Chapter 18

Greenhouse gas and energy efficiency

18 Greenhouse gas and energy efficiency

18.1 Introduction

This chapter summarises the potential greenhouse gas (GHG) and energy efficiency impacts from the proposal. A GHG and energy efficiency assessment report has been prepared and included as **Technical Report N**.

The methodology for the GHG and energy efficiency assessment included:

- Finding out the existing environment through analysing climate trends and the link to GHG emissions
- Assessing the impact of the proposal by categorising the GHG sources from the proposal and calculating the potential GHG emissions during construction and operation of the proposal
- Considering energy reduction measures embedded in design and developing mitigation measures to be applied during construction and operation to increase energy efficiency and minimise GHG generation.

The GHG and energy efficiency assessment has been prepared in general accordance with:

- National Greenhouse Accounts (NGA) Factors (Department of Environment and Energy (DoEE), 2019)
- Greenhouse Gas Protocol (World Business Council for Sustainable Development and World Resources Institute)
- AGO Factors and Methods Workbook (Australian Greenhouse Office (AGO), 2004).
- National Greenhouse and Energy Reporting Scheme Measurement, Technical Guidelines for the estimation of emissions by facilities in Australia (Department of the Environment and Energy, 2017).

18.2 Existing environment

This section talks about existing climate trends in Australia, the link between GHG emissions and climate trends, and the role of the waste sector.

18.2.1 Climate trends

18.2.1.1 Australian climate trends

The State of the Climate Report prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in conjunction with the Bureau of Meteorology (BoM) (2018) analyses recent key climate trends in Australia.

In summary, they observe that Australia's climate has warmed by around 1°C since 1910, sea levels are rising and oceans are becoming more acidic, rainfall has decreased in south-west and south-east Australia, and there has been a long-term increase in extreme fire weather.

Regional climate trends

An 'East coast low' is a low-pressure weather system which forms off the coast of Australia and can result in severe weather to coastal and adjoining areas. An east coast low could result in gale or storm force winds and heavy rainfall, leading to flooding for the western Sydney area. Modelling indicates there will likely be a decrease in the number of winter storms and a small increase in the number of summer storms forming part of the East coast low.[1]

Over the last 12 months, there have been several severe storm events causing significant impact to the greater western Sydney region. These include:

- February 2019 – severe storm event across the greater Sydney region, bringing heavy rain, damaging winds and large hailstones, cutting power to over 5,000 homes in the western Sydney area
- February 2020 – series of mega storms which brought flash flooding, heavy rain, hail and damaging winds to the greater Sydney and Blue Mountains region, causing severe damage rain.

Heatwaves across the greater Sydney region are becoming more regular, with five significant heatwaves recorded since January 2013. Without the coastal sea breeze, prolonged heat has an amplified impact in western Sydney. Statistics from the 2018–19 summer indicates the hottest day recorded was 42.2°C at Penrith Lakes in January 2019. A record run of consecutive hot days of 35°C or higher was experienced at Penrith Lakes, recording nine days in December/January 2019.

[1] Office of Environment and Heritage, 2016.

The western Sydney area is also affected by the heat island effect which is the localised warming of areas due to large paved areas and buildings, with low vegetation cover. The western Sydney area does not receive coastal sea breezes and so is more susceptible to heat island effects.

Figure 18.1 shows a snapshot for Sydney's future climate environment.

Projected **temperature** changes	
Maximum temperatures are projected to increase in the near future by 0.3–1.0°C	Maximum temperatures are projected to increase in the far future by 1.6–2.5°C
Minimum temperatures are projected to increase in the near future by 0.4–0.8°C	Minimum temperatures are projected to increase in the far future by 1.4–2.5°C
The number of hot days will increase	The number of cold nights will decrease
Projected **rainfall** changes	
Rainfall is projected to decrease in spring and winter	Rainfall is projected to increase in summer and autumn
Projected **Forest Fire Danger Index (FFDI)** changes	
Average fire weather is projected to increase in spring by 2070	Severe fire weather days are projected to increase in summer and spring by 2070

Figure 18.1: Projected changes in Sydney Climate (NARCliM).

18.2.2 GHG emissions

GHG emissions and climate patterns

GHGs are defined as any of the gases whose absorption of solar radiation is responsible for the greenhouse effect. The atmospheric concentrations of some GHGs are being impacted directly by human activities, including carbon dioxide, methane, nitrous oxide and ozone, and synthetic gases such as chlorofluorocarbons and hydrofluorocarbons.

In 2014, the Intergovernmental Panel on Climate Change (IPCC) released its Fifth Assessment Report (AR5) which confirms that human influence on the climate system is clear and growing, with emissions of GHGs the highest in history.

Australian trends in GHG emissions

Australia has two current targets to reduce GHG emissions that have been set under international climate agreements. These include the following:

- In response to the Paris Agreement, the Australian Government has agreed a target of 26–28% reduction in GHG emissions below 2005 levels by 2030.
- Under the Kyoto Protocol, Australia seeks to reduce emissions by 5% below 2000 levels by 2020.

The Australian Government Department of Industry, Science, Energy and Resources (DoISER) issues quarterly reports for GHG emissions in Australia. According to the September 2019 statistics, Australia produced 530.8Mt of carbon dioxide equivalent emissions. This is about a 13.1% reduction since 2005 emissions of 610.6Mt.

Role of the waste industry

According to the National Greenhouse Gas Inventory quarterly update, the waste sector contributed 2.2% of Australia's GHG emissions in September 2019, with little to no difference in trend over the past few years.[2]. In 2017, the NSW waste sector contributed 26.4% to the overall waste sector GHG emissions in Australia[3].

Landfills are a large contributor to the emissions by the waste sector. When organic waste decomposes in landfills, methane and other GHGs are produced as a result. Methane absorbs more heat than carbon dioxide and is therefore a worse contributor to the greenhouse effect.

18.3 Assessment

18.3.1 Potential GHG sources

Clear understanding of the likely GHG emissions associated with a project has the benefit of determining the scale of the emissions and providing a baseline from which to develop and apply GHG reduction measures.

The Greenhouse Gas Protocol 2020 includes three types of emissions.

1. Scope 1 emissions are the release of GHGs into the atmosphere as a direct result of an activity or series of activities, including ancillary activities.
2. Scope 2 emissions are the release of GHGs into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the activity but do not form part of the activity.
3. Scope 3 emissions are all other indirect emissions that arise because of an organisation's activities, but occur outside its boundaries, from sources that it does not own or control.

[2] DoISER, 2019a
[3] DoISER, 2019b

As per the Greenhouse Gas Protocol 2020, the potential GHG sources from the proposal are categorised as follows:

- Scope 1: Emissions associated with the thermal treatment of waste and the onsite fuel combustion during both construction (plant and machinery) and operations (plant, and stationary and mobile onsite machinery)
- Scope 2: Electricity imported from the grid and consumed on site
- Scope 3: Transportation of waste to the site and transportation of by-products from the site for offsite disposal, employees commuting to and from the site, electricity exported to the grid from the EfW facility, and avoidance of methane generation as result of diversion of waste from landfill.

Table 2 of **Technical Report N** shows a full list of greenhouse gas emission sources and the estimated quantities.

18.3.2 Construction impacts

Construction emissions

The construction of the proposal would result in the addition of about 4,073t CO_2-e to the atmosphere. Detailed calculations are available in Appendix A of **Technical Report N**. Greenhouse gas emissions resulting from construction works will be generated through the clearing of vegetation for the proposal footprint, and operation of vehicles and machinery during construction works, as shown in **Table 18.1.**

Table 18.1: Construction emissions

Emission source	Quantity	Units	Emission Factor	Total Emissions (t CO_2-e)
Construction machinery – stationary equipment	1,100	kL	2.71	2,981
Vegetation clearing	298	t C	3.67	1,092
Total construction GHG emissions				**4,073**

18.3.3 Operation impacts

First year operation emissions (Scope 1, 2 and 3)

Table 18.2 summarises the total emissions from the first year of operation of the proposal. Detailed calculations are available in Appendix A of **Technical Report N**. The ongoing operations of the proposal would result in indicative generation of 321,408t CO_2-e over the first year of operation of the EfW facility.

Table 18.2: Gross emissions from the first year of operation of the proposal[4]

Emission source	Quantity	Units	Emission factor	Total emissions (t CO_2-e)
Scope 1				
Thermal treatment of waste	500,000	tpa	-	307,431
Onsite fuel combustion (stationary)	2,700	kL	2.710	7,316
Onsite fuel combustion (mobile)	31	kL	2.721	85
Scope 2				
Electricity imported from grid	536,000	kWh	0.73[1]	393
Scope 3				
Employee commute to/from the site	91	kL	2.384	218
Transport of waste to site	1,658	kL	2.721	4,511
Transport of by-products from site	535	kL	2.721	1,455
Gross GHG emissions (indicative of first year)				**321,408**

The proportion of waste type is likely to change over the facilities lifetime, with introduction of new technologies, change in policy and change in consumer behaviour. So, the carbon emissions for Scope 1 and 2 emissions are predicted to decrease overtime. Scope 3 emissions are from vehicle emissions during the transport of waste and employees. The Scope 3 emission trends are dependent on wider technological advances and therefore are outside of the proposal's control.

Electricity export to grid (Scope 2)

As shown in **Table 18.2** above, the proposal will import 536MWh/year for the operation of the facility. Through the thermal treatment of waste that would otherwise be sent to landfill, the WSERRC will generate a nominal equivalent electrical output exported to the grid of 424,000MWh/year. This will result in a reduction in GHG emissions of around 310,731t CO_2-e in the first year of operations.

It is noted that the EfW process would generate up to 58MW of base load electricity with a parasitic load between 3MW and 5MW resulting in a maximum net output of up to 55MW to the electricity grid equal to 440,000MWh/year. However, the assumption made for the GHG calculations have been based on a parasitic load of 5MW meaning a net output of 53MW to the electricity grid, which is equal to 424,000MWh.

[4] The grid carbon factor at start up (year 2024) was based on current factors for 2019, considering the rate of historic decline, with interpolation of estimated emission projections based on historic data and past decline. The assumptions for these interpolations are listed in Appendix A of Technical report N.

Diversion of waste to landfill (Scope 3)

The diversion of waste which would otherwise be disposed to landfill will result in the reduction of methane gases produced during the decomposition process of landfilled waste.

Calculations have been carried out to determine the comparable emissions generated from disposal of the same volume of waste to landfill (500,000tpa). Calculations assumed that 46.2% of methane was captured. This is based on the average Australian landfill operations from the Australian Lifecycle Inventory Database of the Australian Lifecycle Assessment Society and a split of municipal solid waste (MSW) and commercial and industrial (C&I) (30:70) as per the short-term feedstock strategy for the WSERRC, which is detailed in **Chapter 5 EfW policy**. Based on the alternative disposal of waste to landfill, equivalent carbon emissions were equal to 401,192t CO_2-e/year.

The management and treatment of waste close to the source of generation (within the western Sydney region), promotes the proximity principle by reducing transport impacts and associated GHG emissions relating to the haulage of waste to further distances such as Woodlawn, some 200km south of Sydney. This would contribute to a further net reduction in overall GHG emissions, that has not been included in the overall calculations.

18.3.3.1 Net GHG emissions balance

Table 18.3 shows the net GHG emissions balance from the operation of the proposal considering the first-year operation emissions, the electricity export to grid and the diversion of waste to landfill. Appendix A of **Technical Report N** has further detail of these calculations.

Table 18.3: Net GHG emissions balance

Emission source	Quantity	Units	Emission Scope	Emission Factor[5]	Total Emissions (t CO_2-e)
Operating GHG emissions (indicative of first year) (Scope 1, 2 and 3)					321,408
Diversion of waste to landfill	500,000	tpa	Scope 3	0.82 (MSW) 0.79 (C&I)	-123,035 -278,157
Export of energy back to the electricity grid	424,000	MWh/year	Scope 2	0.73	-310,731
Net indicative GHG emissions (indicative of first year of operations)					**-390,515**

[5] Emission factors for MSW and C&I waste were based on actual data from quarterly waste audit completed at Cleanaway's Erskine Park Waste Transfer Station.

As noted above, the DoISER issues quarterly reports for GHG emissions in Australia. According to the September 2019 statistics, Australia produced 530.8Mt CO_2-e. In comparison, the GHG emissions from the waste sector accounted for 2.2% or 11.8Mt CO_2-e of this total. While operation of the facility will generate GHG emissions, consideration of factors including export of electricity back to the grid and the diversion of the equivalent waste which would otherwise be sent to landfill, results in the overall net reduction of GHG emissions by around 390,515t CO_2-e which would reduce Australia's overall emissions by less than 1% and the waste sector emissions by about 3%.

18.3.3.2 Climate impacts

As shown in **Table 18.3**, the operation of the proposal achieves a net reduction in GHG emissions. The proposal will divert waste from landfill, and so will reduce the possibility of methane emissions resulting from landfill. Part of the electricity generated from the proposal qualifies as renewable and displaces fossil fuel-based energy supplied to the grid, which also contributes to emissions reduction.

The proposal supports Australia's efforts to mitigate climate change by reducing GHG emissions and transitioning to a low carbon economy.

18.4 Mitigation

18.4.1 Design measures to reduce impacts

Several energy efficient measures have been considered and incorporated in the design of the proposal, with further measures to be applied during operation of the EfW facility. These measures will make sure operations maximise resource and energy recovery, thus maximising overall energy efficiency and reducing unnecessary GHG emissions. **Table 18.4** below outlines these design-embedded mitigation measures.

Table 18.4 also describes the measures that would be employed to mitigate against, manage and monitor the predicted GHG and energy efficiency impacts during construction and operation of the proposal.

Table 18.4: GHG and energy efficiency mitigation measures

ID	Potential impact	Proposed mitigation
Design embedded mitigation measures		
GHG1	Poor energy efficiency and fuel consumption	The proposal will use its own energy production to power the facility itself before exporting the remaining electricity generation to the grid.
GHG2		The plant is designed to run at 'high steam conditions' which refer to the temperature and pressure of the steam that is generated by the boiler and is used to drive the turbine to generate electricity. High steam conditions maximise the recovery of energy from the flue gases and therefore maximise energy efficiency.
GHG3		Variable Speed Drives (VSDs) will be specified for large motors driving fans and pumps to reduce energy consumption within the plant. This effectively decreases the electricity consumed by the plant and therefore increases the amount of electricity that can be exported to the electricity grid in comparison to the case where single speed drives are used.
GHG4		All plant systems and equipment will be accurately specified and sized so they operate at optimal design point during normal operations. This means that equipment will operate efficiently and therefore energy efficiency of the overall facility will be increased.
GHG5		Use of energy efficient motors.
GHG6		Use of mechanical/pneumatic rapping systems to do online cleaning to the boiler rather than soot blowers which would utilize steam which could otherwise been used for electricity generation.
GHG7		Efficient design of steam turbine with multiple steam extraction points so that all internal process demands can be met with extracted steam for all load conditions.
GHG8		Maximizing natural ventilation of process plant areas where possible to minimize use of forced ventilation.
GHG9		Sub-metering of all electricity distribution at a system level to monitor usage and identify high consumers and opportunities for future improvement.
GHG10	Energy and materials consumed by the administration building and visitor and education centre	Location of the Operations/Administration areas in the main facility, not a stand-alone building which reduces the overall volume of materials needed for construction.
GHG11		Consideration of the orientation of the buildings and glazed facades to limit excess solar gain thus reducing the need for excessive cooling. Use of glazing to balance solar gain with provision of natural light will also be carefully considered to reduce the energy usage from electrical lighting.
GHG12		Use of insulated façade materials to reduce energy consumption for heating and cooling when compared to a non-insulated facility.

ID	Potential impact	Proposed mitigation
GHG13	Energy and materials consumed by the proposed buildings and infrastructure onsite	Materials will be carefully selected, considering life cycle impacts and embedded carbon in materials.
Construction mitigation measures		
GHG14	Fuel consumption Vegetation removal	The CEMP will include appropriate measures to be applied to optimise construction machinery and fuel usage, and the clearing of vegetation will be minimised as much as practical for the construction footprint.
Operation mitigation measures		
GHG15	Poor energy efficiency and fuel consumption	A site-specific Environmental Management Plan will be prepared and applied as part of the OEMP. This will outline energy efficient procedures so that plant operation is optimised, including the logistics to reduce fuel usage. This plan will be continuously reviewed and audited.
GHG16		The OEMP will include measures so that BAT are reviewed, and so opportunities are identified and applied where future technologies may further reduce energy use.
GHG17		The operator will continue to investigate whether the installation of a heat/low pressure steam offtake is possible to allow the facility to operate in a Combined Heat and Power mode which would increase the overall energy efficiency of the facility. Such opportunities will be assessed periodically.