

# Energy from Waste

Guideline



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## Introduction

As outlined in *Getting Full Value: the Victorian Waste and Resource Recovery Policy*, ('Getting Full Value Policy') the Victorian Government is committed to an integrated, statewide waste and resource recovery system that protects the environment and public health, maximises the productive value of resources, and minimises the long-term costs to households, industry and government.

The Victorian Government also outlined that it welcomes investments in energy from waste and other alternative technology that can convert waste into useful products, if it can be demonstrated that investment will deliver strong environmental, public health and economic outcomes.

This guideline outlines how the *Environment Protection Act 1970* ('the Act') and associated statutory policies and regulations are applied to the assessment of proposals that recover energy from waste. The document provides high-level guidance for industry, government and the community on EPA Victoria's (EPA) expectations and requirements for the siting, design, construction and operation of such facilities.

Efficient recovery of energy from the thermal or biological processing of waste is considered a resource recovery as opposed to a waste disposal option. Recovery of energy should not compete with avoidance, reuse or recycling.

## Legal status of this guideline

This guideline provides a summary of the Act's key principles and environment protection requirements as well as subordinate legislation. The technical details in this guideline describe measures to assist in meeting these requirements.

The guideline does not represent a comprehensive statement of the law as it applies to either particular problems or individuals or serves as a substitute for legal advice.

## What is 'energy from waste'?

The terms 'energy recovery from waste', 'waste to energy' or 'energy from waste' can be used interchangeably to describe a number of treatment processes and technologies used to generate a usable form of energy from waste materials. Examples of usable forms of energy include electricity, heat and transport fuels. For the purpose of this document the term 'energy from waste' or 'EfW' is used.

EfW technologies can be divided into two broad categories: biological processing of biodegradable waste and thermal treatment of residual waste, including direct combustion, gasification and pyrolysis.

The main technologies are summarised below:

- combustion to produce heat
- gasification, including plasma gasification or plasma assisted gasification, to produce a combustible syngas
- pyrolysis to produce syngas, oil or char
- biological processes such as anaerobic digestion or fermentation to produce biogas or alcohol.

The most common type of EfW technology around the world is direct combustion of waste to create heat, which can be used directly or to generate electricity. All other technologies described above generate a fuel or gas which can be combusted to generate heat or electricity, or converted to transport fuels, synthetic natural gas or other products.

In some cases, there are opportunities to adapt industrial and power generation facilities that were initially designed to use fossil fuels (coal, oil or gas), to accept a proportion of alternative fuels derived from waste. This is called 'co-combustion or 'fuel replacement'. The most common types of facilities in which co-combustion occurs includes power plants, brick works and cement kilns.

Other indirect EfW pathways include the processing of waste to produce combustible refuse derived fuels (RDF). This is achieved using mechanical sorting and processing techniques such as screening, crushing and grinding at facilities known as materials recovery facilities (MRF) or, if it involves a form of thermal pre-treatment, mechanical heat treatment (MHT). In addition, some processes such as mechanical biological treatment (MBT) can also separate organic material for biological processing such as anaerobic digestion.

## What's in the scope of this guideline

This guideline is intended to apply to all processes and technologies that recover energy or fuel from the thermal or biological processing of solid and liquid waste as described in the previous section, and includes waste preparation/sorting processes. Whilst it covers all currently known or developing types of EfW technologies and processes, this guideline primarily focuses on thermal treatment.

The Victorian Government will work with industry to anticipate the array of new technologies likely to enter the Victorian market, and EPA will provide regulatory certainty by continually updating guidance notes that set out regulatory requirements for new EfW technologies.

## What's not in the scope of this guideline

The processes and applications listed below are outside the scope of this guideline:

- incineration for the disposal of waste without energy recovery as the primary purpose
- heat or gas capture as a by-product from a process
- thermal treatment of contaminated soils
- fuels produced exclusively for or used in the domestic market (for example, fuels made from untreated wood).

Whilst the use of gas from landfill and from wastewater treatment processes are in scope, their production and capture do not directly fall under this guideline. Gas from wastewater treatment is considered a by-product of an existing process and landfill gas comes from waste that is first disposed to landfill. Information in relation to setting up bioreactor landfills can be found in *Siting, design, operation and rehabilitation of landfills* (EPA publication 788.1).

The use of transport fuel is also out of this document's scope because the criteria outlined therein are not relevant.

## Overview of assessment criteria

The EPA has primary responsibility for administration of the Act, which involves upholding the objective of creating a legislative framework for the protection of the environment in Victoria. Through administration of the Act the EPA endeavours to protect the environment and human health from the adverse effects of waste discharges and emissions to the air, land and water environments. EPA administers the Act using a variety of tools, including statutory tools such as works approvals and licenses.

The Environment Protection (Scheduled Premises and Exemptions) Regulations 2007 ('Scheduled Premises Regulations') prescribe the premises that are subject to works approval, financial assurance and/or licensing by EPA, and provide for exemptions in certain circumstances. They provide a means to effectively manage these premises in a transparent way, which ensures an adequate level of community confidence is maintained. The key schedule categories relevant to this guideline are summarised in the table below.

Category	Description
A01 (Prescribed Industrial Waste (PIW) management)	Storage, treatment, reprocessing, containment or disposal facilities handling any PIW not generated at the premises
A02 (other waste treatment)	Waste treatment works engaged in the immobilisation, thermal degradation, incineration or other treatment of waste
A07 (composting)	Premises with aerobic or anaerobic composting which are designed to or have a capacity to process more than 100 tonnes of waste per month
A08 (waste to energy)	Premises which recover energy from waste at a rated capacity of at least 1 MW

These categories apply to EfW activities as follows:

- Activities involving the construction and/or operation of standalone EfW plants and facilities, either at new sites or at existing industrial sites, are generally scheduled under A07 for biological processes and A08 for thermal processes, depending on the scale of operations (as defined in the above table).
- Activities involving the collection, sorting, recycling and mechanical treatment of solid inert waste for the purpose of energy recovery are generally not scheduled. However, if the activity includes a treatment step, such as thermal or chemical, it may be scheduled under A02.
- Any activity involving the storage, treatment, reprocessing, containment or disposal of PIW not generated at the premises is scheduled under A01.<sup>1</sup>

<sup>1</sup> Waste is defined in the Act and PIW is defined in the Environment Protection (Industrial Waste Resource) Regulations 2009. A definition of all waste types is provided in EPA's guideline *Waste categorisation* (Publication IWRG 600.2)

- Co-combustion of waste or RDF at an existing facility will require a works approval or a research, development & demonstration (RD&D) approval if emissions are likely to be altered. Likewise, if the feedstock of a dedicated EfW facility changes significantly over time, to the point where air emissions are likely to be altered, a works approval will be required.

Proponents of EfW proposals which require a works approval or licence will be expected to demonstrate that the siting, design, construction and operation of EfW facilities will incorporate best practice measures for the protection of the land, water and air environments as well as for energy efficiency and greenhouse gas emissions management. Facilities should be able to provide evidence of how they minimise and manage emissions (including pollutants, odour, dust, litter, noise and residual waste) in accordance with relevant statutory requirements. *Demonstrating best practice* (EPA publication 1517) outlines how EPA assesses best practice, and provides guidance on how to demonstrate compliance with best practice requirements. EPA will refer to this guideline when making statutory decisions or providing non-statutory advice. The guideline should be used by all works approval applicants, in conjunction with EPA's *Works Approval Guidelines* (publication 1307.8).

As part of the works approval or licence application, proponents should provide a full description of the proposed EfW process including the process for segregating and preparing the waste when required, processing the waste into energy, and disposing of by-products. Scheduled EfW plants will be assessed against the following key criteria:

- suitability of EfW as an option
- waste acceptance and preparation for energy recovery
- siting, design, construction and operation of EfW facilities
- thermal efficiency of EfW plants.

Engagement with the community from the initial stage of the project and through the life of the plant is strongly encouraged. Proponents need to be responsive to the concerns of the community and should be ready and able to address these concerns. Past experiences in Australia and overseas indicate that comprehensive community engagement is paramount to the success of such projects, as it leads to better understanding and acceptance of a facility.

### Is EfW a suitable option?

When assessing proposals, EPA takes into consideration the 11 principles of environment protection ('the principles') set out in Part 1 of the Act. These principles include: the principle of wastes hierarchy; the principle of integration of economic, social and environmental considerations; the principle of improved valuation, pricing and incentive mechanisms; the principle of product stewardship; and the principle of integrated environmental management. The principles provide a framework for EPA's decision-making. In making decisions, EPA considers the application of the principles where relevant and seeks to apply them in an integrated manner.

EPA's draft guideline *Application of the environment protection principles to EPA's approvals process* (Publication 1554) provides information and guidance on the application of the principles to EPA's works approval and licensing approval processes. The guideline is intended to assist project proponents understand how EPA expects them to consider the principles when developing proposals and preparing applications for an EPA approval. It describes how EPA applies the principles when it assesses project proposals and makes decisions on approval applications.

With reference to the principles EPA encourages EfW options where energy recovery provides the best practicable environmental outcome for the management of the waste having regard to economic, social and environmental considerations, and when the waste has a gross calorific value that can be recovered. It should be considered where generation of the waste cannot be avoided or the waste cannot be recovered for productive purposes through reuse and recycling.

EfW should be considered for 'residual waste' and other wastes for which energy recovery represents the most feasible option, due to the absence of a market for the waste. 'Residual waste' is the waste that is left over after suitable materials have been recovered for reuse and recycling. This generally means the environmental or economic costs of further separating and cleaning the waste are greater than any potential benefit of doing so.

As part of the works approval process, it is the responsibility of the applicant to demonstrate that EfW is the best management option for the waste. This could be demonstrated through a cost and benefit analysis of different recovery options to determine which has the highest benefit.

The waste and resource recovery principles outlined in the Getting Full Value Policy complement the 11 principles of environment management within the Act and provide supplementary guidance in the consideration of options for waste management.

## Waste acceptance and preparation for energy recovery

Some waste streams are recognised as posing limited risks to the environment and human health and are considered as acceptable feedstock for energy recovery. This is the case for:

- biomass from agriculture
- residues from plantation forestry and sawmilling operations
- untreated wood waste
- recycled oil that meets the specifications and standards set out in the Product Stewardship (Oil) Regulations 2000
- vegetable residue from virgin pulp production and from production of paper from pulp.

These wastes can be processed directly, for example in purpose-built boilers or as fuel replacement in existing facilities, if the following requirements are met:

- the wastes are fully characterised, uncontaminated and relatively homogenous
- the wastes have a minimum gross calorific value of 10 MJ/kg as received (for thermal processes)
- The processing capacity does not exceed the A07 and A08 scheduled categories thresholds as outlined on page 2 of this document
- emissions associated with the processing of such waste are consistent with the State Environment Protection Policy (Air Quality Management) 2001 (SEPP AQM).

All other residual wastes, for which energy recovery has been assessed as the most feasible alternative to landfill, would be considered potential EfW feedstock. The composition of the residual waste feedstock will depend on the level of source separation (by the householder in the case of municipal waste or by the business owner in the case of industrial waste), the availability of collection services and the availability of markets for the collected resources. Where such collection services are not currently in place, consideration should be given to the impact of future waste collection services on the composition of the residual waste stream over the life of the proposal. Furthermore, EfW proponents should not rely on a single residual waste supply over the longer term because doing so may undermine future recovery options. It is also recommended that waste generators take into consideration future diversion opportunities when negotiating long-term contracts with EfW providers.

Depending on the type of EfW technology, the level of upstream segregation and the quality of the waste feedstock, the waste would be expected to go through a pre-treatment process where recyclables are removed, and/or where the remaining material is prepared for use in energy recovery by removing contaminants, increasing the calorific value, removing moisture or homogenising the waste to produce an RDF. Pre-treatment and/or source separation can occur at the point of generation, at a third-party site, or embedded within the EfW facility. A detailed analysis of the physical and chemical properties of the RDF should be performed and it should not contain contaminants such as batteries, light bulbs or other electrical wastes. For biological processes, contamination by non-biodegradable substances should be minimised as far as practicable with a view to reusing the digestate. Applicants should characterise the expected waste feedstock and consideration should be given to its likely variability over the life of the proposal. When creating an RDF, components should not be added for the purpose of diluting the waste or chemical substances where, without dilution, the component would not be suitable for use in an RDF.

As part of the works approval process, EPA will assess the suitability of a proposed feedstock for energy recovery, and the benefits and impacts of an EfW plant over the whole lifetime of the plant.

If the pre-treatment step is not directly followed by the energy recovery step (for example, standalone MRF or MBT), the RDF should have a viable and current market and be designed to the specification of a customer to meet the technical requirements of an existing plant. In Victoria, the customer should seek regulatory approval to use the RDF.

In some very specific cases PIW may be used as fuel replacement within an existing plant if it can first be demonstrated that it does not have any negative environmental impacts compared to the existing process, and that any additional contamination that may be introduced is managed to best practice standards. PIW must not be mixed with industrial waste for the purpose of creating an RDF, unless it is first pre-treated to remove the hazard. It may be possible to blend various PIWs together for the purpose of creating a fuel, either in a liquid (solvent) or solid form. However, this should not occur unless EPA has approved the process. EPA will assess the proposed PIWs as part of a works approval process and decide on a case-by-case basis. Proponents will likely be required to first perform trials as part of a Research, Development & Demonstration approval to demonstrate the suitability of the PIW stream being used.

## Siting, design, construction and operation of EfW facilities

In order to minimise the discharge of pollutants to the environment, and reduce risks to human health and the environment, proponents must demonstrate that the proposed technology is suitable for the waste targeted and that current best practice techniques and processes are used in relation to air, land, water, noise and odour management. This includes reception and storage of waste and management of residues from the energy recovery process. Peak emissions and risks of odour generally occur during start up, shut down and non-standard operation (for example, equipment failure) and proponents should demonstrate how these will be minimised.

For full-scale installations where a works approval is required, the proposed technologies must be proven, well understood and robust. This should be demonstrated through reference to other locally or internationally established plants using the same technologies, and, if possible, treat comparable waste streams on a similar scale.

For small-scale, pilot and demonstration projects where an RD&D approval is more appropriate, proponents must demonstrate the above to the extent practicable, bearing in mind that some features of these projects involve innovations for which best practice precedents may not exist.

Plants must meet local planning and zoning requirements applicable to the facility, with adequate separation distances to sensitive receptors. EPA's guideline *Recommended separation distances for industrial residual air emissions* (publication 1518) provides advice on recommended separation distances between industrial land uses for the purpose of minimising the impact of odour and dust emissions on sensitive land uses. The guideline also contains an overview of other regulations, policies and guidance relevant to the consideration of land use separation for environment protection including SEPP AQM, the Act and the *Planning and Environment Act 1987*. In accordance with publication 1518, EPA will assess separation distances for EfW plants on a case-by-case basis, using site-specific scientific evidence from air, noise, odour and dust modelling as it becomes relevant.

Health protection must be an inherent feature during the design, approval process and operation of EfW facilities. In the case of air emissions, EPA currently considers thermal treatment technology as best practice if:

- Emissions of Class 3 indicators as set out in SEPP AQM are reduced to the Maximum Extent Achievable (MEA) which involves the most stringent measures available.
- Emission discharges, under both steady and non-steady state operating conditions, meet all the emissions standards set in the European Union's Waste Incineration Directive 2000/76/EC (WID), which was recast into the Industrial Emissions Directive 2010/75/EU (IED). The IED sets stringent emission limits and monitoring requirements which include:
  - continuous emissions monitoring of total particulate matter (TPM); sulfur dioxide (SO<sub>2</sub>); oxides of nitrogen (NO<sub>x</sub>); hydrogen chloride (HCl); carbon monoxide (CO); total organic carbon (TOC); hydrogen fluoride (HF)). In addition, there must be at least non-continuous air emission monitoring of other pollutants such as heavy metals, dioxins and furans, a minimum of two measurements per year, which should be more frequent during the initial operation of the plant. This monitoring should capture seasonal variability in waste feedstock and characteristics.
  - Additionally, in order to guarantee complete combustion, the IED requires all plants to keep the combustion or co-combustion gases at a temperature of at least 850°C for at least two seconds after the last injection of air. If waste with a content of more than 1 per cent of halogenated organic substances, expressed as chlorine, is combusted, the temperature must be raised to 1,100 °C for at least two seconds after the last injection of air.

Finally, the combustion of waste or RDF as fuel replacement in an existing facility should have comparable or reduced emissions to atmosphere in comparison to the emissions from the standard fuel it replaces, with appropriate risk controls in place.

All EfW residues and by-products must be characterised and managed according to the Environment Protection (Industrial Waste Resource) Regulations 2009 ('IWR Regs'). This includes bottom ash, wastewater, air pollution control residues including fly ash, pyrolysis char, slag or ash from gasification and digestate from anaerobic digestion. Consideration should be given to the cost associated with the management of these residues, as it could significantly impact the overall project cost if classified as PIW. Where possible, and in accordance with the IWR Regs, proponents should explore reuse and recycling options for these residues.

## Thermal efficiency of EfW plants

For thermal processes, proponents must demonstrate that the proposal targets genuine energy recovery. As most EfW technologies produce a fuel or gas instead of energy, the overall environmental benefits will depend not only on the thermal treatment step but also on the energy conversion technology (combustion) to which it is coupled and how much of the produced energy is used to run the overall process. The important factor in assessing any plant is therefore the overall efficiency net of any energy required to run the process. Depending on the type of facility, the thermal efficiency should be assessed as follows:

- Where waste or RDF is used as fuel replacement for co-combustion in an existing facility, the proponent must demonstrate through a mass balance that the traditional fuel required will be reduced.
- For dedicated EfW plants, the proponent should demonstrate the thermal efficiency of the proposed technology using the R1 Efficiency Indicator as defined in the European Union's Waste Framework Directive 2008/98/EC (WFD). For a plant to be considered a genuine energy recovery facility, R1 will be expected to be equal or above 0.65. Alternatively, if R1 is below 0.65, proponents will be expected to provide a justification as to why this value cannot be reached.

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

- $E_p$ : 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 (GJ/year)
- $E_f$ : annual energy input to the system from fuels contributing to the production of steam (GJ/year)
- $E_w$ : annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)
- $E_i$ : annual energy imported excluding  $E_w$  and  $E_f$  (GJ/year)
- 0.97: factor accounting for energy losses due to bottom ash and radiation.

## Definitions

**Anaerobic digestion (AD)** - biological breakdown by microorganisms of organic matter, in the absence of oxygen, into biogas (a mixture of carbon dioxide and methane) and digestate (a nutrient-rich residue).

**Calorific value (CV)** - is a measure of the amount of energy contained within the waste that could be potentially released when it is completely combusted under specific conditions.

**Combustion** - thermal breakdown of waste under excess air or oxygen to produce heat, ash and flue gas. This is the dominant waste to energy approach taken globally.

**Gasification** - thermal breakdown of waste under an oxygen-reduced atmosphere (lower than necessary for complete combustion), which creates a synthesis gas 'syngas' (e.g. the conversion of coal into city gas).

**Incineration** - in the context of this guideline, is the thermal destruction of waste for the primary purpose of disposal.

**Materials recovery facility (MRF)** - specialised plant that receives, separates and prepares recyclable materials for marketing to end-users, including recycling and EfW.

**Mechanical biological treatment (MBT)** - material recovery facility that combines a sorting facility with a form of biological treatment such as composting or anaerobic digestion.

**Mechanical heat treatment (MHT)** - mechanical sorting of waste combined with thermal treatment technology to produce, for example, RDF pellets.

**Plasma gasification** - treatment of waste through a very high intensity electron arc under an inert atmosphere, leading to temperatures of above 2,000°C. The arc breaks down the waste into a vitrified slag and syngas.

**Pyrolysis** - thermal breakdown of waste in the absence of air, to produce char, pyrolysis oil and syngas (e.g. the conversion of wood into charcoal).

**Refuse derived fuel (RDF)** - also called Process Engineered Fuel (PEF), RDF is a fuel produced after basic processing in an MRF or MBT to increase the calorific value and remove recyclable materials and contaminants of municipal solid waste, commercial and industrial waste, and construction and demolition waste.

**Solvent blended fuel (SBF)** - blend of solvent-based PIW and soluble solid PIW to produce a fuel for co-combustion in a cement kiln.

**Syngas** - mixture of mainly carbon monoxide, hydrogen, and methane generated by pyrolysis and gasification processes. Syngas can be combusted to generate heat or be used to create diesel, synthetic natural gas or other product.