

Appendix I

Greenhouse Gas Assessment – Refinery

PACIFIC ALUMINIUM



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Katherine to Gove Gas Pipeline

Greenhouse Gas Assessment of the Pacific Aluminium Gove Alumina Refinery

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EXECUTIVE SUMMARY

Pacific Aluminium (a business unit of Rio Tinto) owns and operates a bauxite mine and alumina refinery at Gove, 650 kilometres (km) east of Darwin in north east Arnhem Land, Northern Territory. The Gove mine and refinery produce high grade alumina which is then shipped to other locations for smelting and further processing.

Power and steam for the Gove Refinery and mining operations are currently generated from imported fuel oil. In order to reduce fuel oil consumption and improve operating costs at the Refinery, it is proposed to provide the facility with natural gas as an alternative fuel source. The lower cost natural gas will help underpin the long term operating viability of the Refinery.

This document provides a high level Greenhouse Gas (GHG) inventory review and assessment for the current and future operations relevant to the change in fuel source from imported fuel oil to natural gas.

The assessment undertaken includes the operational GHG emissions. GHG emissions for direct Scope 1 and relevant Scope 3 activities were assessed. The key Scope 3 GHG emissions arose from HSFO and LSFO fuel importation from the Middle East.

Based on existing operation, the total Scope 1 and 3 GHG emissions are 2,093,600 tonnes CO₂-e per annum. Subsequent to the fuel switch, the total Scope 1 and 3 GHG emissions are 1,715,475 tonnes CO₂-e per annum. Including GHGs from operating the natural gas pipeline, the net GHG savings are approximately 336,110 tonnes CO₂-e per annum.

GHG emissions from commissioning and decommissioning activities are relatively minor compared with annual GHG emissions from refinery operations.

It is expected that the refinery conversion will be complete by 2015. In its current form, the Carbon Pricing Mechanism has set a price on Scope 1 GHG emissions of \$25.40 per tonne CO₂-e. The benefit of the conversion purely in terms of carbon price is that it will reduce the covered Scope 1 GHG emissions by approximately 10% or 182,000 tonnes CO₂-e (taking into account the pipeline operations GHG emissions). This equates to a carbon price benefit of \$4,622,800. GHG emissions will continue to be annually reported under the NGER Act. It is expected that Pacific Aluminium will continue to participate in the Carbon Pricing Mechanism and also in the EEO Program.



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1 INTRODUCTION

Pacific Aluminium (a business unit of Rio Tinto) owns and operates a bauxite mine and alumina refinery at Gove, 650 kilometres (km) east of Darwin in north east Arnhem Land, Northern Territory. The Gove mine and refinery produce high grade alumina which is then shipped to other locations for smelting and further processing.

Power and steam for the Gove Refinery and mining operations are currently generated from imported fuel oil. In order to reduce fuel oil consumption and improve operating costs at the Refinery, it is proposed to provide the facility with natural gas as an alternative fuel source. The lower cost natural gas will help underpin the long term operating viability of the Refinery.

The Katherine to Gove Gas Pipeline (KGGP) is proposed to deliver natural gas from the existing NT Amadeus Gas Pipeline at a point approximately 20 km south of Katherine, to the Gove Refinery. The KGGP would be a high pressure, steel pipeline approximately 603 km long with a nominal diameter of 300mm and a design operating life of 50 years. It will also include above ground facilities at specific locations along the route such as metering facilities, scraper stations, mainline valves and a compressor station. The supplied gas from the Amadeus Pipeline is sales quality so no additional processing of gas would be required. The pipeline would be constructed within a 30 m wide construction corridor and would include supporting infrastructure such as temporary work camps and equipment access tracks to facilitate construction activities.

This document provides a high level Greenhouse Gas (GHG) inventory review and assessment for the current and future operations relevant to the change in fuel source from imported fuel oil to natural gas. GHG savings are expected to arise from the change. These benefits are facilitated by the construction and operation of the Katherine to Gove Gas Pipeline (KGGP) and therefore relevant for consideration within the draft EIS for the KGGP project.

1.1 Scope of assessment

The GHG inventory review and assessment was undertaken in accordance with the principles outlined in the Greenhouse Gas Protocol and the methodologies provided by the Australian Government's *National Greenhouse and Energy Reporting (Measurement) Determination 2008*, 30 June 2012 version.

Of the six Kyoto Protocol GHGs, CO₂, CH₄ and N₂O are considered relevant to the fuel switch and included in the assessment. CO₂ is the most relevant gas. All results are reported in units of tonnes CO₂-equivalent.

The following sources have been accounted for in the assessment:

- The business as usual operation of the current refinery operations relevant to the conversion - utilising HSFO fuel.
- Commissioning of the reticulation pipeline – purging with natural gas.



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- The operation of the refinery using natural gas using LSFO in the initial years of operation.
- Fugitive gas emissions from the reticulation system.
- Gas venting (maintenance and emergency shutdowns).
- The indirect GHG emissions of shipments of HSFO and LSFO, assuming both fuels are imported from the Middle East.
- Decommissioning the reticulation pipeline – venting gas to the atmosphere.

The assessment considers Scope 1 GHG emissions, which arise from the direct combustion of HSFO and LSFO fuels and natural gas required to operate the refinery. Scope 3 emissions which arise from the extraction, production of all fossil fuels, and the shipment of fuels to the GOPA refinery. These GHG emissions Scopes are defined in Section 2.



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2 GREENHOUSE GAS ACCOUNTING METHODOLOGY

The GHG inventory assessment was performed based on the principles outlined in the Greenhouse Gas Protocol and the methodologies provided by the Australian Government's *National Greenhouse and Energy Reporting (Measurement) Determination 2008*, 30 June 2012 version.

The guiding principles for compiling a GHG inventory are:

- Relevance;
- Completeness;
- Consistency;
- Transparency; and
- Accuracy.

Specifically, the GHG Protocol advocates defining a reporting boundary for an inventory, and subsequently segmenting the GHG producing sources within that boundary according to their scope.

The scopes of these GHG emissions are defined as:

- Scope 1 GHG emissions, which are produced directly from combustion of purchased liquid, solid or gaseous fuels, or fugitive emissions of GHGs, within the activity's boundary.
- Scope 2 GHG emissions arise from imported electricity, heat and steam. These emissions are generated outside of the activity's boundary.
- Scope 3 GHG emissions are related to the activity but arise from sources beyond the activity's reporting boundary (i.e. up and down the corporations supply chain or the raw materials and products of a process).
- Scope 3 GHG emissions associated with the extraction, processing and transport of purchased fuels are considered relevant for the present assessment.

These sources are subsequently estimated in terms of quantities of fuels and electricity consumed. These quantities are multiplied by the appropriate emission factors to generate GHG emission quantities.

Note that of the six Kyoto Protocol GHGs, only CO₂, CH₄ and N₂O are included within this assessment. Hydrofluorocarbons, Perfluorocarbons and Sulphur hexafluoride emissions are not considered relevant to the fuel switch. Ozone depleting chemicals such as chlorofluorocarbons are generally used as air conditioning gases, refrigerants and fire extinguishers. Strict regulations have been imposed on the use of ozone depleting chemicals under the Montreal Protocol. It is assumed that GOPA has minimal volumes of these compounds and hence their emissions should be negligible.

CO₂ is the most relevant gas. All results are reported in units of tonnes CO₂-equivalent.



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3 GHG INVENTORY AND EMISSIONS FORECASTS

The GHG inventory for activities arising out of the existing and proposed operations of the refinery is detailed in Table 1.

Table 1: Summary of GHG Emissions

GHG emission activity	Fuel Consumed per annum	Annual GHG emissions (tonnes CO ₂ -e/yr)
<i>Existing operations</i>		
Scope 1 HSFO consumption under business as usual operations	623,756 tonnes	1,931,544
Scope 3 Fuel consumed in shipping HSFO from the Middle East (Scope 3)	7,490 tonnes N/A	21,872 140,170
Extraction and processing of fuels		
Total (Scope 1 + Scope 3)		2,093,586
<i>Post Refinery conversion to natural gas</i>		
Scope 1 Natural gas consumed under business as usual operations	33,410,000 GJ 10,162 tonnes	1,674,509 32,254
LSFO consumed as backup fuel under business as usual operations	9.35 tonnes	100
Vented gas	20.1 tonnes	418
Fugitive gas emissions		
Scope 3 Fuel consumed in shipping LSFO from the Middle East	2,013 tonnes bunker fuel N/A	5,880 2,315
Extraction and processing of fuels		
Total (Scope 1 + Scope 3)		1,715,475



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On the basis of the combined Scope 1 and 3 GHG emissions associated with operating the refinery, switching from HSFO to natural gas will reduce GHG emissions by approximately 378,110 tonnes CO₂-e per annum. The GHG emissions associated with operating the natural gas pipeline was estimated to be 42,000 tonnes CO₂-e per annum, primarily from running an inline gas compression turbine with a smaller contribution from pipeline maintenance venting. The net Scope 1 GHG savings are approximately 336,110 tonnes CO₂-e per annum.

The once-off GHG emissions from commissioning and decommissioning activities are shown in Table 2.

Table 2: GHGs Emissions from Gas Venting in Commissioning and Decommissioning activities

GHG emission activity	Total mass of gas vented (kg)	GHG emissions (tonnes CO ₂ -e)
Commissioning – natural gas purge to remove air/moisture from lines	8,660	158
Decommissioning – inert gas purge to remove natural gas from lines	8,660	158

The GHGs from commissioning and decommissioning activities are relatively minor compared to annual operational GHG emissions.



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4 GHG MITIGATION MEASURES

Pacific Aluminium has participated in the first and second assessment cycles of the Energy Efficiency Opportunities (EEO) Scheme. Several energy efficiency projects have already been implemented saving several PJs of energy.

The following measures are based on opportunities identified in EEO reports and are related to reducing steam consumption, thereby reducing gas usage and GHG emissions.

- Switching from HSFO to natural gas – this will mitigate GHG emissions by 336,110 tonnes CO₂-e per annum.
- Carrying out regular corrosion and leak detection monitoring, and regular patrols to check for leaks and undertake prompt repairs.
- Carrying out regular energy audits, particularly around steam generation.
- Repairing leaking and faulty steam traps to reduce steam losses.
- Reducing steam consumption through use of waste heat or improved heat transfer.
- Running live steam heaters using lower pressure steam to improve the efficiency of power generation.
- During commissioning activities, minimise the volume of gas used to purge the reticulation and branching lines of air and moisture.
- During decommissioning activities, minimise the volume of gas vented when purging the reticulation and branching lines of natural gas.



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5 CONCLUSION

Based on existing operation, the total Scope 1 and 3 GHG emissions are 2,093,600 tonnes CO₂-e per annum. Subsequent to the fuel switch, the total Scope 1 and 3 GHG emissions are 1,715,475 tonnes CO₂-e per annum. Including GHGs from operating the natural gas pipeline, the net GHG savings are approximately 336,110 tonnes CO₂-e per annum.

GHG emissions from commissioning and decommissioning activities are relatively minor compared with annual GHG emissions from refinery operations.

It is expected that operations on natural gas will commence by 2015. In its current form, the Carbon Pricing Mechanism has set a price on Scope 1 GHG emissions of \$25.40 per tonne CO₂-e. The benefit of the fuel switch purely in terms of carbon price is that it will reduce the covered Scope 1 GHG emissions by approximately 10% or 182,000 tonnes CO₂-e (taking into account the pipeline operations GHG emissions). This equates to a carbon price benefit of \$4,622,800. GHG emissions will continue to be annually reported under the NGER Act. It is expected that Pacific Aluminium will continue to participate in the Carbon Pricing Mechanism and also in the EEO Program.



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6 REFERENCES

National Greenhouse and Energy Reporting (Measurement) Determination 2008 (2012 Amendment)

World Business Council for Sustainable Development and the World Resource Institute 2004, The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.

Trans Territory Underground Pipeline, Wadeye to Gove in the Northern Territory, Draft Environmental Impact Statement, November 2004. Section 5. <http://nretas-web01.squiz.net/ntepap/dev/environmental-assesments/assessment/register/tppipeline/draft>

Alcan Gove Alumina Refinery, Draft Environmental Impact Assessment, Section 8, Air Quality, URS, 2004.

US EPA, 2012, <http://www.epa.gov/oaqps001/sulfurdioxide/health.html> (accessed 11 April 2013).