Technical Memorandum

9 June 2025

To	Christopher Eason	**Contact No.**	+61 8 6222 8977
Copy to	Glen Doherty	**Email**	nikita.paul@ghd.com
From	Nikita Paul	**Project No.**	12667323
Project Name	Rio Tinto WINU – Air Quality Comparison Assessment		
Subject	Air Quality Emissions Comparison Assessment		

1. Introduction

Rio Tinto Winu Pty Ltd (Rio Tinto Winu) plans to develop a new copper and gold mine and associated infrastructure, referred to as the Winu Project, approximately 300 km south of Broome and 320 km east of Port Hedland in the Pilbara region of Western Australia, within both the Nyangumarta People's and Martu People's Native Title Determination Areas. The Winu project is in the approvals phase and has been referred to the WA Environmental Protection Authority (EPA).

The Winu Project comprises the following:

– Open pit mining that extends below the water table
– Ore processing facilities
– Dewatering and water management infrastructure
– Mine support facilities and infrastructure

Construction will occur over a two year period and the mine will operate for 38 years.

GHD was engaged to prepare a comparison assessment of emissions from the Winu power station (Project) against similar other facilities to understand the scale and nature of power generation activities as requested by the EPA.

1.1 Purpose of this memorandum

The purpose of this memorandum is to undertake an assessment of air quality emissions profiles between the Project and four other power stations similar in nature (size, fuel source and renewable energy penetration).

2. Scope of work

The scope of this work includes the following:

– Confirm the air quality data from the technical memorandum that was completed (dated 19 December 2024 from Daniel Hoy titled PCN006 – Technical Memorandum).
– Identify comparable power stations, ensuring they have suitable publicly available data to allow comparison.

– Prepare and submit a technical memorandum outlining the comparison.

3. Assumptions

This assessment has been completed assuming National Pollutant Inventory (NPI) emission data as reported by the facilities is reflective of their typical emissions profiles.

4. Limitations

This technical memorandum has been prepared by GHD for Rio Tinto Winu and may only be used and relied on by Rio Tinto Winu for the purpose agreed between GHD and Rio Tinto Winu as set out in Section 2 of this memorandum.

GHD otherwise disclaims responsibility to any person other than Rio Tinto Winu arising in connection with this memorandum. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this memorandum were limited to those specifically detailed in the memorandum and are subject to the scope limitations set out in the memorandum.

The opinions, conclusions and any recommendations in this memorandum are based on conditions encountered and information reviewed at the date of preparation of the memorandum. GHD has no responsibility or obligation to update this memorandum to account for events or changes occurring subsequent to the date that the memorandum was prepared.

The opinions, conclusions and any recommendations in this memorandum are based on assumptions made by GHD described in the supporting report. GHD disclaims liability arising from any of the assumptions being incorrect.

If this memorandum is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

5. Review of technical memorandum

GHD (2024) provided Rio Tinto Winu with a Technical Memorandum in December 2024, which outlined the annual emission contributions of key pollutants of concern from diesel combustion: nitrous oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), total volatile organic compounds (TVOC), particulate matter less than or equal to 10 (PM_{10}) and 2.5 ($PM_{2.5}$) micrometres in diameter.

The calculations and assumptions for emissions were reviewed by a GHD Air Quality Consultant. This included checking unit conversions and an order of magnitude check.

Emission factors for NO_x, SO_2, CO, TVOC, PM_{10} and $PM_{2.5}$ were sourced from the NPI (2008), which is based on the US EPA AP-42 (1996). These emission factors are typically used for combustion engines and are considered the best approach. Emission factors and calculated annual emissions are provided in Table 5.1.

Assumptions for the estimations of diesel emissions were:

– Annual diesel consumption of 12,510 kilolitres (kL) (as advised by GHD renewable energy team)
– Energy content of 38.2 megajoule (MJ) / litre (L) (NPI, 2008)
– Average heat rate of 10.22 MJ/ kilowatt hours (kWh) (NPI, 2008)
– Sulphur (S) fuel content of 10 parts per million (ppm) (as per the Australian Fuel Standard)

– NOx emission rate is controlled

Table 5.1 Key pollutant emission data

Key pollutant	Emission factor (kg/kWh) [1]	Annual emissions (tonnes/yr)
NO_x	$7.90x10^{-3}$	369.50
SO_2	$4.90x10^{-8}$	$2.29x10^{-3}$
CO	$3.30x10^{-3}$	154.35
tVOC	$3.80x10^{-4}$	17.77
PM_{10}	$4.30x10^{-4}$	20.11
$PM_{2.5}$	$4.20x10^{-4}$	19.64

[1] Table 42: Emission factors (kg/kWh) for stationary large (greater than 450 kW) diesel engine (NPI, 2008)

The annual emissions are consistent with the NPI methodology. Fuel was correctly converted for energy content and heat rate, and emissions were correctly calculated using NPI emission factors. Assumptions and inputs given in GHD (2024) are considered reasonable.

6. Comparison assessment

To understand the scale of emissions from the Project, GHD undertook a review of publicly available data from the NPI database to obtain total emission figures from all electricity generation facilities in Australia for the period 2023-2024. Estimated emissions from the Project were compared against these annual figures as shown in Table 6.1.

It was observed that CO, NO_x, PM_{10}, $PM_{2.5}$ and SO_2 emissions from the Project would account for less than 0.5 percent of the total emissions from electricity generation for 2023-24. VOC emissions accounted for 0.6 percent of total emissions from electricity generation. This is based on total emission data available for all electricity generation sources within Australia for 2023/24.

Table 6.1 Annual emissions from all electricity generation facilities vs Project

Pollutant	Emissions from electricity generation in Australia 2023-24 (tonnes)	Estimated emissions from Project (tonnes)	Percentage of total (%)
CO	42,740	154.4	0.4%
NO_X	288,074	369.5	0.1%
PM_{10}	17,858	20.1	0.1%
$PM_{2.5}$	6249	19.6	0.3%
SO_2	388,936	0.002	<0.1%
VOC	2935	17.8	0.6%

The Project has a peak load capacity of 65 MW and will consist of solar and wind generation, battery energy storage system (BESS) and diesel firming generation. A renewable energy fraction of 85 percent applies to the power generation from the Project and only 15 percent of power generation is from diesel firming generation.

GHD undertook a review of publicly available data to identify power stations of similar nature as the Project, which is summarised in Table 6.2. A range of power stations with different peak load capacities and fuel sources were chosen to understand typical emission profile for facilities with peak load capacity in the

[1] Table 42: Emission factors (kg/kWh) for stationary large (greater than 450 kW) diesel engine (NPI, 2008)

range of 9 MW to 94 MW. The stations were also chosen based on the availability of NPI and energy generation data.

6.1 Comparable power stations

Angaston Power Station, owned and operated by Snowy Hydro, is a 30 unit, 50 MW station located in Barossa Valley, South Australia. The method of power generation is diesel engine peaking generation. Angaston Power Station has selective catalytic reduction (SCR) installed to minimise NO_x emissions.

Bairnsdale Power Station is owned and operated by Alinta Energy and is a natural gas fired peaking generation with a capacity of 94 MW. Bairnsdale Power Station also has low NO_x burners installed to minimise NO_x emissions.

Esperance Power Station is owned and operated by Horizon Power and supplies power to the town of Esperance. This hybrid power station has a capacity of 43.6 MW with diesel generation contributing seven percent of power generation. The breakdown of power generation at Esperance Power Station is as below:

– 22 MW low emissions gas power station
– 5.6 MW BESS
– 9 MW wind
– 4 MW solar farm
– 3 MW diesel

Owen Springs Power Station is owned and operated by Territory Generation and supplies power to the Alice Springs community. This station has a peak capacity of 80.9 MW with thirteen reciprocating engines (10 gas and three dual fuel) and one industrial gas turbine (dual fuel).

Higginsville or Norseman Power Station is owned and operated by Pacific Energy and has been powering Higginsville Gold Operations since 2007. The station has peak capacity of 9 MW with diesel being the primary fuel source.

Table 6.2 List of comparable power stations

Power station	Peak load capacity	Fuel source
Angaston	50 MW	Diesel
Bairnsdale	94 MW	Gas
Esperance	43.6 MW	Hybrid
Owen Springs	80 MW	Gas and dual fuel
Norseman	9 MW	Diesel

6.2 Gross annual emissions

GHD undertook review of publicly available NPI data for the power stations listed above and compared their annual emissions against that estimated for the Project. However, emissions are dependent on power generation and hence GHD undertook review of publicly available energy generation data for the power stations and compared against that of the Project. As shown in Figure 6.1, annual average energy generation for the Project is much higher than the other power stations and hence a higher annual emissions profile is expected for the Project.

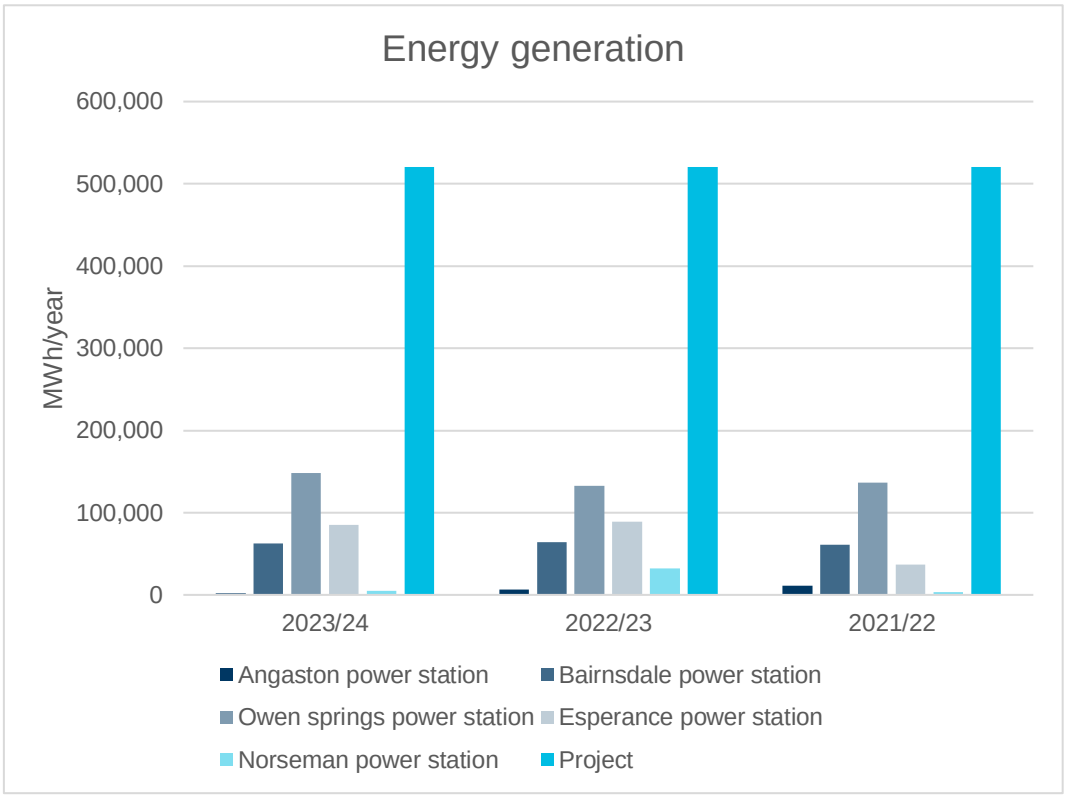

Figure 6.1 Comparison of power generation

CO, SO_2, NO_x, PM_{10}, $PM_{2.5}$ and VOCs were then compared for the periods 2021-2022, 2022–2023 and 2023-2024. This comparison provides typical emission profile for power stations with peak capacity ranging from 9 MW to 94 MW.

The comparison is shown in Figure 6.2 to Figure 6.7 and summarised as below:

– Estimated annual CO emissions for the Project are higher than reported emissions for other power stations for the periods 2021-22 and 2023-2024., with exception of 2022-2023 (Figure 6.2).
– Estimated annual SO_2 emissions for the Project are low, similar to Angaston and Norseman power station which have diesel as their only fuel source (Figure 6.3).
– Estimated annual NO_x emissions for the Project are higher than other stations with exception of Esperance Power Station (Figure 6.4).
– Estimated annual PM_{10} and $PM_{2.5}$ emissions for the Project are higher than other power stations for all periods (Figure 6.5 and Figure 6.6).
– Estimated VOC emissions for the Project are higher than other power stations with exception of Esperance Power Station (Figure 6.7).

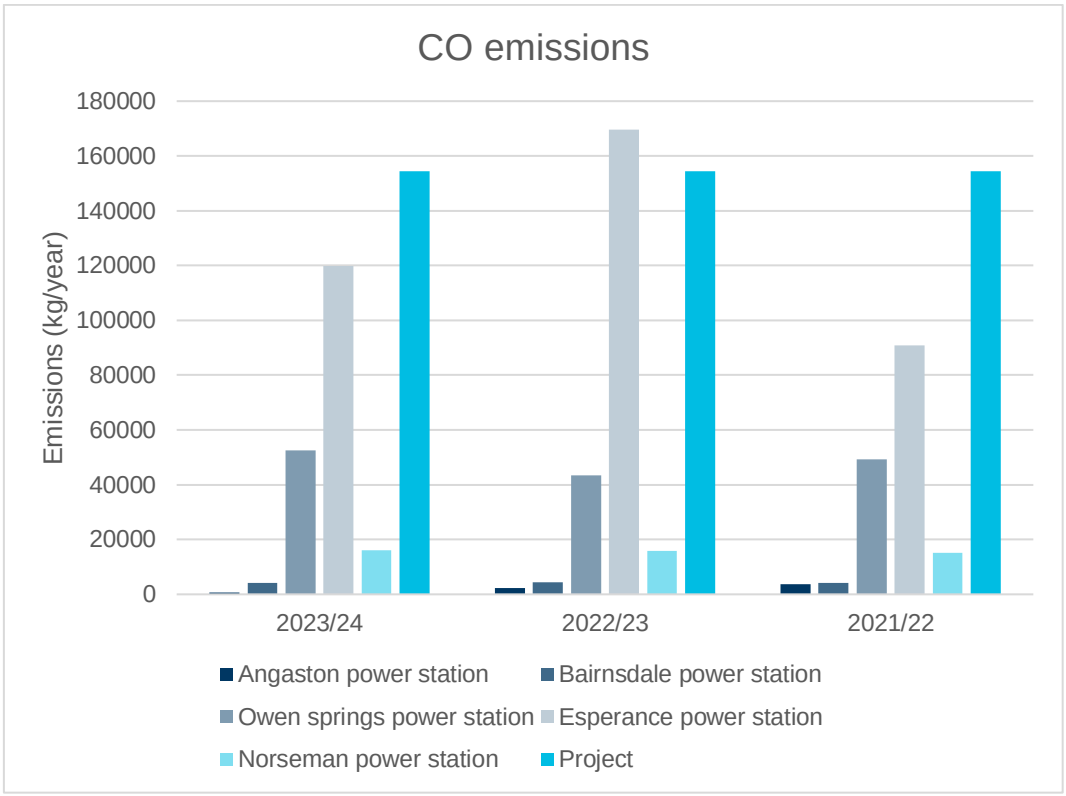

Figure 6.2 Comparison of CO emissions[2]

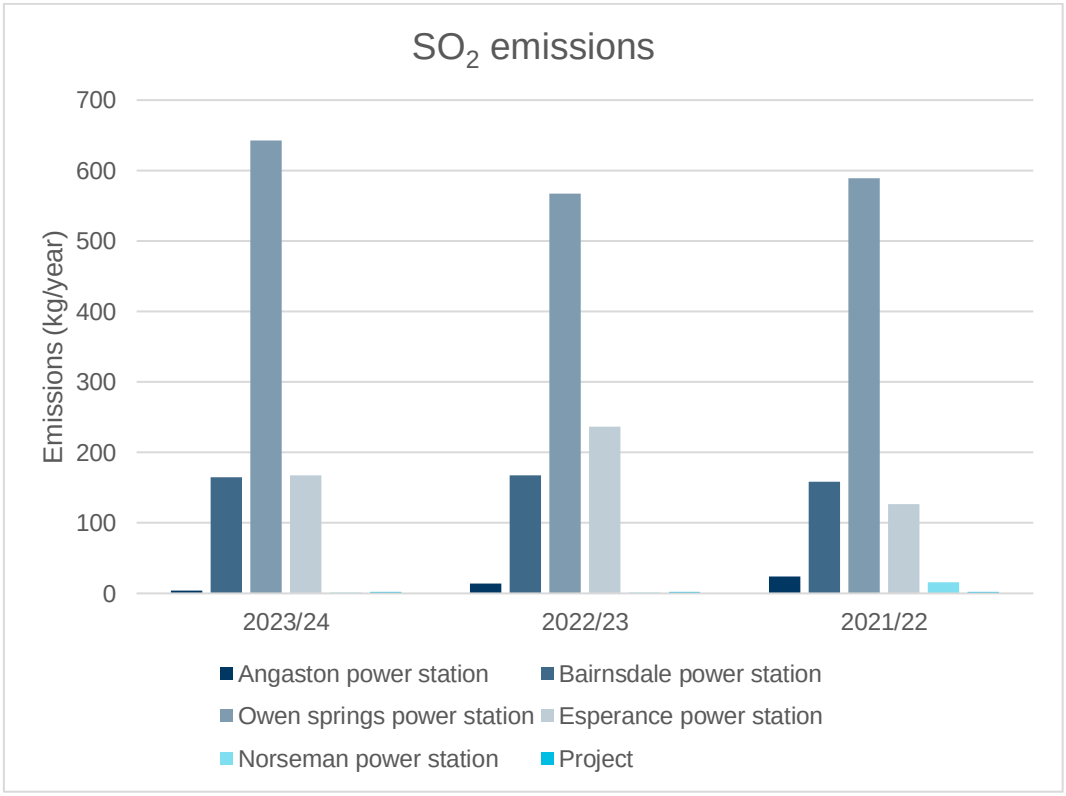

Figure 6.3 Comparison of SO_2 emissions[3]

[2] CO emission for Angaston power station is < 700 kg/year for 2023/24 which is relatively minimal and hence not visible in Figure 6.2.
[3] SO_2 emissions for Norseman power station is < 2 kg/year for 2022/23 and 2023/24 and hence not visible in figure; SO_2 emissions for the Project is < 2 kg/year for all periods and hence not visible in Figure 6.3.

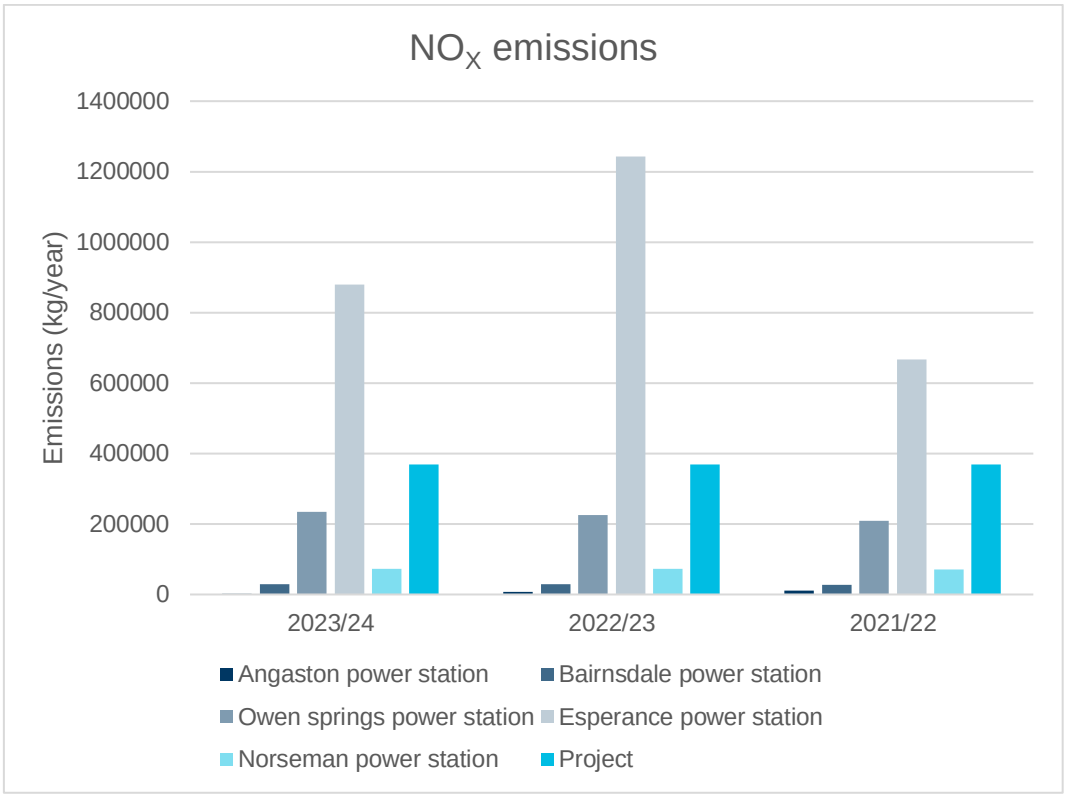

Figure 6.4 Comparison of NO_x emissions[4]

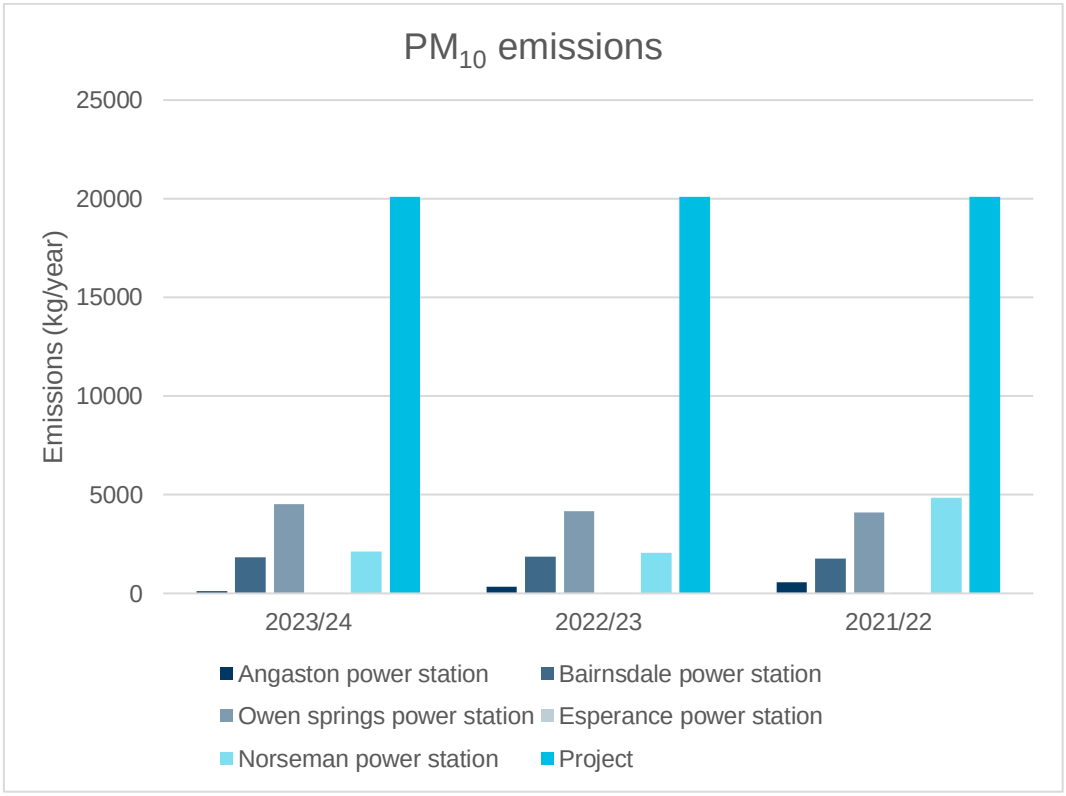

Figure 6.5 Comparison of PM_{10} emissions[5]

[4] NO_x emissions for Angaston power station is < 7000 kg/year for 2022/23 and 2023/24 and hence not visible in Figure 6.4.
[5] PM_{10} emissions for Esperance power station is < 25 kg/year for all periods and hence not visible in Figure 6.5; PM_{10} emissions for Angaston power station is approximately 100 kg/year for 2023/24 and hence not visible inFigure 6.5.

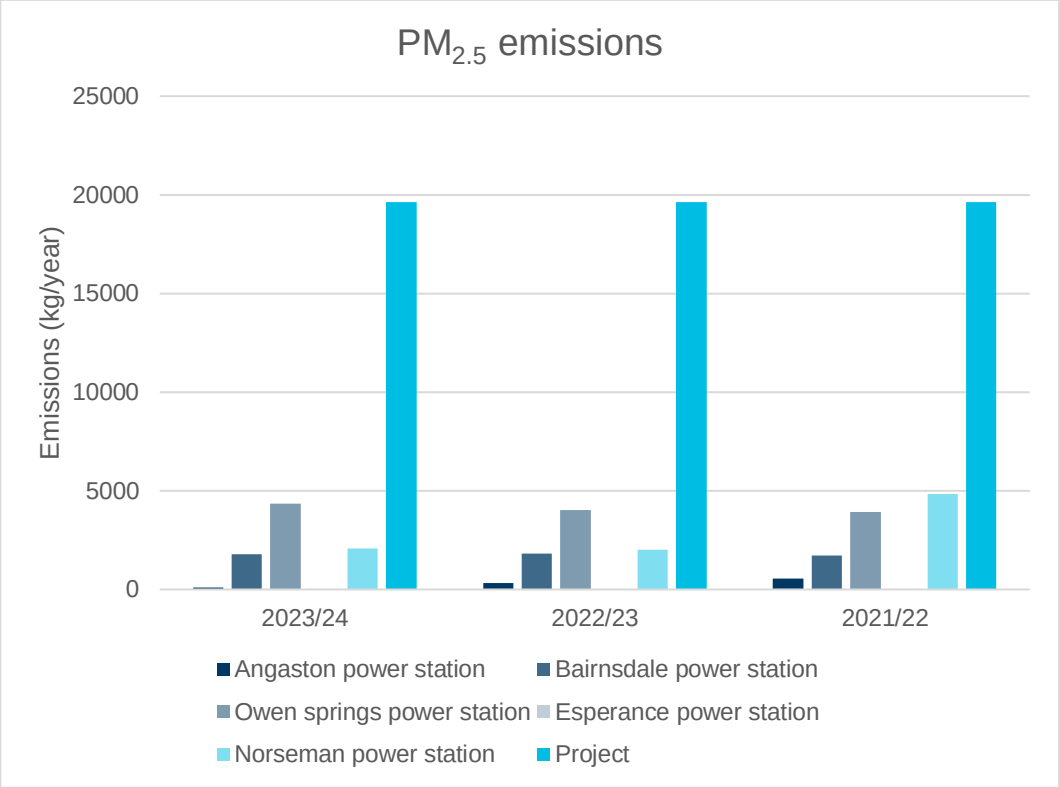

Figure 6.6 Comparison of $PM_{2.5}$ emissions[6]

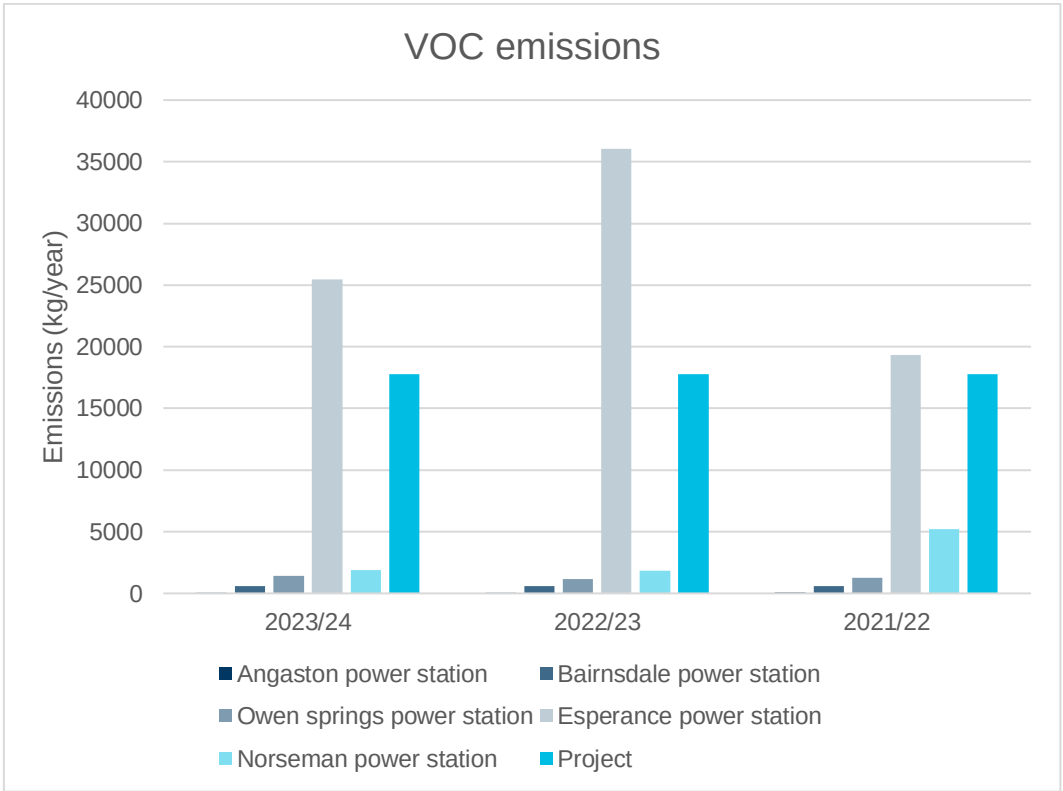

Figure 6.7 Comparison of VOC emissions[7]

[6] $PM_{2.5}$ emissions for Esperance power station is < 25 kg/year for all periods and hence not visible in figure; $PM_{2.5}$ emissions for Angaston power station is just below 100 kg/year for 2023/24 and hence not visible in Figure 6.6.
[7] VOC emissions for Angaston power station is < 70 kg/year for all periods and hence not visible in Figure 6.7.

6.3 Annual emissions per MWh

To obtain a more accurate comparison, emissions per MWh of energy generated for the power stations were compared against that of the Project for periods 2021-2022, 2022-2023 and 2023-2024. The comparison is shown in Figure 6.8 to Figure 6.13 and summarised as below:

– CO emissions per MWh for the Project are comparable to other power stations and much lower than that of Esperance and Norseman power stations (Figure 6.8).
– SO_2 emissions per MWh for the Project are lower than the other power stations (Figure 6.9).
– NO_x emissions per MWh for the Project are comparable to other power stations and much lower than that of Esperance and Norseman power stations (Figure 6.10).
– PM_{10} and $PM_{2.5}$ emissions per MWh for the Project are comparable to other power stations and much lower than that of Norseman Power Station (Figure 6.11 and Figure 6.12).
– VOC emissions per MWh for the Project are comparable to other power stations and lower than that of Esperance and Norseman power stations (Figure 6.13).

This comparison indicates that high annual emissions for the Project relative to other power stations is due to the scale of power generation.

It should also be noted that there are some inconsistencies noted with NPI data. Emissions per MWh for Norseman Power Station is very different to that of Angaston Power Station given that both have diesel as their only fuel source. This is expected for NO_x as Angaston has SCR pollution control technology installed. There are also inconsistencies in emissions per MWh across the different periods for Norseman Power Station which could also mean change in their operations which is not captured here. CO, NO_x and VOC emissions per MWh is quite high for Esperance Power Station, where it would be expected to be lower than other stations due to hybrid fuel source. Although this assessment enables comparison of Project emissions to other sources, there are limitations to using NPI data which may have inaccuracies in the way calculations are done and may not give a full picture of operational changes.

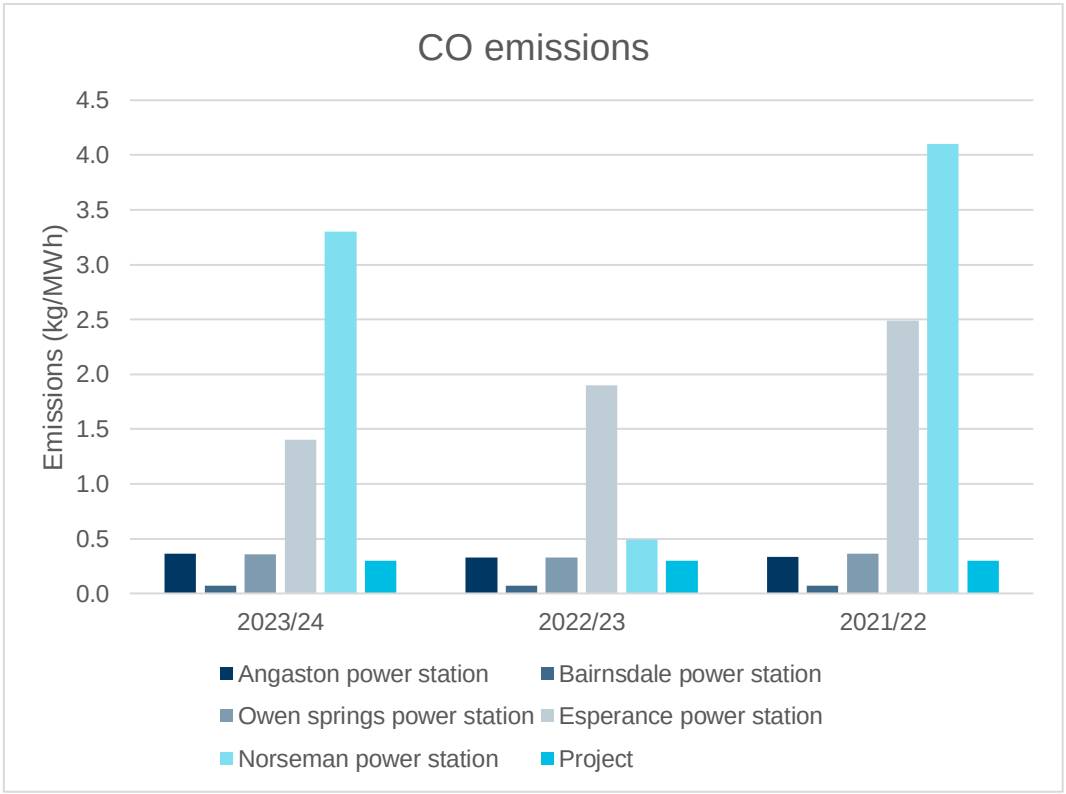

Figure 6.8 Comparison of CO emissions per MWh

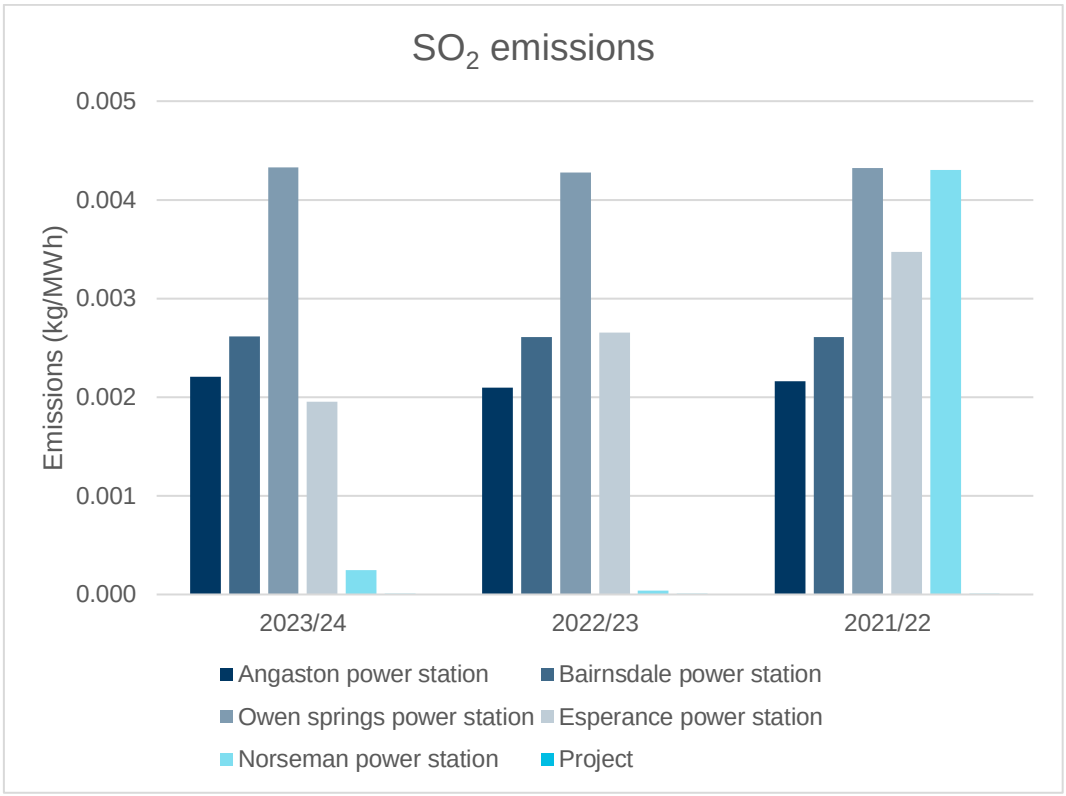

Figure 6.9 Comparison of SO_2 emissions per MWh[8]

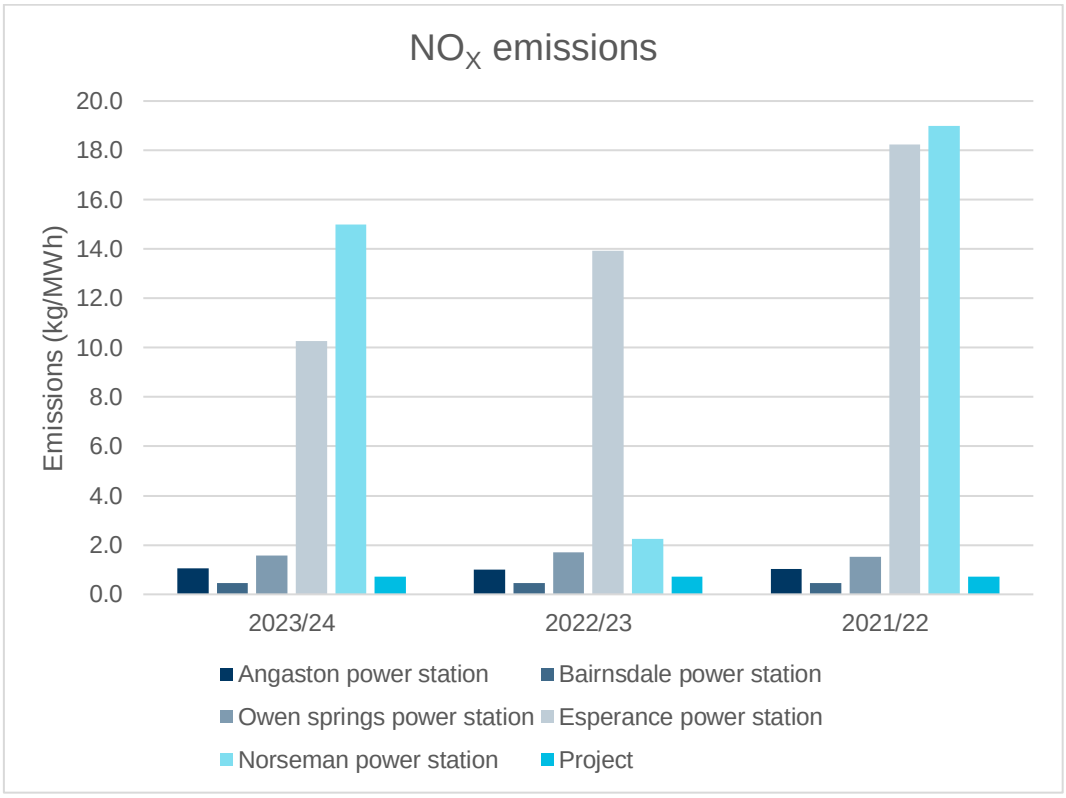

Figure 6.10 Comparison of NO_x emissions per MWh

[8] SO_2 emissions for the Project is < 0.0001 kg/MWh and hence not visible in Figure 6.9.

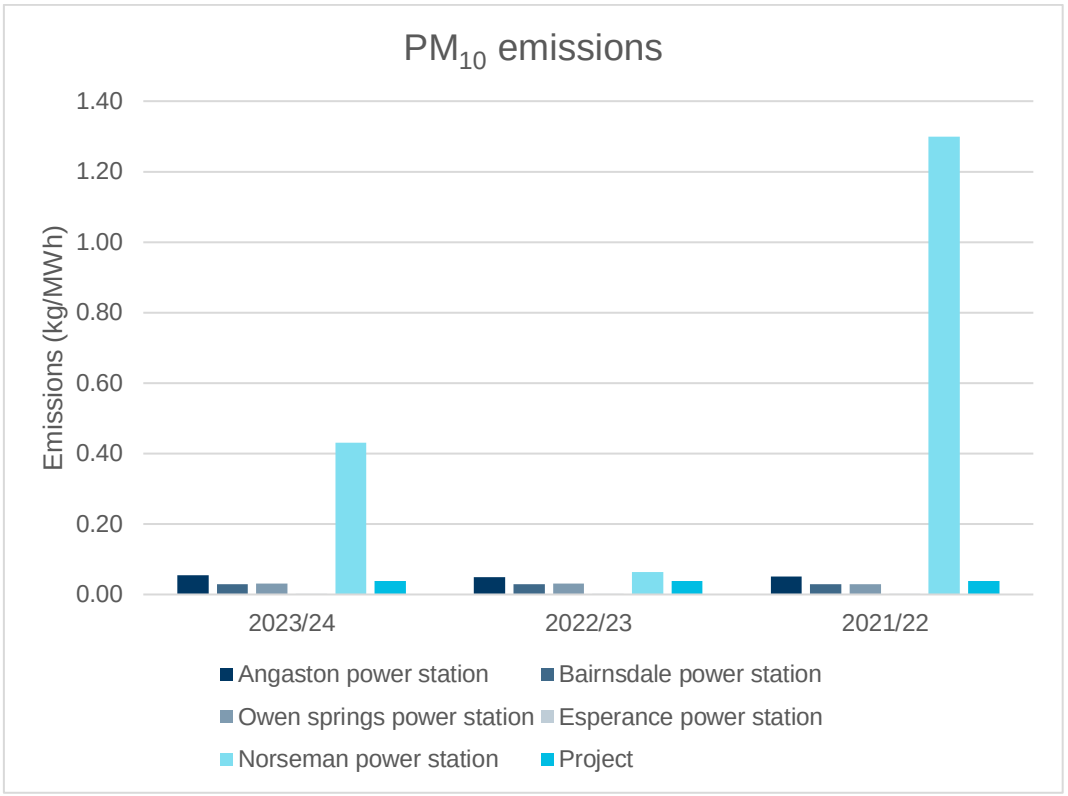

Figure 6.11 Comparison of PM_{10} emissions per MWh[9]

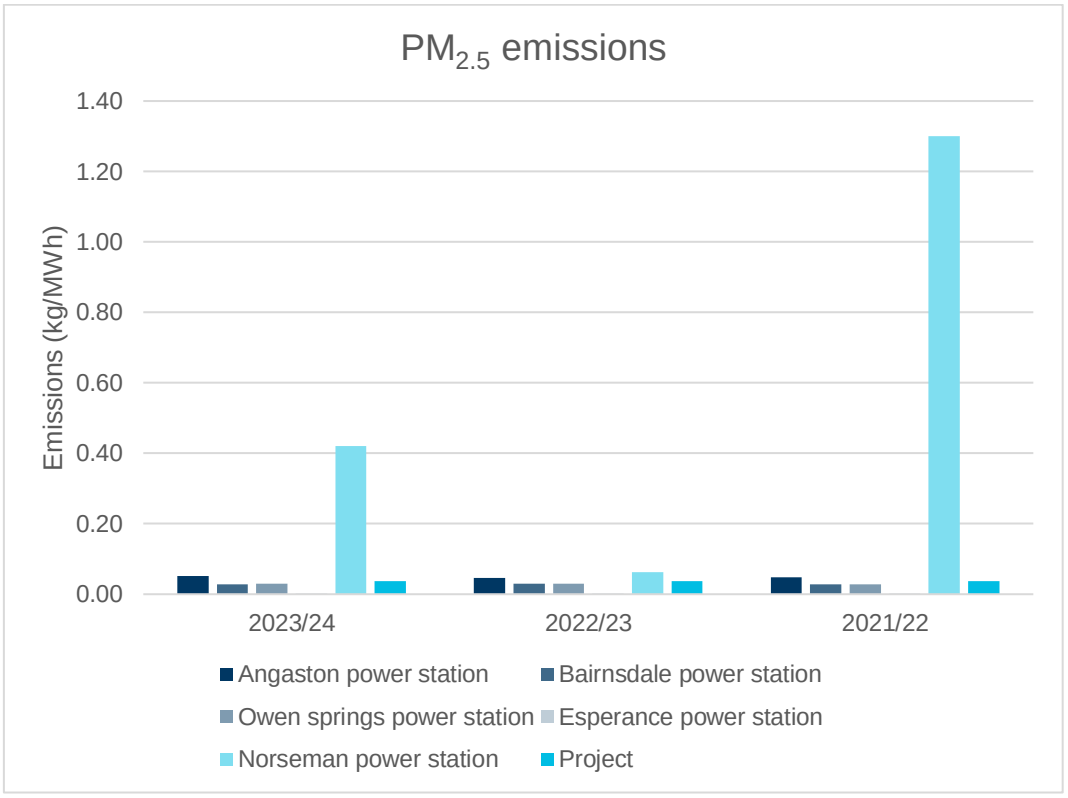

Figure 6.12 Comparison of $PM_{2.5}$ emissions per MWh[10]

[9] PM_{10} emissions for Esperance power station is < 0.01 kg/MWh and hence not visible in Figure 6.11.
[10] $PM_{2.5}$ emissions for Esperance power station is < 0.01 kg/MWh and hence not visible in Figure 6.12.

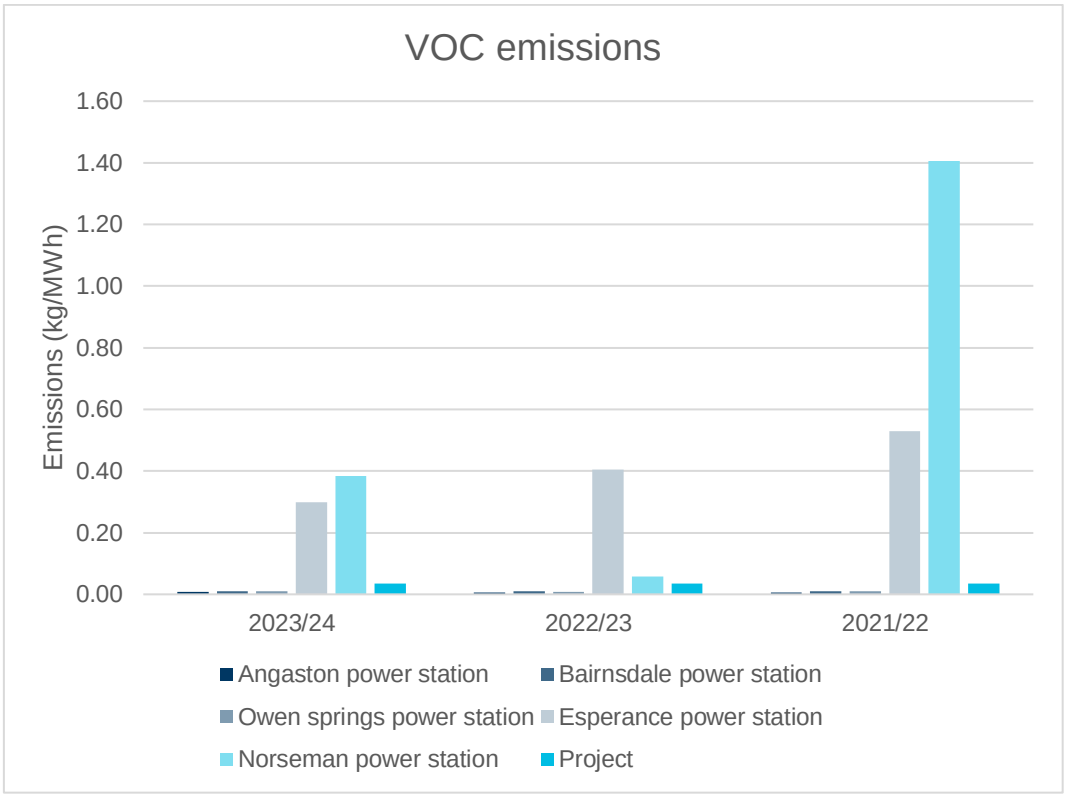

Figure 6.13 Comparison of VOC emissions per MWh[11]

7. Conclusion

GHD undertook a review of assumptions and calculations used to develop the emissions profile for the technical memo previously provided to Rio Tinto Winu and confirmed that is it consistent with NPI methodology. The annual estimated emissions from the Project were then compared against that of other power stations with peak load capacity in the range of 9 MW to 94 MW.

It was observed that gross annual emissions for the Project are generally higher than other power stations with the exception of Esperance Power Station.

Energy generation was also compared as annual emissions are dependent on energy generated. It was observed that the scale of power generation for the Project is much higher than that of the other power stations.

Emissions per MWh generated for the Project was then compared to that of other power stations and was observed to be comparable or lower. Hence, Project emissions are typical to facilities with similar energy generation.

Kind regards

Nikita Paul
Air Quality Consultant

James Forrest
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James Forrest
Technical Director – Air Quality

[11] VOC emissions for Angaston, Bairnsdale and Owen Springs power station are all <0.05 kg/MWh and hence not visible in Figure 6.13.

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