10. Greenhouse gas emissions

10.1 EPA objective

The EPA's environmental objective for proposals where greenhouse gas (GHG) emissions are a significant factor is "To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable" (EPA, 2024e).

10.2 Policy and guidance

The assessment and management of GHG emissions associated with the Proposal and ongoing existing operation of the facilities has been undertaken with consideration to the following State and Commonwealth Policies and Guidelines:

- *WA Environmental Factor Guideline – Greenhouse Gas Emissions* (EPA, 2024e);
- *Instructions on how to prepare an Environmental Review Document* (EPA, 2024c);
- *Template Greenhouse Gas Environmental Management Plan* (EPA, 2023e)
- *Greenhouse Gas Emission Policy for Major Projects* (GoWA, 2024c)
- *National Greenhouse and Energy Reporting Act 2007*
- *National Greenhouse and Energy Reporting Regulations 2008*
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008*
- *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*

In November 2024 the EPA updated its Environmental Factor Guideline for GHG Emissions to ensure compatibility with the WA Government's GHG Emissions policy for Major Projects and facilitate the opportunity to streamline information requirements and assessment with the Commonwealth's Safeguard Mechanism.

In the EPA's updated guidance reference is made to the option for an expert review to demonstrate how best practice measures have been adopted by a proponent. However, this is not a mandatory requirement and the guidance indicates that this would generally only be required where a new technology is proposed, benchmarking shows the technology is poor practice, or there is likely to be substantial (more than 30%, and above 100,0000 tonnes CO2-e in any year) reliance on offsets (EPA, 2024e). From considering the EPA's guidance, Alcoa is of the view that an expert review is not required to support this Proposal. Likewise, Alcoa does not consider it necessary to prepare a GHG environmental management plan to support the Proposal as the pertinent information can be provided in this chapter.

10.3 Receiving environment

Climate change is a global issue. In 2015, world leaders reached an agreement to keep the global average temperature increase below 2ºC and pursue efforts to limit the increase to 1.5ºC. This is referred to as the Paris Agreement. The Paris Agreement requires countries to submit increasingly ambitious Nationally Determined Contributions (NDCs). Australia's current NDC is to reduce Australia's net greenhouse gas emissions to 43% below 2005 levels by 2030 and to reduce net greenhouse gas emissions to zero by 2050. The NDC has been legislated in the *Climate Change Act 2022*.

A number of strategies have been put in place to support the achievement of Australia's ambitions, including the Safeguard Mechanism. The Federal Government has also announced six sectorial decarbonisation plans, which between them will cover all major components of the economy, including resources and industry (DCCEEW, 2023f). These plans will also support the

development of Australia's 2035 emission reduction targets. The Safeguard Mechanism is one of the current emission reduction policies that will contribute Australia's Net Zero plan.

10.4 Basis of Calculations

The scope of this Proposal is limited to Alcoa's mining operations in the Mine DE within the Huntly Mine and the operations at the Pinjarra Refinery with respect to the to the period covered in the Proposal (2026-2045). However, the emissions estimates are for the full operations of Huntly Mine and Pinjarra Refinery during this period.

Consistently with how Alcoa report under the National Greenhouse and Energy (NGER) scheme, emissions up to and including the bauxite stockpiles at Pinjarra Refinery are included as part of the Huntly Mine and downstream scope 1 and 2 emissions are reported by Pinjarra Refinery. The emissions reported here are for the full facilities and not solely the increase related to the Proposal.

In accordance with NGER, reported scope 1 and 2 emissions include those produced by contractors and their equipment working onsite under Alcoa's operational control. At Huntly Mine, reported annual emissions also include rehabilitation of earlier mined areas, construction as part of the ongoing mining sequence and mining of ore for Kwinana Alumina Refinery (fully curtailed in 2024). Alcoa will continue to monitor the many factors that led to the curtailment decision and assess options for the long-term future of the refinery and therefore emissions associated with producing ore for this facility have been considered in the scope 3 estimations.

10.5 Scope 1 emissions

10.5.1 Safeguard Mechanism

For scope 1 emissions reported under NGER, EPA allow the option for Proponents to demonstrate compliance with the Safeguard Mechanism. Alcoa has adopted this option for the Proposal as both the Huntly Mine and Pinjarra Refinery are NGER facilities registered under the operational control of Alcoa of Australia Limited and the controlling corporation Alcoa Australian Holdings Pty Ltd.

10.5.1.1 Huntly Mine

Combustion of diesel and use of electricity are the two main sources of scope 1 and 2 emissions at Huntly Mine. There is natural variability in Huntly Mine's scope 1 emissions intensity, primarily due to changes to the average haul-distance. Haul distances typically increase as mining occurs further away from the crusher in the latter years of mining in a particular region.

Huntly Mine's production-adjusted baseline values are not expected to exceed 100,000 t CO2e per year and therefore this threshold value will be the site's default baseline. Settings for the Safeguard Mechanism, including the threshold value, will be reviewed at regular intervals by the Climate Change Authority (CCA) to ensure alignment with Australia's targets, including net zero 2050.

The Huntly Mine will not be eligible to generate safeguard mechanism credits (SMCs) when using the threshold value as the baseline nor is it eligible to become a trade-exposed baseline adjusted (TEBA) facility.

Due to the complexities of the mine planning process, it is not possible to forecast emissions beyond the period of the current Mine Management Plans. However, the safeguard mechanism will require net scope 1 emissions covered under this scheme to be maintained at or below 100,000 tonnes of carbon dioxide equivalent (t CO2e) per year.

10.5.1.2 Pinjarra Refinery

For the Pinjarra Refinery, the emissions estimates are forecast at the increased Alumina production limit included in the Proposal (5.25 Mtpa) and they continue until the current end of mine life in 2045.

The two main processes that result in scope 1 and 2 emissions at an alumina refinery are digestion and calcination.

- Digestion is where the bauxite and caustic liquor slurry is heated to enable the alumina to enter a soluble state. Medium pressure steam is used as the process heat for digestion. It is produced in the onsite powerhouse via a cogeneration process where natural gas is used to heat boilers which feed into steam turbines to create electricity, the electricity is a by-product. Additionally supplementary scope 2 steam is imported from the co-located Pinjarra Alinta Cogeneration Facility (Alinta Pinjarra). This supplementary steam improves process efficiency relative to the onsite powerhouse derived steam.

- Calcination is the process of "baking" the precipitated alumina to drive off chemically bound water. This requires temperatures around 1,000°C, which are supplied at Pinjarra Refinery by the combustion of natural gas in the calciners.

At the Proposals maximum alumina production rate (5.25 Mtpa) the safeguard mechanism baseline for Pinjarra Refinery is forecast to increase to financial year[1] (FY) 2030 with the transition from baselines using predominately site specific values to 100% industry average (see Figure 10-1). This reflects the refinery's significantly lower than average emissions intensity for both alumina and onsite electricity generation. After 2030, the trajectory is expected to follow the default emissions reduction contribution (ERC) set by the safeguard mechanism. This will be reviewed at regular intervals by the Climate Change Authority to ensure alignment with Australia's GHG emission reduction targets, including net zero by 2050, which aligns with EPA's expectations.

Due to the trade exposed and hard to abate nature of alumina refining, the refinery may, in future years, be eligible to apply for a reduced emissions reduction contribution (ERC) under the trade-exposed baseline-adjusted (TEBA) criteria. This is unlikely to occur prior to 2035 and is likely to be based on a number of factors including other carbon leakage policy development, technology development, and future offset and alumina prices. The default ERC will consider facilities with adjusted baselines, so it is not expected to impact Australia's ability to meet its greenhouse gas (GHG) emission reduction goals.

[1] For NGER, emissions are reported on an Australian financial year (July to June).

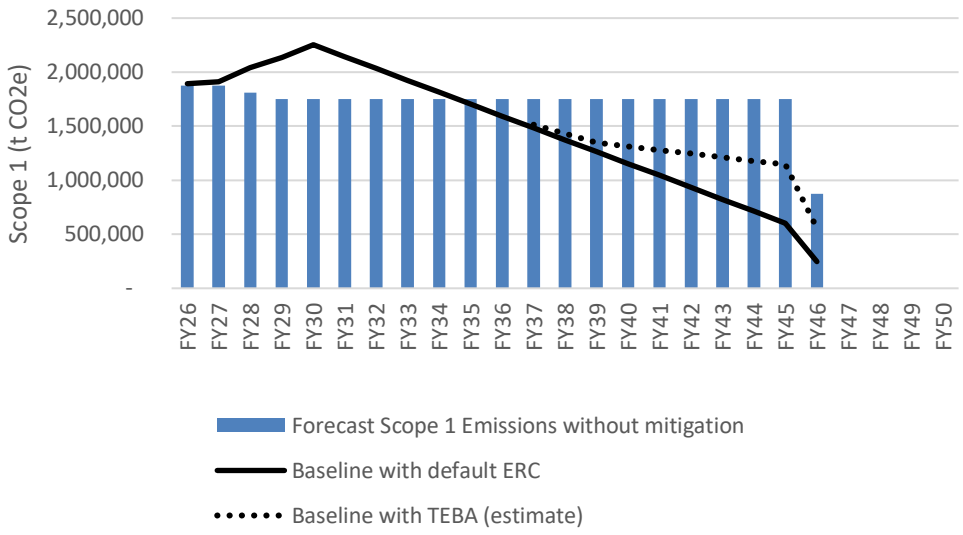

Figure 10-1 **Pinjarra Refinery NGER Scope 1 forecasted emissions and Safeguard Mechanism baseline at 5.25 Mtpa**

The emission intensity at the refinery is initially forecast to be higher than under normal operating conditions due to the use of lower grade ore until the commencement of operational mining at Myara North under the Proposal, in approximately 2028. The reduction in emissions and baseline in FY46 is due to current end of mine life in 2045.

10.5.1.3 Mitigation measures

Alcoa's ability to maintain net scope 1 emissions below its safeguard mechanism baselines will depend on the technology development, marginal cost of abatement, access to third party funding, and for the mines, timing of mine region moves. Scope 1 mitigation options assessed are presented in the Table 10.1 for the Huntly Mine and Table 10.2 Pinjarra Refinery Scope 1 mitigation options assessed for the Pinjarra Refinery. Emission reduction options will not be limited to maintaining net emissions below the current Safeguard Mechanism baselines.

Table 10.1 Huntly Mine Scope 1 mitigation options assessed

Target horizons	GHG mitigation option assessed	Description	Mitigation Hierarchy	Current status	Technology Readiness
Short Term (2026-2030) – Myara North operations and consideration for Holyoake	Fuel additive	An additive being blended with all diesel use to realise ~5% efficiency gains	Reduce	In implementation	Proven system
	Conveyor extension to Myara North	Extending electric conveyors into the new mining areas to reduce haul truck requirements and associated fuel burn.	Reduce	Not adopted - To maintain planned alumina production, there is not sufficient time to install a conveyor for mining at Myara North. Likewise, the expense and clearing required are not warranted due to the short time period of operations in this area	Proven system
	Mining equipment fleet transition pathways studies	Studies to assess opportunities to progressively reduce emissions from all fleet classes and other equipment, as technologies become commercially viable. Options under consideration include (but not limited to), renewable diesel, hybrid diesel-battery haul truck, battery electric ancillary fleet and battery electric vehicles.	NA	Progressing through preliminary studies	Small scale trials
	Zero emission haul truck studies	Studies to explore battery electric and renewable diesel trucks with smaller payload for combined zero emission and complementary environmental footprint benefits such as reduced noise, reduced land clearing and enhanced water management.	NA	Progressing through preliminary studies	Small scale trials
	Ongoing truck utilisation and optimisation projects	Continuously reviewing and improving practices regarding payload size, idle times, route optimisation etc. to reduce fuel burn per trip.	Reduce	Ongoing -continuous improvement practice	N/A – operational
Medium term (2030-2035)	Conveyor extension to Holyoake	Extending electric conveyors into the new mining areas to reduce haul truck requirements and associated fuel burn.	Reduce	Under consideration as part of mine plan	Proven system
Longer term (2030 onwards) *Net zero 2050 Alcoa corporate target*	Zero emissions haulage fleet and equipment transition pathways review	Potential to implement lower emissions haulage fleet and equipment transition pathways, if and when commercially favourable, following studies in the short term horizon.	Reduce / avoid*	Pending commercial and technical outcomes of studies	Small scale trials
Ongoing obligation	Surrender offsets as required by the safeguard mechanism	If emissions cannot be avoided or reduced to below the levels required under the safeguard mechanism baselines, carbon credits will be surrendered. These credits will comply with the requirements of the safeguard mechanism.	Offset	Legislative obligation	N/A
* Electrification options may increase scope 2 emissions for a short period; however, this will be mitigated by ongoing decarbonisation of the South West Interconnected Scheme (SWIS).					

Table 10.2 Pinjarra Refinery Scope 1 mitigation options assessed

Target horizons	GHG mitigation option assessed	Description	Mitigation Hierarchy	Current status	Technology Readiness
To 2035 – incremental upgrades to the refinery	Calciner energy efficiency improvements	**Reduction of gas usage through changes** such as: Product hydrate deliquoring prior to feeding calcination filters, to drive calciner feed moisture lower and reduce wash water requirement. Future scope: Additional heat recovery stage (C1A) in calciners. The product hydrate deliquoring is a prerequisite for this scope. Additional low temperature cyclone to remove cold conveying air and reduce energy.	Avoid	Preliminary studies complete. Progressing through pre-feasibility studies.	System validation in relevant environment
	Improved water balance	Improvements in the refinery's water balance to reduce the requirement for evaporation and thus related energy consumption. This could include: Reduced plant dilution from product hydrate deliquoring. Improvements in mud washing circuit to reduce water requirements for caustic recovery. Indirect slurry heaters for bauxite slurry to reduce direct steam injection.	Avoid	Preliminary study phase. Many of the drivers are well understood, but business cases need to be prepared to define the highest impact options.	Readiness differs by initiative. Some are known technology, and some require testing. All require capital investment.
	Partial boiler electrification	Partial displacement of natural gas use for steam generation in the digestion process, with an electrical alternative*	Reduce	Preliminary studies have been completed. Under consideration for further pre-feasibility studies & business case evaluation. In use at Poços de Caldas Refinery.	Commercially available
Ongoing operations beyond 2035 – *Net Zero 2050 Alcoa corporate ambition*	Implementation of step change technologies as they become commercially viable	Research is being conducted to make step changes into the digestion and calcination processes, broadly to electrify fossil fuel heavy processes. These may become commercially available in the late 2030s.	Avoid / reduce	Early stage technology development internally. Continuously monitor externally.	Subsystem validation in laboratory environment
Ongoing obligation	Surrender offsets as required by the safeguard mechanism	Under the SGM, Alcoa will need to retire ACCUs and/or Safeguard Mechanism Credits as appropriate, unless performing below the baseline.	Offset	Legislative obligation	N/A
Note: * Electrification options may increase scope 2 emissions for a short period; however, this will be mitigated by ongoing decarbonisation of the SWIS.					

10.5.2 Change in Carbon Sequestration from Vegetation Clearing

The Proposal's ESD requires a consideration of the GHG emissions and by inference loss of carbon sequestration, associated with land clearing. Any consideration of carbon sequestration needs to factor in the counterbalance associated with Alcoa's extensive rehabilitation activities. Alcoa progressively rehabilitates mined regions in the areas that it operates and has committed that this Proposal will match the rehabilitation of active areas to the area of native vegetation cleared for active areas over a rolling 3 rehabilitation season period across the Huntly Mine (see section 2.4).

Guidance on the GHG accountancy practices associated with forest clearing and rehabilitation is an emerging area, these emissions are currently not captured by NGERs or regulated by the Safeguard Mechanism.

Alcoa has a study underway to estimate emissions from vegetation clearing and carbon sequestration from rehabilitation using the Full Carbon Accounting Model (FullCAM). The study is considering the emerging global and Australian policy frameworks informed in part by:

- GHG Protocol Land Sector and Removals Guidance (2022 draft)
- Australia's National Inventory Methodology
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories & 2019 Refinement
- Clean Energy Regulator's FullCAM Guidelines for Reforestation by Environmental Plantings
- Climate Active Draft guideline (Dec 2023): Accounting for carbon removals from tree plantings.

No clearing is included in the Proposal for the Pinjarra Refinery and therefore emissions related to vegetation clearing are not considered for the refinery component of the Proposal.

10.5.2.1 Initial estimates

As the study is still underway, only initial estimates of net emissions from clearing in 2050 are available for this Proposal and also the cumulative emissions of this Proposal and MMP Proposals (EPA Assessments 2384 and 2385). Alcoa anticipates that a final version of the *GHG Protocol Land Sector and Removals Guidance* will be available later in 2025, as will the 2024 update to the FullCAM model; these will enable further refinement of the initial estimates.

Clearing GHG emissions

Alcoa's clearing GHG emissions comprise disturbance to the carbon stock of the forest, which is conservatively calculated as comprising of:

- Above-ground woody biomass (trunk and branches)
- Below-ground woody biomass (woody roots)
- Forest debris (resistant and decomposable foliage debris).

Further study is underway to understand the influence of the carbon stored in the forest's topsoil, which Alcoa strips and then reuses for rehabilitation.

To calculate the GHG emissions a worst-case scenario was used whereby it was assumed that all the carbon stock would be released to the atmosphere. Since Alcoa no longer burns any cleared forest products, further study is underway to understand potential pathways for direct release to the atmosphere, which relate to how the cleared forest products will be used. Use of the cleared forest products has recently altered following the cessation of native timber harvesting by the Forest Production Commission.

Sequestration by rehabilitation

The GHG emissions from clearing are counterbalanced by the carbon sequestration provided by Alcoa's rehabilitation planting. The sequestration rate varies with the age of the rehabilitation and Alcoa has used the forest growth rate simulated in the FullCAM model. As described at the start of Section 10.5.2, cleared areas will be matched by rehabilitated areas elsewhere within the Huntly Mine.

Net GHG emissions from clearing

Net GHG emissions from clearing have been initially estimated from a consideration of the hectares of clearing potentially undertaken in each year across the Proposal's 20 year life, and the assumption that the same amount of rehabilitation would be completed in the same year elsewhere within the Huntly Mine. The total sequestration of a year's rehabilitation was estimated over the period starting from the year of planting up until 2050.

For the clearing for the Proposal the net GHG emissions as of 2050 are estimated to be 2,806,640 tCO2e. This deficit is estimated to turn positive (rehabilitation sequestration exceeds clearing emissions) in around 2077-2078.

For the clearing for the Proposal and Assessments 2384 and 2385 the cumulative net GHG emissions as of 2050 are estimated to be 3,278,208 tCO2e. This deficit is estimated to turn positive (rehabilitation sequestration exceeds clearing emissions) around 2075-2076. The date occurs sooner due to rehabilitation associated with Assessments 2384 and 2385 having already commenced.

10.6 Scope 2 emissions

The forecast scope 2 emissions from electricity consumption are calculated using SWIS location based NGER 2024/25 emission factor (0.51 t CO2e/MWh), however this is likely to decline over the 20 year Proposal period.

The efficiency method (WRI and WBCSD, 2006) is used to allocate emissions between electricity and steam produced at Alinta Pinjarra to estimate the scope 2 emissions from steam (heat) use for Pinjarra Refinery. Using this method, the emission intensity for the steam varies based on a number of factors, including the comparative amounts of steam and electricity generated, an average of previous years has been used.

Scope 2 emissions for the Huntly Mine are not expected to exceed 100,000 t CO2e in any year based on the current mine plans.

At the Proposal's alumina production rate of 5.25 Mtpa, the scope 2 emissions from the refinery are estimated to be approximately 600,000 t CO2e per year.

Electrification of processes to reduce scope 1 emissions at both the mine and refinery may increase scope 2 emissions for a short period, however this will be mitigated by ongoing decarbonisation of the SWIS and potential renewable energy options.

10.6.1 Mitigation measures

Alcoa has assessed potential mitigation options to reduce scope 2 enabled by internal and sectoral mechanisms for the Pinjarra Refinery, these are outlined in Table 10.3.

Table 10.3 Scope 2 emissions mitigation options assessed for Pinjarra Refinery

Target horizons	GHG mitigation option assessed	Description	Mitigation Hierarchy	Current status	Technology Readiness
To 2035 – incremental upgrades to the refinery	Behind the meter renewable generation	Direct connection PPA renewable projects.	Reduce	Progressing through internal Alcoa processes.	Commercially available
	Two-stage blowers	Electricity reduction by running calciners on a combination of high and low pressure blowers.	Avoid	Has been previously installed on one calciner. Progressing through pre-feasibility studies for expansion.	Proven system
Ongoing obligation and passive decarbonisation	Decarbonisation of the SWIS	Increased renewable electricity generation in the SWIS will reduce scope 2 emissions. See more detailed description below, including how the refinery and mine are contributing.	Reduce	Regular coordination with grid planning bodies regarding load.	N/A

10.6.2 Electricity

Scope 2 emissions from electricity consumption are expected to decline over the life of the Proposal with new large and small-scale renewable electricity incentivised via the federal Renewable Energy Target until 2030, and comparative costs for renewable electricity declining. In August 2023 the State and Federal Governments announced up to $3 billion in funding from Rewiring the Nation for upgrades to the Western Australian electricity grids to support decarbonisation (WA Government 2023). A significant decrease in scope 2 emissions is expected after 2030, following the closure of the two state-owned coal-fired power (WA Government 2022).

Pinjarra Refinery and Huntly Mine can be called upon to participate in the Reserve Capacity Mechanism. Under this mechanism, large electricity consumers can be required to reduce demand from the electricity network when demand for electricity is high. This typically happens in the afternoon on the hottest days of the year. This role in balancing the grid supports higher renewable capacity in the SWIS, as the facilities can perform the firming services typically provided by fossil fuel generators that don't require the sun to be shining or the wind blowing to produce electricity. This helps support efficient investment in electricity infrastructure and avoids additional costs of electricity generation to cover events that only occur a few times a year.

Alcoa recently commissioned a study to evaluate installing renewable energy sources (wind and solar) on Alcoa's freehold land around our operations (Resource WA 2023). The findings from this study will help to inform future renewable energy projects, including those required to support electrification.

10.6.3 Steam

Alinta Pinjarra, as a grid connected generator, is covered by the sectorial baseline under the safeguard mechanism. This baseline type does not decline like standard baselines. With the ongoing closures of the state-owned coal-fired power stations this decade, natural gas fired power stations like Alinta Pinjarra will likely be increasingly required for firming the SWIS to support the reduction in baseload capacity and the increasing 'duck' curve of electricity use[2]. Therefore, although scope 2 steam emissions may not decrease like grid-based scope 2 emissions, Alinta Pinjarra will play an important role in the grid decarbonisation, anchoring demand and supporting the stability of the overall grid.

Alinta Pinjarra utilises cogeneration technology to improve fuel efficiency to produce scope 2 steam for Pinjarra Refinery, and electricity which is exported to the SWIS. In standard electricity generation, the energy in the medium pressure steam and condensate is lost as waste heat. At Alinta Pinjarra the waste heat from the electricity generation is harnessed in a Heat Recovery Steam Generator (HRSG) rather than going to stack/atmosphere. Low temperature condensate from the Alcoa Refinery is sent to the Alinta heat recovery steam generator (HRSG) and returned as superheated steam (see Figure 10-2). This steam is used to offset the Alcoa steam boiler generation while still maintaining turbo-alternator electricity generation that is vital to the refinery process; overall this allows for a marked reduction in gas consumption.

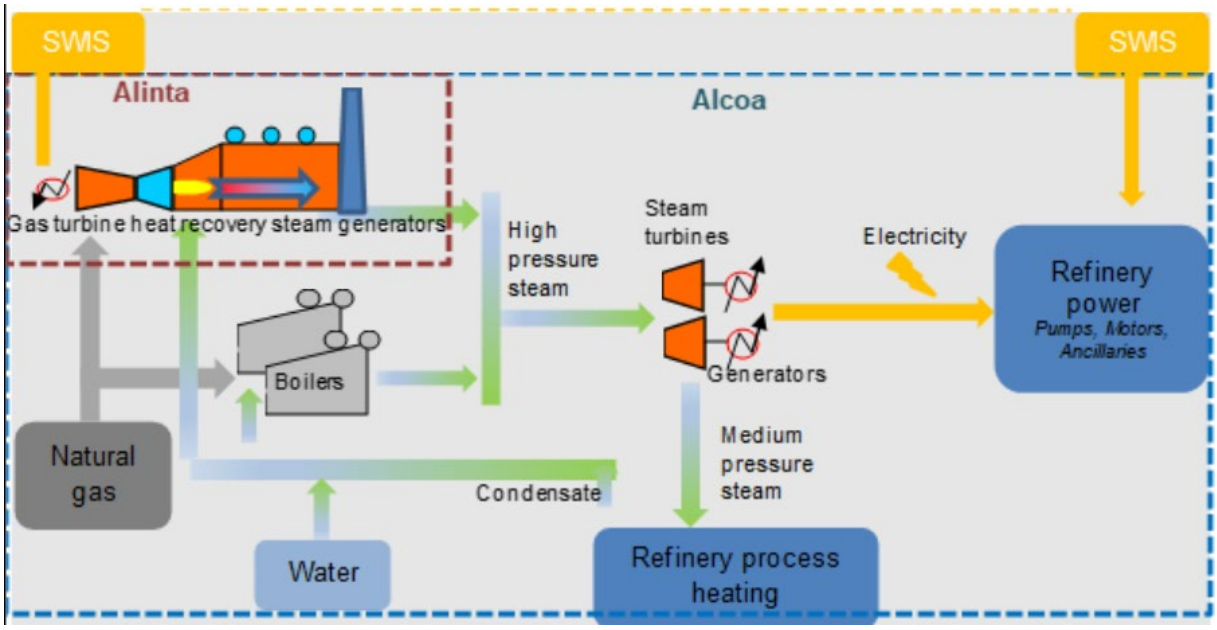

Figure 10-2 Cogeneration process at Pinjarra Refinery

[2] A 'duck' curve refers to a graphical representation of the imbalance between peak electricity demand, the head and the tail of the duck, and solar power generation when grid demand is low, the body of the duck. https://www.synergy.net.au/Blog/2021/10/Everything-you-need-to-know-about-the-Duck-Curve

10.7 Scope 3 emissions

Scope 3 emissions were estimated using the Greenhouse Gas Protocol (WRI and WBCSD 2011) methodology for the categories listed in the table below. Other scope 3 categories were not included due to their relatively minor nature and the degree of assumptions needed in the calculations or for category 11 (use of sold products), due to the wide range of potential products with very different emissions, such as drink cans compared to an aeroplane panel. The ability of aluminium to be infinitely recycled also affects the ability to calculate downstream scope 3 emissions. The categories used here, along with the reported scope 1 and 2 emissions, are consistent with the International Aluminium Institute's (IAI) cradle-to-gate primary aluminium life cycle assessment (IAI, 2022).

Table 10.4 below presents scope 3 emissions for Huntly Mine and Pinjarra Refinery separately, which include the scope 1 and 2 emissions from the other facility and scope 3 emissions that apply to both facilities. For Huntly Mine, the scope 3 emissions estimates are also included for bauxite refined at Alcoa's Kwinana Refinery. This facility is currently fully curtailed for alumina production; however, the port facilities continue to be used to export alumina produced at Pinjarra Refinery and Alcoa will continue to monitor the many factors that led to the curtailment decision and assess options for the long-term future of the refinery.

Combined, the scope 3 emissions estimate for Huntly Mine and Pinjarra Refinery is 47.409 million (M)t CO_2e (this figure is not simply the arithmetic sum of the Scope 3 emissions from mine and the Refinery, as that would involve elements of double counting).

Alcoa's integrated mining and refining system in Western Australia minimises scope 3 emissions from transport as the refining occurs within 100 km of mining, significantly reducing the volumes required to be transported over long distances compared to raw bauxite. As both Pinjarra and Kwinana refineries are predominately fuelled by natural gas, rather than coal as occurs at many other global refineries, this also reduces the Huntly Mine's scope 3 emissions.

The most significant scope 3 emissions for bauxite and alumina are related to downstream processing. These will significantly decrease as aluminium smelters are increasingly powered by renewable electricity, as is occurring globally.

Table 10.4 Scope 3 emissions for Huntly Mine and Pinjarra Refinery

Cat.	Description	Inclusions	Comments	Huntly			Pinjarra		
				Scope 3 total (Mt CO_2e)	Scope 3 in WA (Mt CO_2e)	Scope 3 (t CO_2e/ t bauxite)	Scope 3 total (Mt CO_2e)	Scope 3 in WA (Mt CO2e)	Scope 3 (t CO_2e/ t alumina)
1	Purchased goods and services	Bauxite, lime and caustic	Bauxite is calculated using the average scope 1 and 2 and maximum upstream scope 3 intensities forecast for the Proposal. Lime and caustic are the most emission intensive purchased goods used in significant quantities at the Refinery (not included in category 3). Estimated using emission intensities from the GaBi database.	N/A	N/A	N/A	1.077	156	0.205
3	Fuel and energy related activities (not included in scope 1 and 2)	Fossil fuels and electricity import	Estimated using scope 3 factors from the National Greenhouse Account Factors (DCCEEW, 2024c).	.001	<0.1	<0.001	0.200	198	0.038
9	Downstream transportation and distribution	Rail transport of bauxite from Pinjarra Refinery to Kwinana Refinery. Rail transport of alumina from Pinjarra Refinery to Alcoa's Kwinana or Bunbury ports. Sea transport of alumina from to smelting customers	Estimated using the default emissions intensity values for rail transport of bulk freight on a non-dedicated line and bulk freight water transport from safeguard mechanism. The sea transport distance is an average value based on potential customers.	0.385	0.018	0.015	0.271	8	0.052
10	Processing of sold products	Alumina refining and aluminium smelting	For Huntly, scope 3 emissions from refining used the refinery emission rates including upstream scope 3 (minus bauxite). For downstream smelting for both sites, the 2022 IAI (2023) cradle to gate intensity for anode production, electrolysis (minus transport) and casting of 12.2 t CO_2e/t aluminium (Al) was used in the estimation. Due to differing electricity sources the emissions intensity of global aluminium smelters ranges from <2 to ~20 t CO_2e/t Al creating the greatest potential source of variation in the scope 3 calculations. Kwinana Refinery produced some alumina for use in chemical applications and not for metal production, therefore this is excluded from the emissions from smelting estimation for Huntly.	49.366	3.975	1.895	33.709	0	6.421
	Total			49.409	3.993	1.910	35.257	362	6.716

To further reduce downstream emissions, as a fully integrated aluminium business, Alcoa Corporation is investing in technology development to decarbonise the aluminium industry. The technology roadmap includes three key innovations, ELYSIS™, Refinery of the Future (RoF), and ASTRAEA™ (Alcoa Corporation 2022).

- **ASTRAEA™** Probably the most effective way to avoid emissions with aluminium production is to recycle it. Aluminium is already infinitely recyclable, and Alcoa is working to recycle even more of it. Alcoa has patented technology called ASTRAEA™ that can purify low-value automotive scrap, removing impurities to make aluminium with higher purity than commercial-grade metal produced at a smelter.
- **ELYSIS™** Regarding our Smelting business, Alcoa is in a joint venture to commercialise ELYSIS™, a process that emits oxygen as a by-product and eliminates all the scope 1 greenhouse gas emissions associated with traditional smelting. This innovation involves replacing the carbon anodes used in traditional aluminium smelting with inert, proprietary materials. ELYSIS™ is a partnership between Alcoa and Rio Tinto, facilitated by Apple with funding support from the Canadian and Quebec Governments.
- **Refinery of the Future** Alcoa's global alumina refinery portfolio, including its Western Australian operations, already has the lowest carbon footprint among global producers. Despite this, the alumina refining processes are hard to abate emissions, owing in part to the scale of energy requirement, energy intensity and inherent complexity. Today, its existing facilities are reliant on natural gas for both process heat and internal electricity generation. Refinery of the Future is investigating decarbonisation, fresh water use reduction and bauxite residue elimination opportunities for alumina refining. The work includes research and development of Electric Calcination with support from the Australian and Western Australian governments. The final stage in the alumina refinery process, calcination, currently uses fossil fuels such as natural gas to heat alumina hydrate crystals to remove water molecules. A pilot project planned at Pinjarra Alumina Refinery, will use renewable energy to drive the calciner - eliminating carbon emissions and allowing residual energy currently lost to the atmosphere as steam to be captured and reused.

Also, as a strong and lightweight material that can be infinitely recycled, aluminium can help significantly reduce GHG emissions and energy consumption. Aluminium products contribute to the decarbonisation of society through the light weighting of vehicles, improved energy efficiency of buildings, preservation of food and beverages and many other ways. Alcoa has committed to expand its SUSTANATM line of low carbon products and develop and/or enhance other low carbon products, to support its customers in reducing their carbon footprint. One of the products in this line is EcoSourceTM, alumina with carbon emissions (scope 1 and 2 mining and refining) less than half of the industry average (Alcoa Corporation 2023).

The Safeguard Mechanism will support the reduction of most of Huntly Mine and Pinjarra Refinery's Australian scope 3 emissions. As shown in Table 10.4 the majority of scope 3 emissions occur in other jurisdictions, some with established emission reduction schemes such as Europe and Quebec, and others such as the People's Republic of China are still developing, with the electricity sector covered and expansion to industry, including aluminium, expected in the coming years. Some aluminium producing regions, including some developing nations, are yet to set limits for industry.

10.8 Environmental outcomes

Alcoa considers that the legislative requirements of the Safeguarding Mechanism will adequately regulate the Proposal's reduction in non-clearing related net scope 1 emissions, with standard regulatory reporting requirements (NGER) already in place. Alcoa does not consider additional conditions are required to ensure consistency with the EPA's environmental factor objective for Safeguarding Mechanism regulated scope 1 greenhouse gas emissions.

Alcoa will continue to refine its estimates of non-Safeguarding Mechanism scope 1 emissions and take appropriate actions to align with the WA Government's policy objective and the EPA's expectation, that major projects will achieve net zero scope 1 GHG emissions by 2050.