Appendix 2 – Greenhouse gas assessment

Chapter 7. Energy Use and Greenhouse Gas Emissions

7.1 Overview

The objective of this energy use and greenhouse gas (GHG) chapter is to demonstrate how the proposed facility meets the requirements of the State Environment Protection Policy (Air Quality Management) 2001 (SEPP (AQM)) and the requirements of the Protocol for Environmental Management – Greenhouse Gas Emissions and Energy Efficiency in Industry 2002 (PEM).

The Australian Paper Energy from Waste Project (the Project) will require energy during construction and operation, and will also give rise to non-energy related emissions of GHGs through its life cycle. The assessment aims to provide the necessary information to support the Works Approval Application (WAA). In general, this includes assessment and discussion of:

- Commonwealth and State government regulatory frameworks and responses to the management of greenhouse gases
- Expected energy and non-energy related greenhouse gas emissions from the project, including study boundaries, calculations methodologies and activity data
- Implementation of 'best practice' and eco-efficient practices with respect to GHG emissions and energy consumption.

While the study is focussed on the construction and operation of the EfW plant, the study boundary includes emissions associated with production and supply of construction materials, logistics associated with waste feedstock delivery and residue disposal. It also includes an assessment of the emissions avoided and/or offset as a result of avoiding landfill of waste, and substituting electricity and gas consumption from fossil sources.

It should be noted that this assessment has adhered to EPA Victoria and National Greenhouse Accounts guidance and used industry standard data and calculation methods.

This chapter is supported by additional information found in Appendix F.

7.1.1 Australian Paper environmental policy

The Australian Paper Safety, Health, Environment and Quality Policy is shown in Figure 7.1: Australian Paper Safety, Health, Environment and Quality Policy. This outlines corporate commitments including those related to conservation of energy and raw materials, sustainable business and a desire to go beyond compliance and seek continuous improvement.

As one of the largest natural gas users in the state (required for boilers on site used for the pulping and paper making process), Australian Paper is well aware of its impact in terms of energy consumption and greenhouse gas emissions. Accurate control over its processes to conserve energy is vital, and the incentives for identifying opportunities for lowering this usage are potentially large financial savings.

The Maryvale mill is the largest industrial generator of base load renewable energy in Victoria, using black liquor biofuel, a renewable fuel which is a by-product of the pulp and paper manufacturing process. In 2016/17, Australian Paper produced 678,744 tonnes of black liquor which was used within the site for the generation of renewable energy; used in the pulp and paper manufacturing plant in the form of steam and electricity.

Australian Paper reports its emissions annually to the Clean Energy Regulator as part of the National Greenhouse Gas and Energy Report (NGER) scheme. Additionally, Australian Paper production activities are identified as eligible emissions-intensive trade-exposed (EITE) activities, which grants it exemption certificates

from the renewable energy target (RET). These are traded with power suppliers each year to assist in improving the competitiveness of Australian business.

ZERO harm to our people
ZERO harm to our environment
ZERO harm to our property

ENVIRONMENT, SAFETY & HEALTH STANDARDS & EXPECTATION

Safety, Health, Environment and Quality Policy

Reference No: AP SHE&Q 1.0

This policy applies to Paper Australia Pty Ltd, trading as Australian Paper, and its controlled entities including PPM.

Australian Paper manufactures and markets high quality communication, speciality and security papers, stationery products, packaging and industrial papers. Australian Paper is committed to establishing measureable objectives and targets

1.	**Zero harm to our people**	Eliminate work related injuries and illnesses through the provision of a safe and healthy workplace. Minimise workplace health and safety risks. Ensure that personnel are properly trained, have appropriate safety and emergency equipment, and are consulted in the decision making processes impacting on workplace health and safety.
2.	**Employer of choice**	Our diverse workforce is provided with respect and employed within strong principles of equal opportunity, ethical behaviour and transparent management practices.
3.	**Responsible member of the communities in which we operate**	Be a responsible member of the communities in which we operate by correcting incidents or conditions that may endanger health, safety or the environment, promptly reporting them to authorities and informing affected parties as appropriate.
4.	**Conservation of natural resources**	Ensure the responsible use of natural resources throughout our business, including the conservation and efficient use of energy, water and materials and giving preference to renewable over non-renewable natural resources when feasible.
5.	**Zero harm to our environment**	Seek to develop and improve operations and technologies to prevent air, water and other pollution. Use the waste hierarchy to minimise waste. Purchase recycled materials where appropriate, and disposes of waste safely and responsibly.
6.	**Development of safe and environmentally friendly technology and products**	Develop, manufacture and market products that are safe for their intended use, efficient in their use of energy, protective of the environment, and that can be reused, recycled or disposed of safely.
7.	**Beyond Compliance**	Meet or exceed all applicable legal requirements and other requirements to which Australian Paper subscribes. Set and adhere to stringent requirements of our own.
8.	**Continuous Improvement**	Consider issues and manage risks and opportunities to achieve continuous improvement in Australian Paper's management systems and performance.
9.	**Sustainable business**	Meet or exceed the expectations of our customers and sustainably improve shareholder value.

All personnel, contractors and visitors on Australian Paper premises are expected to follow this policy and to report any concerns to Australian Paper management. Management is expected to take prompt action.

Kunihiko Kashima
Chief Executive Officer

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Figure 7.1: Australian Paper Safety, Health, Environment and Quality Policy

7.2 EPA Requirements

This section presents the regulatory requirements against which the Victorian EPA assesses compliance of works approval applications with GHG policy and legislation.

As a Scheduled Premise (deemed under the *Victorian Scheduled Premises and Exemptions Regulations 2007*) the proposed EfW plant will be subject to the *Victorian Climate Change Act 2017*. This requires EPA, when making a works approval decision, to consider the potential impacts on climate change. Clauses 18, 19 and 33 of the SEPP (AQM) 2001 sets out the regulatory requirements that the project needs to comply with.

The clauses in SEPP AQM are supported through the implementation of the Protocol for Environmental Management (PEM) - Greenhouse Gas Emissions and Energy Efficiency in Industry 2002. The PEM is the mechanism by which EPA will assess compliance with the SEPP (AQM) policy principles.

7.2.1 State Greenhouse Gas Policy

7.2.1.1 Climate Change Act 2017

On 23 February 2017, the Climate Change Bill 2016 (VIC) was passed by the Victorian Parliament to create a new climate change Act. The *Climate Change Act 2017* (VIC) sets out a clear policy framework and a pathway to 2050 that is consistent with the Paris Agreement to keep global temperature rise below two degrees Celsius above pre-industrial levels. It provides a platform for subsequent action by the Victorian Government, community and business and the long term perspective and policy stability to drive innovation and investment.

In summary, the *Climate Change Act 2017* (VIC) includes a long term carbon reduction target of net zero emissions by 2050, a requirement to set five-yearly targets and strategies, frequent reporting and mitigation measures that support climate change adaptation.

This project has the potential to assist Victoria in meeting this target. This chapter identifies a significant annual reduction in emissions as a result of the project from the avoidance of ongoing landfill of waste, and energy generated from non-renewable sources.

Section 17 of the *Climate Change Act 2017* (VIC) states that “Decision makers must have regard to climate change” and sub sections 17(2), (3) and (4) require decision makers to have regard to greenhouse gas emissions and climate change impacts. These sub sections state:

(2) A person making a decision or taking an action referred to in subsection (1) must have regard to—

(a) the potential impacts of climate change relevant to the decision or action; and

(b) the potential contribution to the State's greenhouse gas emissions of the decision or action; and

(c) any guidelines issued by the Minister under section 18.

(3) In having regard to the potential impacts of climate change, the relevant considerations for a person making a decision or taking an action are—

(a) potential biophysical impacts; and

(b) potential long and short term economic, environmental, health and other social impacts; and

(c) potential beneficial and detrimental impacts; and

(d) potential direct and indirect impacts; and

(e) potential cumulative impacts.

(4) In having regard to the potential contribution to the State's greenhouse gas emissions, the relevant considerations for a person making a decision or taking an action are—

(a) potential short-term and long-term greenhouse gas emissions; and

(b) potential direct and indirect greenhouse gas emissions; and

(c) potential increases and decreases in greenhouse gas emissions; and

(d) potential cumulative impacts of greenhouse gas emissions.

For more detailed assessment of climate change factors, refer to Chapter 11 (Other environmental considerations).

7.2.1.2 Environmental Protection Act 1970

The *Environment Protection Act 1970* (EP Act) provides a legal framework to protect the environment in the State of Victoria. It applies to emissions to the air, water and land environments in Victoria as well as noise emissions. Under the EP Act, SEPP AQM is subordinate legislation made under the provisions of the EP Act to

provide more detailed requirements for the application of the EP Act. Specifically relevant to GHG emissions, the EP Act includes:

- Clause 18 – General Requirements – including a definition of the management of emissions, generators of emissions and requirements to comply with the policy. This clause compels generators of emissions to manage activities and emissions in accordance with the principles and intent of SEPP (AQM) and to pursue continuous improvement in environmental management practices.

- Clause 19 – Requirements for the management of new sources of emissions. This clause compels generators of new sources of emissions to apply best practice to the management of emissions.

- Clause 33 – Requirements to implement the Protocol for Environmental Management (PEM) for GHGs. This clause specifies that GHGs must be managed in accordance with clauses 18 and 19.

7.2.1.3 Protocol for Environmental Management: Greenhouse gas emissions and energy efficiency in industry (2002) (PEM)

The PEM is an incorporated document of SEPP (AQM) and specifies the steps that will need to be taken by businesses to demonstrate compliance with the policy principles and provisions of SEPP (AQM) related to energy efficiency and greenhouse gas emissions. The PEM is the regulatory instrument that is used to align GHG assessment methodology and approach with the requirements under the EP Act and SEPP (AQM).

GHG assessment is required as part of an EPA works approval. Satisfying the objectives of SEPP (AQM) and the PEM will be met with the project's commitment to implementation of best practice GHG abatement during construction and operation.

The PEM's objectives are as follows:

> *The protocol aims to ensure that Victorian businesses subject to EPA works approvals and licensing system that have an impact on the environment in terms of their energy consumption and greenhouse gas emissions (as defined in the protocol):*
>
> - *Take up cost-effective opportunities for greenhouse gas mitigation, noting that in many cases they will achieve cost savings through greater energy efficiency*
>
> - *Integrate consideration of greenhouse and energy issues within existing environmental management procedures and programs.*

The approach set out in the protocol is intended to support these objectives, in particular, by promoting integrated environmental management, including energy management. The protocol supports businesses in addressing the greenhouse implications (including energy use) of their activities, and assists them to respond in ways that will strengthen their long-term business sustainability.

The protocol also seeks to streamline procedures in order to minimise duplication of requirements with other programs in which a business may be involved, such as the Energy Smart Business Program of the Sustainable Energy Authority and the Commonwealth's NGER system.

7.2.1.4 Environmental Effects Act 1978

Under the *Environmental Effects Act 1978*, the Minister in administering the Act may decide that an Environment Effects Statement (EES) should be prepared where there is a likelihood of regionally or State significant adverse effects on the environment. One of the criteria for an EES referral relates to emissions of GHGs, with the specific trigger being:

"potential greenhouse gas emissions exceeding 200,000 tonnes of carbon dioxide equivalent per annum, directly attributable to the operation of the facility."

This assessment quantifies the direct emissions attributable to the facility, which (as can be seen within this chapter) exceed the EES criteria threshold and as such, an EES referral has been made. However, although direct emissions may exceed the threshold, there will be significant avoided GHG emissions for the existing AP Paper Mill through the implementation of the Project, which is discussed further in section 7.5.3. The net emissions would bring the project significantly under the EES referral trigger level for potential GHG emissions.

7.3 Methodology

This section outlines the scope and boundary of the study, the methodology adopted to determine GHG emissions associated with the project as outlined in the PEM and various sources of emissions within that boundary, details on emissions factors used and the process of calculating emissions for the project.

Section 2.1 of the PEM sets out compliance requirements for new applicants or works approvals for scheduled premises:

- Step 1 – estimate energy consumption – annual energy consumption by energy type and associated GHG emissions
- Step 2 – estimate direct (non-energy related) GHG emissions (e.g. business travel or use of products)
- Step 3 – identify and evaluate opportunities to reduce greenhouse gas emissions
- Step 4 – document the information generated in Steps 1 – 3.

This process has been followed and outlined herein.

7.3.1 Scope & boundary

The scope of this study includes a greenhouse gas assessment of the construction and operation of an EfW plant and associated infrastructure at the Australian Paper Maryvale pulp and paper mill, considering the material sources of emissions. The assessment compares the proposed future operation with a current baseline of operation where waste is sent to landfill, and some of the electricity and steam supplied to the paper mill is derived from fossil fuels. The boundary of this study scope therefore includes all material sources (and sinks) of emissions within the construction and operation (over approximately 25 years) of the proposed EfW plant.

7.3.2 Sources of emissions

The GHG inventory has been prepared in accordance with:

- The Greenhouse Gas Protocol (GHG Protocol) issued by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)
- ISO 14064-1:2006 Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.

The GHGs associated with the project include:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O).

The GHG emissions sources are categorised into three different scopes in the GHG Protocol as follows (refer to Figure 7.2 : Sources of greenhouse gases

for a schematic diagram distinguishing scope types):

- **Scope 1** – Direct emissions from sources that are owned or operated by a reporting organisation (examples – combustion of fuel used in on-site power generation equipment)
- **Scope 2** – Indirect emissions associated with the import of energy from another source (examples – purchases of electricity)
- **Scope 3** – Other indirect emissions (other than Scope 2 energy imports) which are a direct result of the operations of the organisation but from sources not owned or operated by them (examples include embedded emissions in raw materials, business travel by air/rail and product usage).

In the PEM, GHG emissions are categorised into energy and non-energy related GHG expressed in CO_2 equivalent terms (or CO_2e). Energy related GHG emissions include emissions from the use of fuels or consumption of electricity. Non-energy related GHG emissions include process emissions (e.g. emissions from chemical reactions or direct releases of greenhouse gases from activities such as land clearing) and incidental emissions (e.g. use of products).

The initial action for a greenhouse gas assessment is to determine the sources of greenhouse gas emissions, assess their likely significance and set a boundary for the study.

The results of this study are presented in terms of the above-listed 'Scopes' to help understand the direct and indirect impacts of the project.

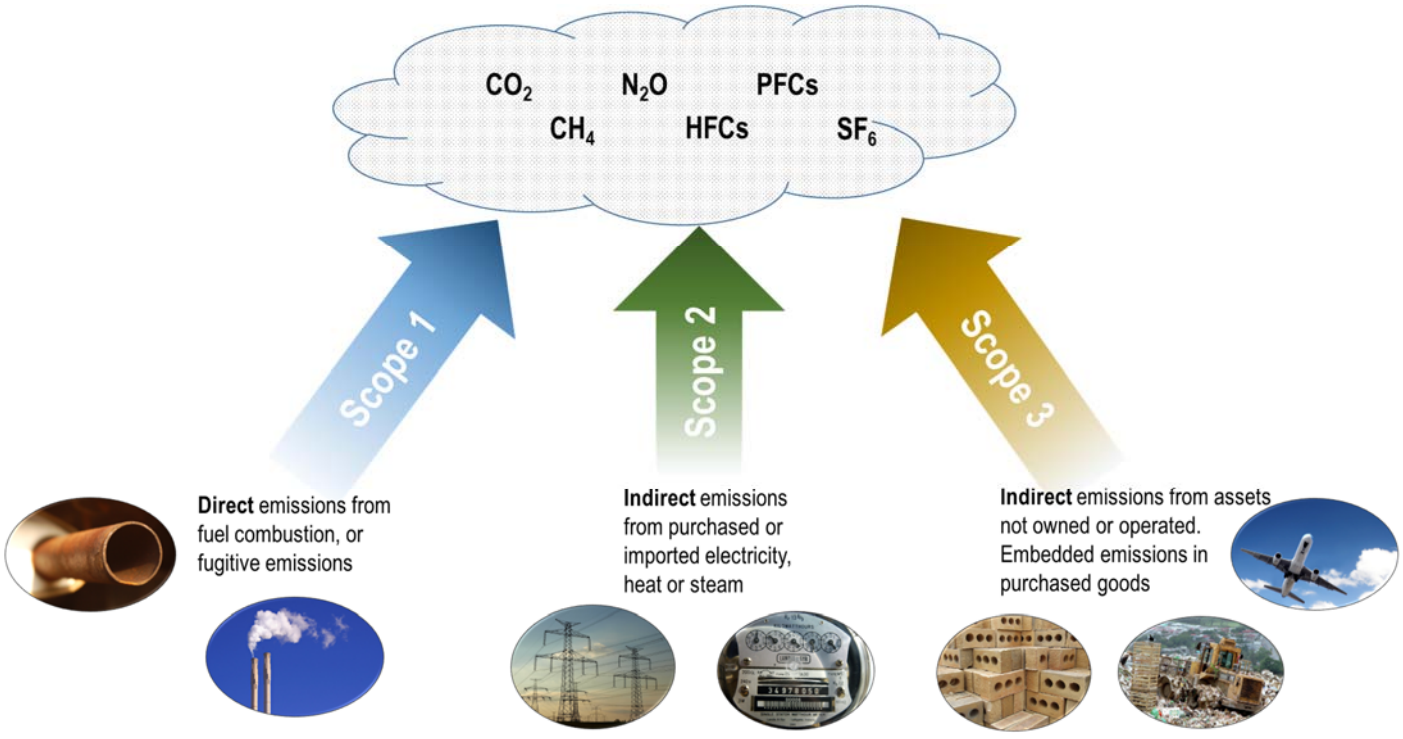

Figure 7.2 : Sources of greenhouse gases

The following sections are separated, as per PEM requirements, into:

- Energy related GHG emission sources, with for construction and operation considered separately.
- Non-energy related GHG emission sources, with construction and operation considered separately.

7.3.2.1 Construction

The sources of emissions for construction of the Maryvale EfW plant are provided in Table 7.1: Sources of Emissions – Construction.

Table 7.1: Sources of Emissions – Construction

Source	Greenhouse gases	Included	Scope		
			1	2	3
Energy related emissions					
Construction fuel – excavated material haulage	CO_2, CH_4, N_2O	✓			●
Construction fuel – earthworks and civil works	CO_2, CH_4, N_2O	✓	●		●
Material deliveries	CO_2, CH_4, N_2O	✓			●
Construction materials – embedded emissions*	CO_2, CH_4, N_2O	✓			●
Non-energy related emissions					
Loss of carbon stored in vegetation	CO_2	✓	●		

* Construction materials – embedded emissions will contain a mixture of fugitive process and energy related emissions. However, it is not possible to separate these due to the emissions factors used, which do not separate the individual GHGs or provide a breakdown of the process steps which give rise to these gases (and whether they are energy related or not)

7.3.2.2 Operation

The sources of emissions for operation of the Maryvale EfW plant are provided in Table 7.2

Table 7.2: Sources of Emissions – Operation

Source	Greenhouse gases	Included	Scope		
			1	2	3
Energy related emissions					
Emissions associated from combustion of waste – fossil sources	CO_2, CH_4, N_2O	✓	●		
Emissions associated from combustion of waste – biogenic sources	CH_4, N_2O	✓	●		
Emissions from natural gas combusted	CO_2, CH_4, N_2O	✓	●		●
Emissions from onsite diesel generators used for start up and during shutdowns, and for generation only (note emergency use has not been included as it is not material)	CO_2, CH_4, N_2O	✓	●		●
Emissions associated with fuel used in operation of on-site equipment used to handle waste	CO_2, CH_4, N_2O	✓	●		●
Emissions from use of grid electricity during operation	CO_2, CH_4, N_2O	x Only used during shutdowns. Not considered material		●	
Emissions associated with transport of waste from point of generation to waste transfer	CO_2, CH_4, N_2O	x			●

Source	Greenhouse gases	Included	Scope		
			1	2	3
point		Outside Scope			
Emissions associated with transport of waste from waste transfer point to site (train and truck)	CO_2, CH_4, N_2O	✓			●
Emissions associated with transport of residues from site to landfill (train and truck)	CO_2, CH_4, N_2O	✓			●
Avoided emissions resulting from displaced grid electricity	CO_2, CH_4, N_2O	✓		●	
Avoided emissions resulting from displaced natural gas consumption (for on-site steam production)	CO_2, CH_4, N_2O	✓	●		●
Non-energy related emissions					
Avoided emissions resulting from landfill of waste	CH_4	✓			●
Emissions associated with landfilling of rejected loads of waste	CH_4	x Not considered material			●
Emissions associated with landfilling ash residues	CH_4	x Inert waste – not expected to be material			●

7.3.3 Emissions factors

Emissions factors are used to determine emissions of greenhouse gases from processes or activities, where it is impractical to directly measure (or model) emissions. Standard factors are published by numerous sources for a range of common emission-generating activities, and it is appropriate to use them in the calculation of greenhouse gas footprints where direct measurement is not possible or practical.

To determine the appropriate emissions factors for a project, EPA Victoria Publication 1658 *Works approval application guideline* (June 2017) refers proponents to the National Greenhouse Accounts (NGA) Factors published by the Commonwealth Department of Environment and Energy. For this greenhouse gas assessment, emissions from EfW are a focus, and hence emissions of CO_2 from fossil sources have been modelled, as has the equivalent baseline of waste sent to landfill (for CH_4).

There are aspects of the project which are not covered by process emission modelling. These include the combustion of fuel in construction plant and equipment (as well as delivery vehicles), and the embedded emissions in construction materials (i.e. the emissions generated during their extraction, processing and manufacture) as well as emissions associated with use of natural gas as a fuel. The emissions factors for all activities are presented in Table 7.3.

Table 7.3 : Emissions factors summary with references

Activity	Emissions Factor	Reference
Process emissions (EfW)	Scope 1	Methodology derived from various

Activity	Emissions Factor	Reference
	Modelled for CO_2 only (from fossil sources). See Appendix F	Emissions Reduction Fund (ERF) methods.
Process emissions (EfW)	Scope 1 0.0002 kgCH_4 / t waste incinerated 0.056kgN_2O / t waste incinerated	Intergovernmental Panel on Climate Change 2006 (IPCC 2006) (highest non-fluidised bed factor taken for N_2O)
Landfill (baseline)	Scope 3 Modelled for CH_4 only – see Appendix F	Based on ERF Alternate Waste Treatment (AWT) methodology
Natural gas consumption	Scope 1 CO_2 - 51.4 kgCO_2e / GJ CH_4 - 0.1 kgCO_2e / GJ N_2O - 0.03 kgCO_2e / GJ Scope 3 3.9 kg CO_2e / GJ	National Greenhouse Accounts Factors - July 2017 (NGA 2017)
Gasoline use (transport)	Scope 1 CO_2 – 2.305 kgCO_2e / kL CH_4 – 0.017 kgCO_2e / kL N_2O - 0.062 kgCO_2e / kL Scope 3 3.6 kg CO_2e / kL	NGA 2017
Diesel use (transport)	Scope 1 CO_2 – 2.698 kgCO_2e / kL CH_4 - 0.004 kgCO_2e / kL N_2O - 0.019 kgCO_2e / kL Scope 3 3.6 kg CO_2e / kL	NGA 2017
Diesel use (stationary)	Scope 1 CO_2 – 2.698 kgCO_2e / kL CH_4 - 0.004 kgCO_2e / kL N_2O - 0.008 kgCO_2e / kL Scope 3 3.6 kg CO_2e / kL	NGA 2017
Electricity (offset)	Scope 2 0.82 kgCO_2e / kWh	NGA 2017 – Table 6 (as used in ERF offset methodologies)
Articulated truck (>33t) 0% Laden	Scope 3 CO_2 - 0.64462 kgCO_2e / km CH_4 - 0.00019 kgCO_2e / km N_2O - 0.01216 kgCO_2e / km	Department for Business, Energy & Industrial Strategy (UK) – 2017 (DBEIS 2017)
Articulated truck (>33t) 100% Laden	Scope 3 CO_2 - 0.05769 kgCO_2e / t.km CH_4 - 0.00001 kgCO_2e / t.km	DBEIS 2017

Activity	Emissions Factor	Reference
	N_2O - 0.00065 $kgCO_2e$ / t.km	
Articulated truck (>33t) Average Loading	Scope 3 CO_2 - 0.07633 $kgCO_2e$ / t.km CH_4 - 0.00002 $kgCO_2e$ / t.km N_2O - 0.00100 $kgCO_2e$ / t.km	DBEIS 2017
Rail (Freight train)	Scope 3 CO_2 - 0.0336 $kgCO_2e$ / t.km CH_4 - 0.00004 $kgCO_2e$ / t.km N_2O - 0.0003 $kgCO_2e$ / t.km	DBEIS 2017
General Cargo Ship (Average)	Scope 3 CO_2 - 0.01305 $kgCO_2e$ / t.km CH_4 - 0.00001 $kgCO_2e$ / t.km N_2O - 0.0001 $kgCO_2e$ / t.km	DBEIS 2017
Material use - Steel	2.336 tCO_2e / t	Infrastructure Sustainability Council of Australia (ISCA) Materials Calculator – Worldsteel data, global Plate, C2G, GLO S & Welding, arc, steel/RER U/AusSD U
Material use - Concrete	0.2 tCO_2e / t	ISCA Materials Calculator – 40MPA concrete 0%SCM
Material use - Aggregate	0.011 tCO_2e / t	ISCA Materials Calculator – Aggregate – referenced to 'Gravel, crushed, at mine/CH U/AusSD U'

It should be noted that some of the factors referenced are expected to change over the modelled (25 year) life of the EfW plant. These include:

- Changes to the composition of waste over time. Various factors will influence the composition of waste coming in to the plant, which will have a 'knock-on effect' on other aspects of the calculation, such as the quantity of waste combusted, the fossil content and the amount of heat and electricity produced. This variation has not been modelled as part of this assessment. It would be expected that the calorific value of the waste would need to remain relatively constant, and whilst there will be programs to improve the recycling rate of waste pre-EfW treatment, that this would affect both biogenic and non-biogenic fractions (and high and low calorific value materials);

- Changes to the grid factor for electricity. Victoria's electricity grid will most likely become less carbon intensive over the lifetime of the proposal, meaning that whilst the quantity of electricity offset will remain steady, the emissions offset will decrease. The factor used for electricity in this assessment is taken from National Greenhouse Assessment (NGA) Factors, and represents the offsetting of future energy generation. It is used within ERF methodologies torepresent emissions offset from the National Electricity market. It may be that the Victorian grid will be lower than this value later in the life of the EfW plant, but given the uncertainty of this, the chosen factor is deemed appropriate for determining the emissions profile for this assessment over its lifetime, and for other emissions generation sources it may displace. The results are also presented using the current Victoria electricity emissions GHG factor to demonstrate the magnitude of the offset at year 1 of operation, as well as an indication of what the factor may be towards the end of the intended life of the plant.

Therefore the operational emissions for the initial year have been multiplied by 25 to determine the emissions over the 25-year life of the plant.

7.4 Step 1 – Energy related greenhouse gas emissions

Based on the activities identified as being within the scope of this assessment, this section provides a summary of the activities that consume energy and the resulting calculation of the emissions relative to the project. Full working of calculations of energy and emissions is provided in Appendix F.

7.4.1 Construction

Construction will require excavation of material to prepare the groundworks for the plant, as well as the formation of foundations. Steel plant and equipment is assumed to be transported to the site from overseas and erected on site through the use of cranes and welding equipment.

A breakdown of the results by greenhouse gas source is presented in Table 7.4 and Figure 7.3: Construction energy-related emissions summary – by source

: Construction energy-related emissions summary – by source.

Table 7.4: Construction energy-related emissions summary – by source

	Source	Total quantity	Energy consumption (GJ)	Scope 1 GHG emissions carbon dioxide (tCO_2e)	Scope 1 GHG emissions methane (tCO_2e)	Scope 1 GHG emission nitrous oxide (tCO_2e)	Scope 1 GHG emissions (tCO_2e)	Scope 3 GHG emissions (tCO_2e)	GHG emissions – all scopes (tCO_2e)
Construction plant and equipment	Construction Fuel Transport Diesel	807,500 t.km	NA					62	62
	Construction Fuel Transport Petrol	73.8 kL	2,524	170	1	5	176	9	185
	Construction Fuel Stationary Diesel	884.1 kL	34,126	2,385	3	7	2,396	109	2,505
	Construction Materials (embedded emissions)	16465 t	NA	-	-	-	-	9,790	9,790
	Construction Material transport	Sea – 34,349,010 t.km Land – 1,309,336 t.km	NA	-	-	-	-	528	528
Total			**36,650**	**2,556**	**5**	**11**	**2,572**	**10,500**	**13,071**

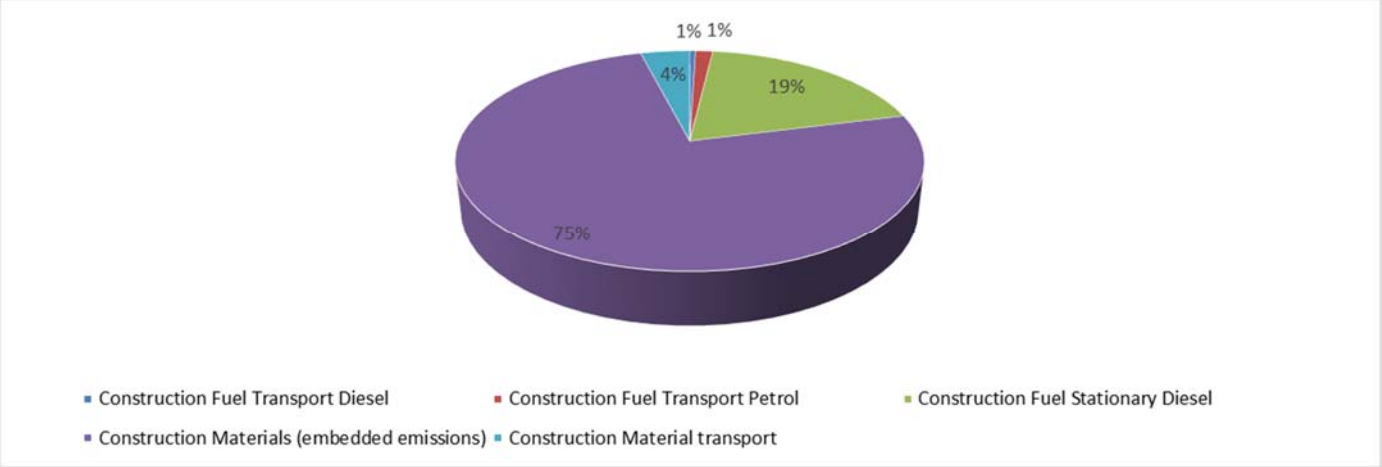

Figure 7.3: Construction energy-related emissions summary – by source

Figure 7.3 shows that the construction energy-related emissions profile is dominated by the embedded emissions in construction materials. Given that much of the plant will be manufactured off-site and transported to the site, this is expected. Following materials, the fuel used during construction is the next largest source. Fuel used, during spoil haulage and material transport, do not contribute significantly to the emissions profile.

A breakdown of the results by greenhouse gas 'scope' is presented in Table 7.5**Error! Reference source not found.** and Figure 7.4: Construction energy-related emissions summary – by scope

Table 7.5: Construction energy-related emissions summary – by scope

Scope	Emissions (tCO_2e)
Scope 1	2,572
Scope 2	-
Scope 3	10,500
Total Emissions (all Scopes)	13,071

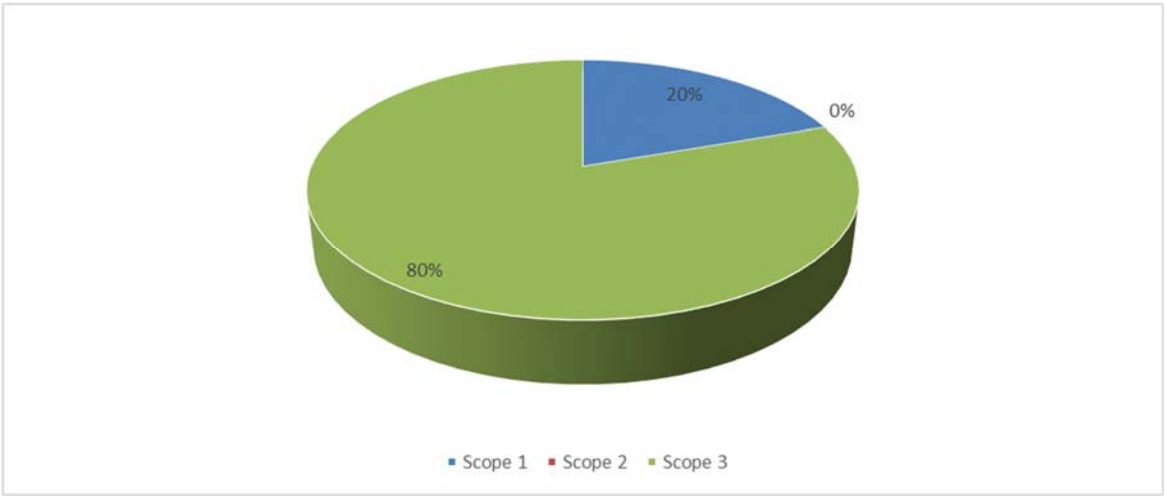

Figure 7.4: Construction energy-related emissions summary – by scope

Figure 7.4: Construction energy-related emissions summary – by scope

shows that the majority of the emissions are Scope 3 – i.e. indirect emissions not under the direct control of the proponent. These largely relate to the embedded emissions in purchased materials. The Scope 1 emissions are the direct emissions on site under the direct control of the construction contractor and relate to combustion of fuel in construction plant and equipment.

7.4.2 Operation

During operation, waste will be transported to the site:

- By rail from Metropolitan Melbourne;
- By road from South East Melbourne;
- By road from Gippsland

After arrival at the site, the waste will be transferred to the tipping hall, where it will be mixed before being combusted in the EfW plant. The heat produced from the combustion will be used to produce steam. This steam will be used to generate electricity before being used within the existing pulp and paper mill. The plant will require the use of natural gas on occasions at start-up or when the waste fuel feedstock is of lower calorific value, but this is expected to represent (at worst case) 1% of the energy input. The plant will be powered with the electricity it generates, Electricity will also be supplied to existing pulp and paper mill with any surplus exported to the national grid.

The site will also house a diesel generator with the capacity to produce approximately 6MW power. The primary function of this generator is to produce power for the EfW plant during outages, and for start up processes, but it will also be used to generate power on occasion. A forecast of this generation and fuel consumption has been determined separately.

The solid wastes from the EfW plant are the bottom ash from the combustion process and residues from the Air Pollution Control (APC) system. These will be sent to landfill by train or truck (for bottom ash) and truck (for APC residue). This is the worst case, as it is expected that some this waste may be diverted to a secondary beneficial reuse, subject to industrial waste categorisation testing.

A breakdown of the results by greenhouse gas source is presented in Table 7.6: Annual operation energy-related emissions summary – by source and Figure 7.5: Operation energy-related energy emissions summary – by source

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Table 7.6: Annual operation energy-related emissions summary – by source

	Source	Total quantity	Energy consumption (GJ)	Scope 1 GHG emissions carbon dioxide (tCO_2e)	Scope 1 GHG emissions methane (tCO_2e)	Scope 1 GHG emission nitrous oxide (tCO_2e)	Scope 1 GHG emissions (tCO_2e)	Scope 2 GHG emissions (tCO2e)	Scope 3 GHG emissions (tCO_2e)	GHG emissions - all scopes (tCO2e)
Facility Emissions	Facility Emissions - Waste Combustion	650,000 t	6,110,000 GJ	340,885	3	10,847	351,736			351,736
	Facility Emissions - Gas Consumption	61,100 GJ (LHV)	61,100 GJ (LHV)	3,141	6	2	3,148		238	3,387
	Facility Emissions - Diesel Consumption in Generators	3,370 GJ	3,370 GJ	575	1	2	578		30	607
Displaced Energy	Displaced Electricity Emissions	-277,301 MWh	998,284 GJ					-227,387		-227,387
	Displaced Steam / Heat Production from Natural Gas Emissions	-2,809,840 GJ	-2,809,840 GJ	-144,426	-281	-84	-144,791		-10,958	-155,749
	Displaced Electricity Emissions from Diesel Power Generators (sent out generation)	-936 MWh	3370 GJ					-768		-768
Waste Logistics	Incoming Waste Logistics	9,523,800 t.km - train 11,700,000 t.km truck	NA						5,456	5,456

	Source	Total quantity	Energy consumption (GJ)	Scope 1 GHG emissions carbon dioxide (tCO_2e)	Scope 1 GHG emissions methane (tCO_2e)	Scope 1 GHG emission nitrous oxide (tCO_2e)	Scope 1 GHG emissions (tCO_2e)	Scope 2 GHG emissions (tCO2e)	Scope 3 GHG emissions (tCO_2e)	GHG emissions - all scopes (tCO2e)
	Onsite waste handling equipment fuel	364 kL	14050 GJ	982	1	3	986		51	1,037
	Outgoing Waste Logistics	21,080,450 t.km truck	NA						1,281	1,281
Total				**201,157**	**-269**	**10,769**	**211,657**	**-228,155**	**-3,902**	**-20,400**

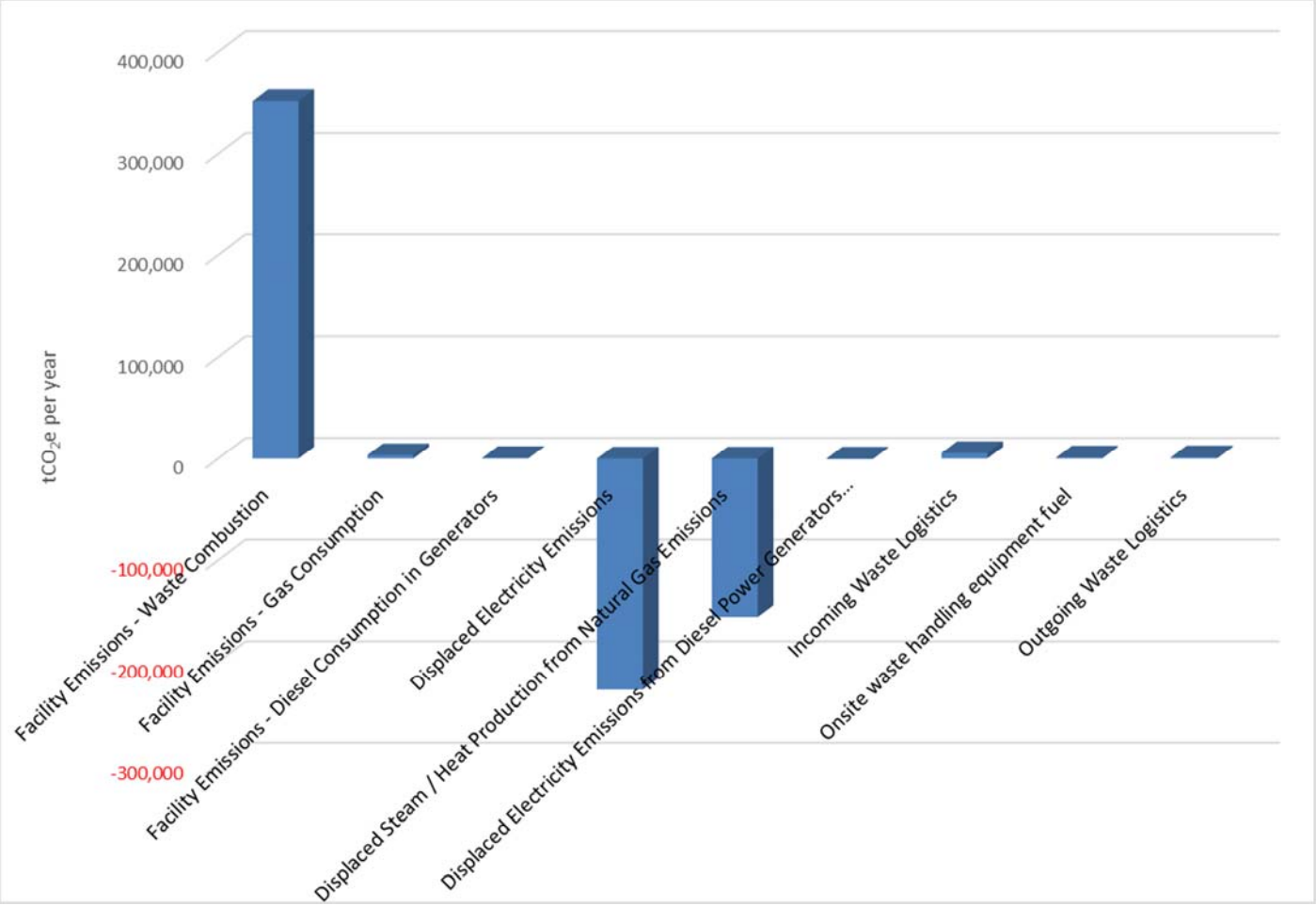

Figure 7.5: Operation energy-related energy emissions summary – by source

A breakdown of the results by greenhouse gas 'scope' is presented in Table 7.7**Error! Reference source not found.** and Figure 7.6: Operation emissions summary – by scope

Table 7.7: Operation energy-related emissions summary – by scope

Scope	Annual Emissions (tCO_2e)	Total Emissions (25 years - tCO_2e)
Scope 1	211,657	5,291,423
Scope 2	-228,155	-5,703,863
Scope 3	-3,902	-97,561
Total Emissions (all Scopes)	**-20,400**	**-510,001**

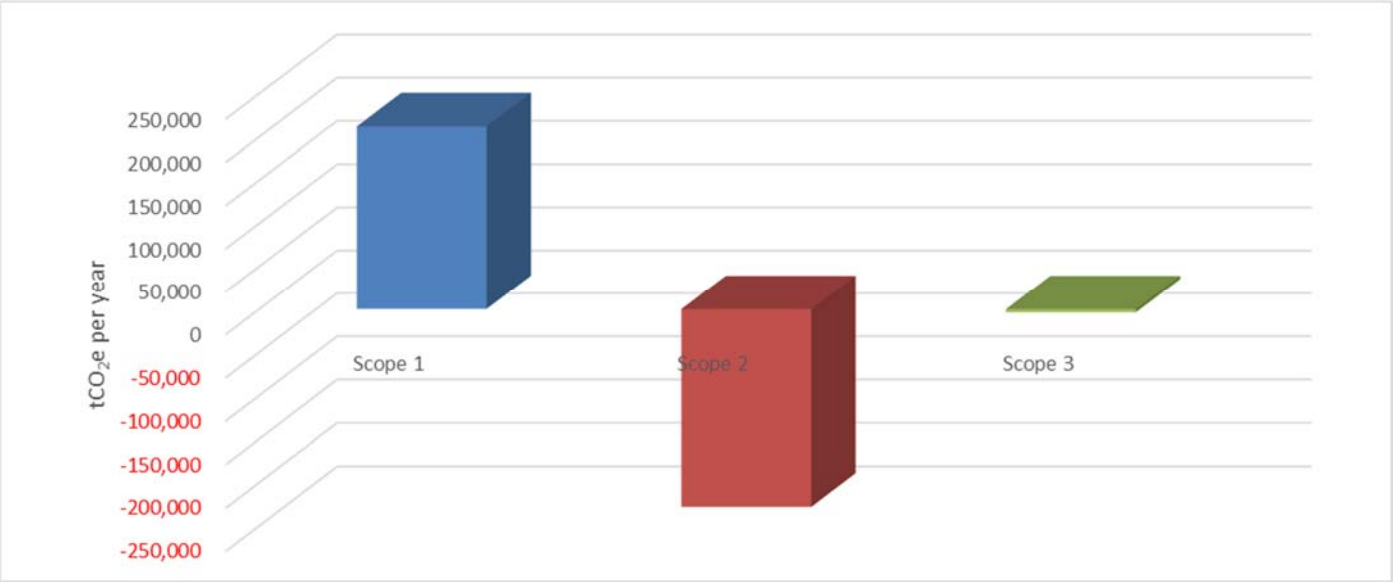

Figure 7.6: Operation emissions summary – by scope

The figures show, as expected, that the emissions associated with operation are dominated by those associated with waste combustion. These emissions relate to the fossil-derived carbon in the waste only. (Positive) emissions associated with other sources are not material. Displaced natural gas (for heat / steam generation) and electricity emissions are a significant contributor to the offset in emissions that the plant achieves. These are counted as both Scope 1 (natural gas) and Scope 2 (electricity offset).

7.5 Non-energy related greenhouse gas emissions

Based on the activities identified as being within the scope of this assessment, this section provides details of the activities that give rise to the emission of non-energy related greenhouse gases, and the resulting calculation of the emissions relative to the project. Full working of calculations of emissions is provided in Appendix F.

7.5.1 Construction

During earthworks, approximately 5 hectares of trees will be removed from the site. These are plantation trees to be used within the paper mill when they reach maturity for the production of paper. A breakdown of the results by greenhouse gas source is presented in Table 7.8 : Construction non-energy-related emissions summary – by source .

Table 7.8 : Construction non-energy-related emissions summary – by source

	Source	Total quantity	Energy consumption (GJ)	Scope 1 GHG emissions (tCO_2e)	GHG Emissions – all scopes (tCO_2e)
Vegetation Clearance	Vegetation Clearance	5 Ha	NA	1,535	1,535
Total				**1,535**	**1,535**

Vegetation clearance figures are considered a Scope 1 source. Approximately 5 hectares of vegetation removal has been assessed to contribute 1,535 tCO_2e emissions. As stated in Appendix F, this is expected to be an overestimate, given that the trees being removed are plantation, whereas the emissions factor used assumes native vegetation.

7.5.2 Operation

In addition to the energy-related emissions sources modelled, the diversion of waste to the EfW plant will avoid landfill. The emissions attributable to this avoided landfill are calculated and a breakdown of the results by greenhouse gas source is presented in Table 7.9: Operation non-energy related emissions summary – by source .

Table 7.9: Operation non-energy related emissions summary – by source

	Source	Total quantity	Energy consumption (GJ)	Scope 3 GHG emissions (tCO_2e)	GHG Emissions – all scopes (tCO_2e)
Offset Landfill Emissions	Offset Landfill Emissions	650,000 t	NA	-523,531	-523,531
Total				**-523,531**	**-523,531**

The only non-energy related emission associated with operations is expected to be offset emissions associated with avoided landfill, and account for a significant overall emissions reduction. These are the emissions that would have been expected to occur should the waste have been sent to landfill. These emissions are classified as a Scope 3 source (given that they would have occurred at a site not owned or operated by the proponent).

A breakdown of the results by greenhouse gas 'scope' is presented in Table 7.10 : Operation non-energyrelated emissions summary – by scope .

Table 7.10 : Operation non-energyrelated emissions summary – by scope

Scope		Annual Emissions (tCO_2e)	Total Emissions (25 years - tCO_2e)
Scope 1		0	0
Scope 2		0	0
Scope 3		-501,050	-12,526,255
Total Emissions (all Scopes)		**-501,050**	**-12,526,255**

Table 7.10 : Operation non-energyrelated emissions summary – by scope shows that the project is expected to avoid landfill emissions of approximately 12.5 MtCO2e over 25 years of operation, in addition to savings associated with electricity and steam / heat generation.

7.5.3 Cumulative Emissions Profile

The cumulative emissions over the lifetime of the project are presented in Table 7.11: Cumulative emissions summary and Figure 7.7: Cumulative emissions summary

Figure 7.7

Table 7.11: Cumulative emissions summary

	Construction emissions (tCO_2e)	Operation Energy-related emissions (tCO_2e)	Operation Non-energy related emissions (tCO_2e)	Total emissions (tCO_2e)
Construction	14,606			14,606
Years 1-25		-20,400	-523,531	-543,931
Total (25 years)	**14,606**	**-510,001**	**-13,088,284**	**-13,583,678**

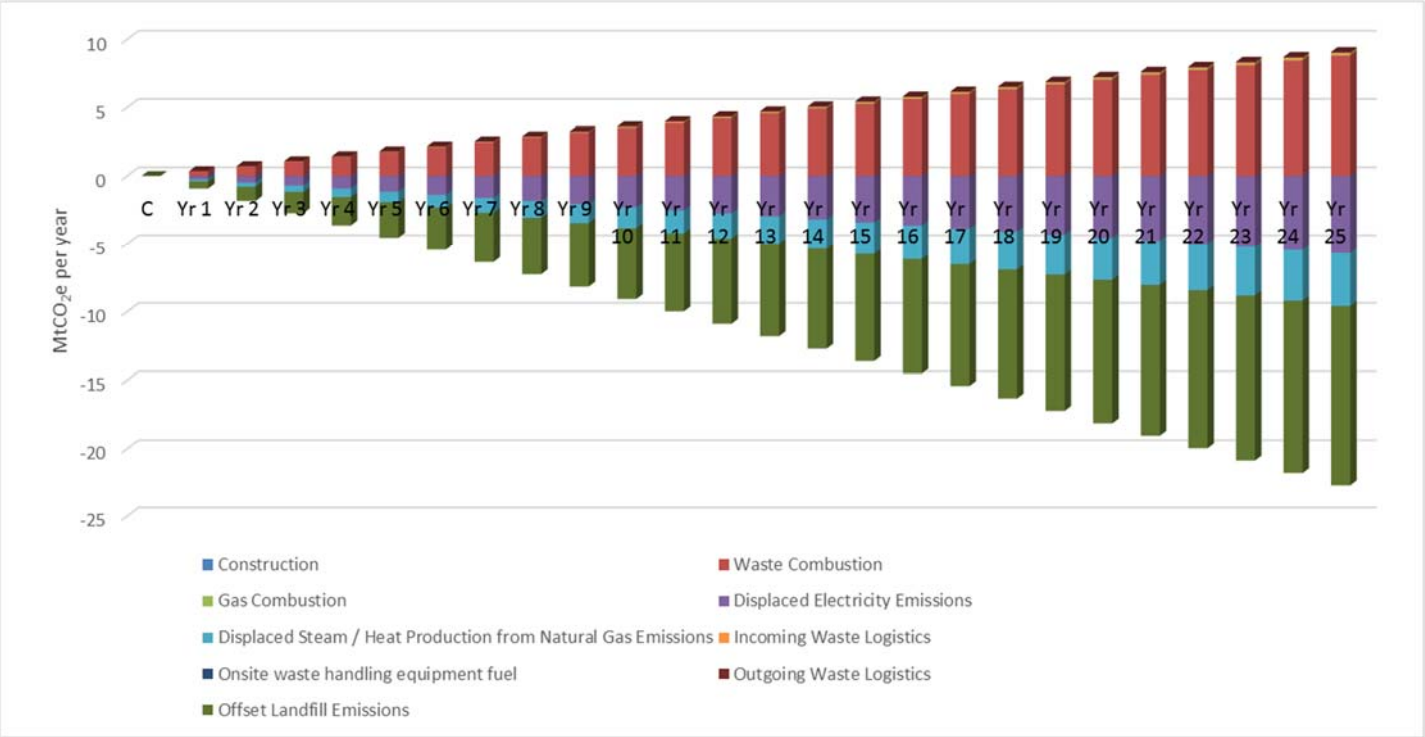

Figure 7.7: Cumulative emissions summary

Figure 7.7 gives the cumulative GHG emissions over an assumed 25-year life of the EfW plant. This shows the cumulative emissions of the plant are expected to be approximately 9 $MtCO_2e$ over this period, whilst the cumulative avoided emissions are expected to be approximately 23 $MtCO_2e$. This results in a net GHG benefit associated with the project of approximately 14 $MtCO_2e$. Of the benefits, the avoided landfill emissions and displaced electricity emissions are the greatest benefit, followed by the offset steam / heat generation emissions (associated with gas combustion).

7.6 Best practice energy and greenhouse gas management

As the project will use greater than 500GJ (and emit greater than 100 tonnes of carbon dioxide equivalents), identification and implementation of best practice energy consumption is required in accordance with the PEM. The best practice assessment for energy use and greenhouse gas management has included the application of the waste hierarchy and the integration of economic, social and environmental considerations. This project is committed to use best practice in the selection and operation of the EfW plant and equipment, and to deliver the emissions savings identified in this chapter.

7.6.1 Construction

The proponent will seek opportunities to reduce the energy and greenhouse impact of the construction process. This may include the following:

- Undertaking detailed modelling to ensure that cut and fill balances are managed to minimise any unnecessary movements of material;
- Review opportunities to specify biofuel use on construction plant and equipment based on site for excessive periods;

- Review opportunities to use alternative materials in construction, such as fly ash as a supplementary cementitious material (to replace traditional Portland cement) and reclaimed aggregate;

- Specify high recycled content in steel use (where technically possible and cost effective));

7.6.2 Operation

This assessment presents a waste management solution for a large proportion of waste in Victoria and as such has been considered in terms of best practice. Waste management and environmental best practice is also described in Chapters 5, 10 and 12.

The results of this energy and GHG assessment show that although the project will have direct emissions of approximately 350 $ktCO_2e$ per year, the net benefit of the project (including emissions avoided or offset) is approximately 550kCO_2e per year. By comparison, landfill of the waste alone would result in emissions of 520 $ktCO_2e$ per year. This will be a measurable impact on Victoria's (and Australia's) emissions profile.

The emissions profiles of Victoria and Australia (and the proportion reduction that this project would represent) are (for 2015 – latest dataset available):

- Australia – 537,851 ktCO2e / year – 0.10% reduction

- Victoria - 119,589 ktCO2e / year – 0.45% reduction

The above figures are calculated on the basis of the EfW plant offsetting electricity at a rate which is lower in emissions intensity than the current Victorian grid factor (i.e. using a factor of 0.82 tCO_2e / MWh as opposed to 1.08 tCO_2e / MWh), Using the current Victorian grid emissions intensity factor, the project will result in a net benefit of approximately 616$ktCO_2e$. As the Victorian grid switches to lower carbon forms of generation (such as this project), this offset value will decrease in quantity. For example, at a grid rate of 0.6 tCO_2e / MWh the total offset for the project is closer to 483 $ktCO_2e$. The rate chosen for this project is consistent with the methodologies used in the Emissions Reduction Fund and representative of the likely change in the magnitude of the offset over the life of the plant.

As noted in Section 7.2.1.1, Victoria is aiming to become carbon neutral by the year 2050. Diversion of material from landfill, and the recovery of energy from residual waste will make a contribution to Victoria in achieving this, alongside generating electricity from renewable sources.

The carbon intensity of the electrical and thermal energy generation of the EfW plant has been calculated in accordance with the GHG Protocol Calculator: Allocation of Emissions from a Combined Heat and Power (CHP) Plant (GHG Protocol, 2006). Based on the gross emissions from the plant operation only (including emissions from the fossil content of waste combustion and emissions from gas combustion); the resulting carbon intensity factors for electricity and steam production are:

- 0.54 tCO2e/MWh for electricity; and

- 0.26 tCO2e/MWh for steam

The thermal efficiency of the EfW plant must meet the criteria as defined in the Victorian EPA's Energy from Waste Guideline (EPA, 2013). This states that:

"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 (WID). 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."

The R1 figure for the proposed EfW plant is 0.87, which comfortably exceeds this value, and represents the fact that both electrical and steam outputs are being utilised in line with best practice. See Appendix F for calculation details.

Figure 7.8: Electricity Generation – GHG comparison

presents a comparison of the emissions intensity of electricity production of the proposed EfW plant (0.54 tCO_2e / MWh) alongside a range of comparator emissions intensity factors, including local (Latrobe Valley) generators Loy Yang Power Station (PS) and Mine, Loy Yang B and Yallourn. It also presents comparator figures for a range of other renewable and non-renewable generators, as well as state and national averages. The data were derived for the 2015/16 financial year from information reported to the Clean Energy Regulator (CER (2017)) and include both Scope 1 and Scope 2 emissions.

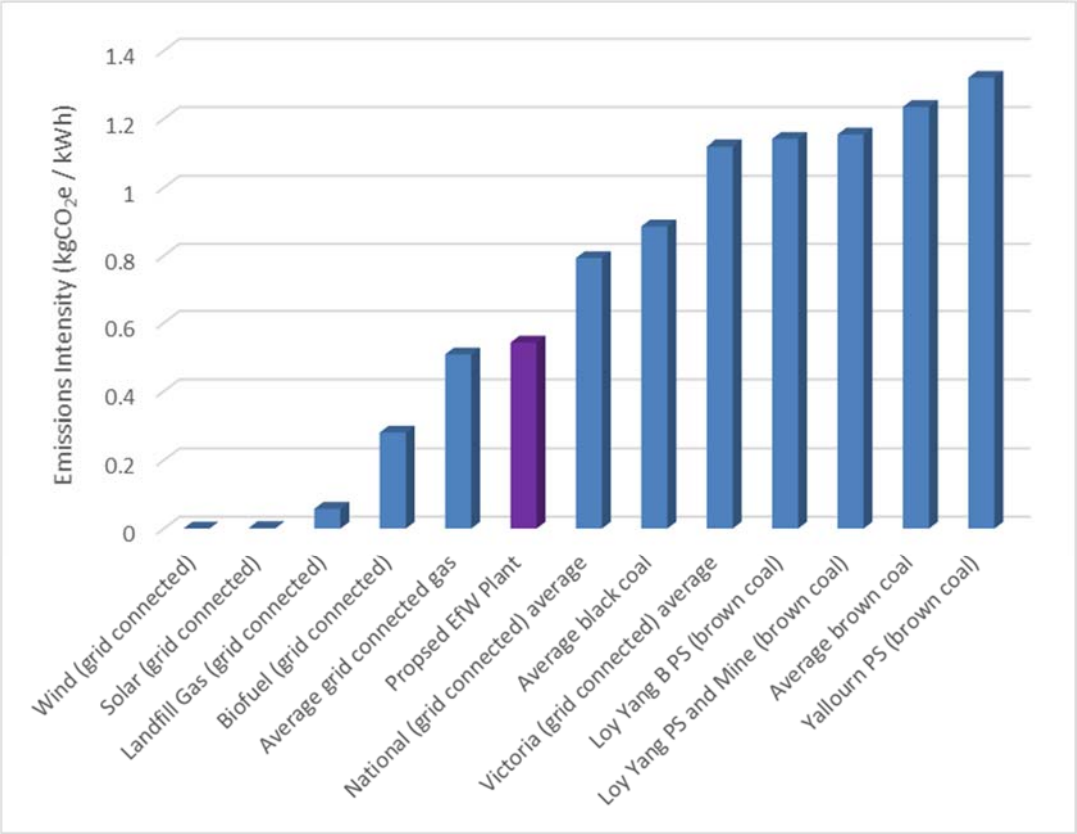

Figure 7.8: Electricity Generation – GHG comparison

Figure 7.8 shows that the proposed EfW plant's emissions intensity is slightly higher than that for grid connected gas fired power stations, and significantly lower than that for black and brown coal fired stations. Wind and solar are much lower intensity forms of energy generation (but are not as significant contributors to energy generation in Victoria, and do not form baseload generation).

It is difficult to compare the derived figure with others for energy from waste plants internationally, due to differences in waste stock, and difficulties in obtaining comparable numbers – for instance determining what emissions were and were not included in the assessment boundary. However, the figure presented of 0.54

tCO$_2$e / MWh is comparable (but lower) than that presented for the UK Cory Riverside Energy Plant (0.62 tCO$_2$e / MWh) (ICE 2017).

Within this assessment it has been assumed that the solid waste from the EfW plant will be sent to landfill in Melbourne, and the appropriate haulage distances have been calculated based on the tonnage expected. It is the proponent's intention to seek beneficial reuse of the residues as markets allow. This includes:

- Bottom Ash (BA) – this is used widely in Europe as a substitute aggregate. The material undergoes a process of conditioning and final metals screening before being used as (for example) road base. Use of this material in Victoria would offset virgin aggregate manufacture and provide a sustainable alternative;

- Air Pollution Control Residue (APCR) – the proponent is investigating the opportunity to process this material to bind the contaminants it contains into a concrete like mixture, and then use within concrete, or as a screed. Use of this material would also offset virgin material manufacture. Further, some APCR treatment processes (such as the carbon8 process – see www.c8a.co.uk) use liquefied carbon dioxide (from power generation operations) within the process – resulting in a carbon negative product.

7.6.3 Greenhouse gas emissions reporting

With gross emissions in excess of 50ktCO$_2$e per year the EfW facility will need to report GHG emissions to the Clean Energy Regulator each year in its own right, or as part of the Australian Paper annual reporting process.

7.6.4 Eligibility for Renewable Energy Large Scale Generation Certificates

Renewable electricity generated by power stations, whether they are off grid or connected to an electricity grid, may be eligible for the creation of large-scale generation certificates. According to Section 17 (subsection 1q) of the *Renewable Energy (Electricity) Act 2000* the biomass components of municipal solid waste are eligible to generate large-scale generation certificates (LGCs).

The net electrical output of the EfW plant will be 277,301MWh per year. Of this, approximately 1% could be generated by gas used (when waste feedstock calorific value dips below the required level). Of the remainder, the assessment shows that approximately 50% of the incoming waste is of biogenic origin, and then potentially eligible to generate LGCs. This would therefore equal approximately 137,264 LGCs (as one certificate is generated for every eligible MWh). LGCs are sold to liable entities (electricity retailers) which are required to surrender a certain amount of LGCs each year to the Clean Energy Regulator in order to assist in meeting the Renewable Energy Target (RET).

7.7 Conclusion

The Greenhouse Gas Assessment has been conducted in accordance with EPA Victoria and National Greenhouse Accounts guidance and associated factors. The GHG emissions were calculated for the construction and operational phases of the EfW Plant, with the operational phase GHG emissions divided into energy and non-energy related emissions.

The construction phase emissions have been calculated as 14,606 tCO$_{2\text{-e}}$. Table 7.12 shows the calculated GHG emissions for the operational phase of the EfW Plant. Taking into account the GHG emissions saved by the displacement of onsite electricity and steam use as well as avoided landfill GHG emissions, the Project will have a net saving of 543,931 tonnes of CO$_2$ equivalent per annum. Over the 25-year life of the Project, the GHG emissions savings are expected to be 13,583,678 tonnes of CO$_2$ equivalent.

Table 7.12: Operational phase emissions summary (per annum)

	EfW Plant	Transport and logistics	Offset from displaced electricity and steam	Offset from avoided landfill emissions	Total GHG Emissions (tCO_2e) per annum
Operational phase Emissions	355,730	7,774	-383,136	-523,531	**-543,931**