmission grid and may also authorise a transmission grid to connect to another transmission grid
- a distribution authority allows electricity to be supplied using a supply network within a specified distribution area.

The Regulator must invite interested persons to make a submission about an application for a generation, transmission or distribution authority, before issuing the authority. It is the responsibility of proponents of EfW facilities to determine whether an electricity authority is required and to comply with any relevant requirements. Additional obligations under federal legislation may also apply. Further information on electricity authorities is available on the Queensland Government website at: https://www.business.qld.gov.au/industries/mining-energy-water/energy/electricity/regulation-licensing/licensing-framework.

Implementation and Review

To support implementation of this policy, the department has prepared an EfW Guideline to provide further guidance on applying the policy in practice and to showcase Australian and international facilities that are achieving outcomes in line with the policy. Further information on the EfW Guideline is available on the Queensland Government website at: https://www.qld.gov.au/environment/pollution/management/waste/recovery/energy-waste.

The department will also investigate development of EOW codes to support environmentally-sound utilisation of the products and by-products from EfW processes including refuse derived fuel, and incinerator bottom ash.

The department will periodically review and evaluate the effectiveness of this policy.

Definitions

Anaerobic digestion means the biological breakdown of organic matter by microorganisms and enzymes, in the absence of oxygen to produce biogas and digestate (a nutrient rich residue).

Circular economy means an economy in which products and materials keep circulating within the economy at their highest value for as long as possible, through reuse, recycling, remanufacturing, delivering products as services, and sharing.

Biogas means gas produced from anaerobic digestion, which is a mixture of methane and carbon dioxide.

Bioenergy means a form of renewable energy that uses organic renewable materials (biomass) to produce fuels, heat and electricity.

Biological EfW means technologies or processes that use microorganisms and enzymes to breakdown waste materials in the absence of oxygen to produce a biogas and a fertiliser-like residue. Anaerobic digestion, and fermentation of waste materials are examples of biological EfW.

Chemical EfW means the production of energy (fuel) from waste materials using chemical agents. An example of this is transesterification, which involves reacting waste fats and oils which an alcohol (methanol) in the presence of a catalyst (sodium hydroxide) to produce biodiesel.

Combustion means the breakdown of waste at elevated temperatures under excess air or oxygen to produce heat, ash, and flue gas.

Commercial technology means a technology that has been in commercial operation for at least two (2) years.

Commercial operation means operation of the technology or facility, in return for financial gain or other valuable consideration, and which is available to the public, or performed under a contract between the technology or facility operator and a customer with no control over the operator.

Comparable jurisdiction means a jurisdiction that imposes requirements similar to those imposed in this policy and in applicable Queensland legislation, including the *Environmental Protection Act 1994* and its subordinate legislation, and the *Waste Reduction and Recycling Act 2011* and its subordinate legislation.

Emerging technology means a technology one that is still going through the research and development process as determined against the Technology Readiness Level Index.

End of waste (EOW) code means a code that sets out the requirements for a particular waste to be reclassified into a resource for one or more specified end uses.

Energy from waste (EfW) means the extraction of energy from waste materials. The energy can be extracted in the form of solid, liquid or gaseous fuels, heat, or electricity generated using the former.

Fermentation means the breakdown by microorganisms, of the sugars such as glucose, fructose and sucrose, in waste organic matter, into ethanol and carbon dioxide.

Gasification means the breakdown of waste at elevated temperatures under oxygen-reduced conditions to produce a syngas comprising mainly of carbon monoxide, hydrogen, carbon dioxide, nitrogen, and methane.

Headline waste means municipal solid waste, commercial and industrial waste, and construction and demolition waste streams, which are generated from everyday household and business activities. These wastes form the basis of state and federal waste targets and reporting. Headline waste does not include regulated wastes.

Incineration means the destruction of waste using heat, for the primary purpose of disposal.

New technology means a technology that has been in commercial operation for less than two (2) years.

Pyrolysis means the breakdown of waste at elevated temperatures in the absence of oxygen to produce char, pyrolysis oil, and syngas.

Recycling means extracting materials from waste and converting them into useful products. For example, concrete may be extracted from the construction and demolition waste stream and converted into recycled aggregate suitable for use in road base as a virgin material substitute. Recycling includes biological energy-from-waste processes.

Refuse derived fuel (RDF) means a fuel produced from waste, typically by shredding to reduce particle size, dehydrating to remove moisture, and removal of non-combustible materials such as metals.

Residual waste means waste that is not technically, environmentally, and economically practicable to reuse or recycle.

Social licence means the informal approval or endorsement of a project granted by a community.

Stakeholder engagement plan means a plan developed by the proponent of an EfW facility that provides details about project stakeholders, how they will be engaged over the life of the facility and the associated communication activities, and mechanisms to address stakeholder grievances.

Syngas (or synthesis gas) means a fuel gas mixture containing methane, hydrogen, carbon monoxide, carbon dioxide and nitrogen.

Technology Readiness Level (TRL) Index means a method of estimating the maturity level of a particular technology. It is used by the Australian Renewable Energy Agency (ARENA) to measure the technical readiness of renewable energy solutions. It is also used by several government agencies in the USA, including the National Aeronautics and Space Administration (NASA), and the United States Department of Energy. Further information is available from:

- NASA: https://www.nasa.gov/topics/aeronautics/features/trl_demystified.html
- US Department of Energy: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04/view
- ARENA: https://arena.gov.au/assets/2014/02/Technology-Readiness-Levels.pdf.

Thermal EfW means the decomposition of waste at high temperatures to produce heat or release the energy contained in the waste. Combustion with energy recovery, pyrolysis and gasification are examples of thermal EfW.

Appendix A: Technology Readiness Level Index

The Technology Readiness Level (TRL) Index is a globally-accepted benchmarking tool for tracking progress and supporting development of a specific technology through the early stages of the innovation chain, from blue sky research (TRL 1) to actual system demonstration over the full range of expected conditions (TRL 9). It is used to estimate the maturity of a particular technology.

The following table provides further details of the nine TRLs including examples of the supporting information to help justify a TRL classification.

Table A1: Technology Readiness Levels[4]

Relative level of technology development	TRL	TRL Definition	Description	Supporting information
System operations	TRL 9	Actual system operated over the full range of expected mission conditions	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.	Operational test and evaluation reports.
System commissioning	TRL 8	Actual system completed and qualified through test and demonstration	The technology has been proven to work in its final form and under expected conditions in almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning.	Supporting information includes results of testing the system in its final configuration under the expected range of environmental conditions in which it will be expected to operate. Assessment of whether it will meet its operational requirements. What problems were encountered? What are/were the plans, options or actions to resolve problems before finalising the design?
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning. Final design is virtually complete.	Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment.
Technology demonstration	TRL 6	Engineering/ pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to	Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment.

4 US Department of Energy Technology Readiness Assessment Guide (DOE 413.3-4 10-12-09). Available at https://www.directives.doe.gov/directives/0413.3-EGuide-04/view.

Relative level of technology development	TRL	TRL Definition	Description	Supporting information
			engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.	
Technology development	TRL 5	Laboratory-scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory- scale system in a simulated environment with a range of simulants and actual waste. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.	Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/ environment, and analysis of what the experimental results mean for the eventual operating system/ environment.
	TRL 4	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively “low fidelity” compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste. TRL 4-6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function	Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals.
Research to prove feasibility	TRL 3	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory- scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modelling and simulation may be used to complement physical experiments	Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems.

Relative level of technology development	TRL	TRL Definition	Description	Supporting information
Basic technology research	TRL 2	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.	Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept.
	TRL 1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world.	Supporting Information includes published research or other references that identify the principles that underlie the technology.

Further information on the TRL Index is available from the following sources:

- National Aeronautical and Space Administration: https://www.nasa.gov/topics/aeronautics/features/trl_demystified.html
- US Department of Energy: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04/view
- Australian Renewable Energy Agency 2014, *Technology readiness levels for renewable energy sectors*, https://arena.gov.au/assets/2014/02/Technology-Readiness-Levels.pdf.