9.0 Greenhouse Gas

9.1 Alcan's Greenhouse Strategies

Alcan has made steady progress over the last decade in reducing greenhouse gases associated with climate change. It has committed to a number of strategies to address climate change including:

- TARGET (Targeting Climate Change);
- Life Cycle Analysis; and
- Greenhouse Challenge Agreement.

9.1.1 Targeting Climate Change

In 2000, Alcan Inc, Alcan Gove's parent company developed TARGET which is world-wide company initiative to address greenhouse gas emissions. The goal of the program is to accommodate economic growth, to embed an emissions reduction philosophy throughout the company, and to optimise the potential for long-term, cost effective reduction and ongoing reporting of greenhouse gas emissions.

During the implementation year of TARGET, an initial company-wide greenhouse gas inventory was developed. Based on these data, a cumulative reduction objective of 500,000 tonnes (t) of CO_2 equivalent (CO_2e) for the 2001 – 2004 period was established. This objective was then extended to include a further 0.5% reduction (approximately 125,000 tonnes of CO_2e) for 2005.

In 2001, the first year of the program, Alcan's global operations reduced greenhouse gas emissions by some 1.1 million tonnes of CO_2e, or 5% from 1999 levels on a growth adjusted basis. In 2002, this performance improved with further reductions of 1.8 million tonnes (Mt). This achievement surpassed both the annual and four-year objectives. As part of the program's rolling objectives, future commitments will be established annually.

This performance was achieved through numerous and accelerated greenhouse gas reduction initiatives including improvements in process technology and energy efficiency. The greenhouse gas emissions per tonne of aluminium produced by Alcan dropped by 15% of 1999 levels by the end of the second year of the program.

A senior management steering committee oversees the TARGET program and provides guidance and support. All Alcan sites (including Alcan Gove) are committed to TARGET implementation with site coordinators developing and implementing reduction programs to assist with achievement of the TARGET goals. Greenhouse gas improvements are a key performance indicator for all Alcan operations.

At present, the world-wide average from alumina refineries is 991 kg of greenhouse gases emitted per tonne of alumina produced (International Aluminium Institute, 2003). Alcan Gove is currently well below this average at 780 kg/t of alumina produced. One of the main reasons for Alcan Gove's relatively low rate of greenhouse gas generation is its highly efficient cogeneration steam power station where high pressure steam from the power station's boilers is initially used to drive turbines to generate electricity. Following this, the steam emerges from the turbines at low pressure and is then distributed throughout the refinery for heating and process purposes. Reuse of the steam in this way is an efficient way of reducing the refinery's overall energy demand.

In 2002, Alcan Gove achieved a 0.4% reduction in CO_2 emissions per tonne of alumina. For each tonne of production, 0.779 t of CO_2 were emitted compared to 0.782 t in 2001. A number of projects contributed to this achievement including:

- A 1.3% increase in the amount of hot condensate returned to the steam power station. When hot condensate is lost from the system or diverted for another purposes, it is replaced with cold water that must be treated and heated, consuming additional energy.
- Use of a steam management model to monitor, further prioritise and control team users, allowing more efficient use of steam and management of the demand on the stem power station.

9.1.2 Life Cycle Analysis

Aluminium plays a significant role in reducing greenhouse gas emissions due in part to its recyclability and its use in certain applications such as transportation (approximately 75% of the aluminium used in cars today is recovered and recycled). Producing new metal from used aluminium saves 95% of the primary aluminium production energy requirements and greenhouse gas emissions.

Alcan is committed to undertaking life cycle analysis of projects. The International Aluminium Institute is working to complete a full life cycle analysis covering the main applications of aluminium. The Aluminium Institute in the 'Aluminium Industry's Sustainable Development Report' states that the real impact on the environment from the production of aluminium can be identified from a full cradle-to-grave life cycle analysis providing the example of recycling aluminium beverage cans. The recycling of aluminium beverage cans reduces greenhouse gas emissions by over 150 kg for every 1,000 cans recycled compared to emissions from aluminium sourced from primary aluminium smelters. In 2001, Alcan recycled approximately 40 billion used aluminium beverage cans. This recycling lead to a reduction of 6 Mt of CO_2e emissions over an equivalent amount of aluminium sourced from primary aluminium smelters.

The aluminium life cycle has significant benefits in terms of greenhouse gas emissions. For example, lightweight aluminium designs for vehicles improve vehicle performance by lowering fuel consumption. Every 10% reduction in vehicle mass provides a 6 to 8% improvement in fuel economy. Aluminium is 100% recyclable and every tonne of aluminium used in place of steel eliminates 20 t of greenhouse gas emissions over the average life of a motor vehicle. Alcan is heavily involved in the development of lighter weight, energy efficient vehicles, having established a number of partnerships with major vehicle manufacturing companies around the world.

9.1.3 Greenhouse Challenge

In addition to Alcan's TARGET program, Alcan Gove is a signatory to the Australian Government's Greenhouse Challenge Program. Alcan Gove has held co-operative agreements with the Commonwealth Government since May 1997. As a result, Alcan Gove is committed to quantifying emissions and developing action plans for limiting greenhouse gas emissions. Alcan Gove submits annual reports to the Australian Greenhouse Office on performance against emission management targets.

As part of its commitment to the Challenge Program, Alcan Gove has significantly reduced specific emissions of carbon dioxide (CO_2) per tonne of alumina produced since 1990. Since then, the greenhouse emission per tonne of alumina produced has been reduced by more than 11%. The reduction in emissions between the 2001 and 2002 years was 0.4%.

An energy review committee which formed at Gove in the mid 1990s monitors energy use and reviews energy saving projects at the mine, refinery and township. For last year, these energy saving projects included:

- A saving of 10,000 t CO_2 per annum by addressing digestion related steam venting losses.

- The installation of water meters across the refinery has enabled excessive water consumption to be targeted. This has resulted in a 25 m^3/h reduction in water use as well as the associated savings in energy from reduced pumping requirements.
- New steam export metering devices have been installed at the steam power station on lines to process areas. These meters enable better measurement of the distribution of steam resulting in energy saving projects by improving energy efficiencies.
- A modification to the insulation to be used in town housing has produced power savings. Also the committee is monitoring a housing trial using a split system air conditioner and solar hot water unit with potential power savings of up to 60% expected.

9.2 Government Strategies

9.2.1 Northern Territory Greenhouse Strategies

The NT Greenhouse Policy Framework provides guidance for the development of a Northern Territory Strategy for Greenhouse Action. The Strategy will build on the 1993 NT Greenhouse Strategy and the 2000 NT National Greenhouse Strategy Implementation Plan. The Strategy will provide a Territory based response to greenhouse gas emissions and adaptations to climate change.

In accordance with the requirements of the NT Greenhouse Policy Framework, the NT government recently released the paper, 'Developing a Strategy for NT Greenhouse Action' which seeks input from community, government and non-government stakeholders to develop a comprehensive strategy for greenhouse action for the NT. Alcan Gove is providing input into this process.

9.2.2 Australian Greenhouse Strategies

9.2.2.1 National Greenhouse Strategy

The 1998 National Greenhouse Strategy (NGS) extends the program of action launched by governments in Australia through the 1992 National Greenhouse Response Strategy. The Australian approach is based on voluntary action. The Strategy contains measures that different governments are pursuing through a variety of policy approaches. As a result, the Commonwealth, State and Territory governments have prepared implementation plans.

The 2000 Progress Report is the latest document detailing progress with the NGS. In summary, the following progress has been made:

- The Commonwealth Government has committed to implement measures including:
  - Legislation to require that, by 2010, Australia sources an additional 9,500 gigawatt hours (GWh) of electricity from renewable sources;
  - Minimum energy performance standards for equipment and appliances, as well as pursuing the incorporation of energy efficiency measures into the Building Code of Australia;
  - New power station energy efficiency standards; and
  - Innovative Bush for Greenhouse Program and Plantations-2020 Vision Program.

- State and Territory Governments have implemented a variety of measures. The Northern Territory's initiatives are detailed in the Northern Territory Greenhouse Policy Framework, the 1993 Northern Territory Greenhouse Strategy, and the 2000 Northern Territory National Greenhouse Strategy Implementation Plan.

9.2.2.2 Greenhouse Challenge Program

The cornerstone of the National Greenhouse Strategy is the Greenhouse Challenge Program, managed by the Australian Greenhouse Office (AGO). The Greenhouse Challenge Program was launched in 1995 and is a joint voluntary initiative between the Commonwealth Government and industry to reduce greenhouse gas emissions. It requires participating organisations to sign agreements with the Government. The agreements detail a process for undertaking and reporting on actions to reduce greenhouse gas emissions from their operations.

Alcan Gove is a signatory to the Greenhouse Challenge Program.

9.2.3 International Arrangements

The Kyoto Protocol is an international treaty designed to limit global greenhouse gas emissions. Many parties to the United Nations Framework Convention on Climate Change (UNFCCC), including Australia, have signed the Protocol since negotiations were concluded at the third Conference of the Parties to the UNFCCC (COP3). The Kyoto Protocol was developed at COP3, held in Kyoto, Japan, in December 1997.

Before it can be considered binding, the Protocol must first be ratified by at least 55 of the countries listed in Annex I to the UNFCCC (generally the developed countries). This must also include enough countries to account for at least 55% of the total 1990 CO_2 emissions of the Annex I countries.

Annex B of the Kyoto Protocol lists the greenhouse gas emission reduction commitments for the developed countries. Commitments are expressed as a percentage of the base year emissions (in most cases the base year is 1990). They are a target for average annual emissions during the commitment period from 2008-2012, termed the First Commitment Period. At COP3, Australia accepted a target of 108% of its 1990 emissions, one of the only nations in the developed world to achieve an allowed increase in greenhouse gas emissions. This was in recognition by the international community of the fact that many Australian industries are energy intensive and that the greenhouse benefit from using Australian products often occurs in other countries.

While Australia has not ratified the Kyoto Protocol, there has been commitment both nationally and at the state and territory level to a reduction of greenhouse gas emissions in line with the Kyoto Protocol commitments.

9.3 Greenhouse Gas Effects of Refinery Expansion

Energy consumption for the existing operation occurs through the use of a highly efficient fuel oil-fired cogeneration steam power station that supplies steam to the refinery and electric power to both the plant and nearby community.

The annual energy consumption for the existing refinery (2.0 Mt/y) and the expanded refinery (both gas and oil fired) including production optimisation (3.8 Mt/y) is detailed in Table 9.3.1. This includes the energy consumed by the refinery, mine, and residential communities.

Table 9.3.1
Energy Consumption

Energy Source	Annual Energy Consumption (PJ/y)		
	Existing Refinery	Expanded Refinery (Gas)	Expanded Refinery (Fuel Oil)
Fuel Oil – Steam Power Station	14.2	-	26.5
Fuel Oil – Calcination	7.6	-	11.7
Fuel Oil – Lime Plant	0.2	0.4	0.4
Fuel Oil – Liquor Purification	-	-	1.8
Diesel - On-site transport	0.35	0.45	0.45
Natural Gas – Steam Power Station	-	27.2	-
Natural Gas – Calcination	-	12.8	-
Natural Gas – Lime Plant	-	-	-
Natural Gas – Liquor Purification	-	1.9	-
Total	22.35	42.75[1]	40.85[1]

[1] *Natural gas is approximately 5% less energy efficient than fuel oil*

In order to ascertain the total greenhouse gas emissions, emission factors were applied from the following sources:

- Workbook for Fuel Combustion Activities (Stationary Sources);
- National Greenhouse Gas Inventory Committee (NGGIC) Workbook 1.1 (NGGIC, 1998);
- Workbook for Transport (Mobile Sources), NGGIC Workbook 3.1 with Supplements (NGGIC, 1998); and
- Workbook for Industrial Processes and Solvent and Other Product Use, Workbook 7.1 with Supplements (NGGIC, 1998).

The relevant emission factors are summarised Table 9.3.2.

Table 9.3.2
Greenhouse Gas Emission Factors

Greenhouse Gas	Emission Factors				Units	Diesel Emission Factor	Units
	Fuel Oil		Natural Gas				
	Kiln	Boiler	Kiln	Boiler			
Carbon Dioxide	73.6	73.6	51.9	51.9	Gg/PJ	69.7	g/MJ
Methane	1	0.8	1	0.1	Mg/PJ	0.07	g/km
Nitrous Oxide	0.6	0.6	0.1	0.1	Mg/PJ	0.025	g/km

Emissions of hydrofluorcarbons, perfluorocarbons and sulfur hexafluoride were not calculated as their presence is associated with aluminium smelting rather than alumina refining. They are not used at Alcan Gove.

The methodology in NGGIC (1998) was used along with oxidation factors and the energy requirements for the existing refinery and the expanded refinery to calculate the total greenhouse gas emissions for the operation. Oxidation factors of 0.99 for oil and 0.995 for natural gas combustion have been used to correct emissions for the incomplete combustion of carbon.

NGGIC Workbook 7.1 was used to calculate the sink effect of formatting carbonate in the Bayer liquor stream. Carbonate is formed from the reaction of liquor ingredients with either CO_2 in the atmosphere or organic material in the bauxite. As a result of the reaction with CO_2 in the atmosphere, this process acts as a greenhouse gas sink.

Table 9.3.3 outlines the annual greenhouse gas emissions and the annual carbon dioxide equivalent greenhouse emissions for the existing refinery.

Table 9.3.3
Existing Refinery Greenhouse Gas Emissions

Greenhouse Gases	GWP[1]	Greenhouse Gas Emissions – CO_2e (tonnes/year)					
		Steam Power Station	Digestion[2]	Calcination	Lime Plant	Onsite Transport (diesel use)	Total for Existing Refinery
Carbon Dioxide	1	1,034,669	-8,195	553,766	14,573	24,621	1,619,435
Methane	21	236	0	158	4	1	420
Nitrous Oxide	310	2,615	0	1,399	37	0	4,361
Total		1,037,520	-8,195	555,323	14,614	24,622	1,624,216

1. Global Warming Potential, a number developed to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to that of carbon dioxide.
2. Negative sign indicates a sink.

Table 9.3.4 outlines the annual greenhouse gas emissions and the annual carbon dioxide equivalent greenhouse emissions for the expanded refinery fired on natural gas.

Table 9.3.4
Expanded Refinery Greenhouse Gas Emissions (Natural Gas)

Greenhouse Gases	GWP	Greenhouse Gas Emissions - CO_2e (tonnes/year)						
		Steam Power Station	Digestion	Calcination	Lime Plant	Liquor Purification	Onsite Transport (diesel use)	Total for Expanded Refinery
Carbon Dioxide	1	1,404,622	-10,550	660,998	29,146	98,117	31,466	2,213,799
Methane	21	57	0	267	8	4	2	338
Nitrous Oxide	310	839	0	395	74	59	1	1,368
Total (weighted for GWP)		1,405,518	-10,550	661,660	29,228	98,180	31,469	2,215,505

Note – negative sign indicates a sink.

Whilst the total greenhouse gas emissions will increase by approximately 595,000 tonnes/year once the refinery is converted to natural gas, the emissions per tonne of alumina will decrease significantly. Table 9.3.6 shows that the emission rate per tonne of alumina reduces by approximately 28%.

In the event that gas is delayed, the expanded refinery will use fuel oil until the gas becomes available. For that interim period, the greenhouse gases emitted are given in Table 9.3.5.

Table 9.3.5
Expanded Refinery Greenhouse Gas Emissions (Fuel Oil)

Greenhouse Gases	GWP	Greenhouse Gas Emissions - CO_2e (tonnes/year)						
		Steam Power Station	Digestion	Calcination	Lime Plant	Liquor Purification	Onsite Transport (diesel use)	Total for Expanded Refinery
Carbon Dioxide	1	1,981,901	-10,550	932,659	29,146	138,442	31,466	2,994,356
Methane	21	452	0	267	8	32	2	761
Nitrous Oxide	310	5,009	0	2,357	74	583	1	8,024
Total (weighted for GWP)		1,987,362	-10,550	935,283	29,228	139,057	31,469	3,002,610

Note – negative sign indicates a sink.

Table 9.3.6
Greenhouse Gas Emissions
(tonnes/tonne of alumina)

Existing Refinery	Expanded Refinery (Natural Gas)	Expanded Refinery (Fuel Oil)
0.78	0.59	0.79

9.4 Management of Greenhouse Gas Emissions

The conversion from fuel oil to natural gas will reduce greenhouse emissions significantly below the existing emissions per tonne of alumina produced. The cost of natural gas is approximately $500 million for the pipeline and about $30 million for the conversion of the refinery. Nevertheless, the expansion will result in an increase in the total amount of greenhouse gases emitted because of the increased refinery production.

To address this increase in greenhouse gas emissions, Alcan Gove is investigating the implementation of the following greenhouse gas offset projects:

- Ongoing involvement in Alcan's TARGET program;
- Contribution to bushfire research and management;
- Revegetation and tree planting;
- Energy management program at Nhulunbuy;
- Energy management program at Alcan Gove Refinery; and
- Free bus service for employees and contractors.

There has been an emphasis on energy efficient design in the development of the expansion project. The effectiveness of these design initiatives will be monitored, investigated and reviewed through the site's energy review committee. The results will be reported in Alcan Gove's Greenhouse Challenge annual progress reports and in Alcan Gove's annual public review of environmental performance.

9.4.1 Ongoing Involvement in Alcan's TARGET Program

Alcan Gove is committed to ongoing involvement in Alcan's TARGET program. The energy review committee is an ongoing initiative with committee members researching options for improving greenhouse performance on an annual basis. Progress is measured on an annual basis through the Greenhouse Challenge reports. The agreed key performance indicator used for the purposes of these reports is tonnes of CO_2e per tonne of production. At present, the world-wide average from alumina refineries is 991 kg of greenhouse gases emitted per tonne of alumina produced (International Aluminium Institute, 2003). Alcan Gove is currently well below this average at 780 kg/t of alumina produced, and with the conversion to natural gas, performance will improve even further to 590 kg/t of alumina produced.

9.4.2 Contribution to Bushfire Management

Along with the energy sector, the agricultural sector (including savanna burning) is one of the Northern Territory's largest sources of greenhouse gas emissions. Agricultural sector emissions are predominantly derived from prescribed burning of savanna woodlands and enteric fermentation in cattle. The NT Government's discussion paper outlining a strategy for greenhouse action (Northern Territory Government, undated) states that improved management of savanna burning might have abatement potential in the Northern Territory. Alcan Gove is committed to working with the Northern Territory Bushfires Council, the Northern Land Council and the Dhimurru Land Management Group to assist with fire management within the Gove Region to reduce emissions from savanna burning.

9.4.3 Tree Planting

Alcan Gove is continuing to revegetate a number of areas around Nhulunbuy. In addition to its landscape benefits, this activity will also assist in offsetting greenhouse gas emissions from the refinery. Furthermore, Alcan Gove is an active supporter of landcare activities in the region which include additional revegetation programs which would provide further offset benefits.

9.4.4 Energy Efficiency Program at Nhulunbuy

Alcan Gove has already implemented an energy efficiency program at some of the houses at Nhulunbuy (Section 9.1.3). This program will be extended to other energy consumers to further reduce energy consumption and hence greenhouse gas emissions. Initially, it is proposed that a baseline assessment be undertaken to identify energy consumption, costs, equipment and hours of use. From this assessment, an energy efficiency program would be developed focusing on issues including lighting, cooling, building design, location of trees for shade, and other equipment use as well as education programs for the community on energy use.

9.4.5 Energy Management Program at the Refinery

Alcan Gove has already implemented an energy efficiency program at the refinery (Section 9.1.3). While energy efficiency has been a major consideration for the design and selection of equipment for the Third Stage Expansion, consideration will also be given to opportunities for ongoing energy efficiency improvements at the existing refinery. This will include the identification of opportunities and implementation of changes to plant and equipment to reduce energy consumed and therefore greenhouse gas emissions. The management systems are designed to ensure energy and the associated greenhouse emissions are considered at all levels on an ongoing basis. Examples of the types of issues to be considered include the following:

- Continuous improvement in energy / greenhouse management initiatives and integrating them into existing Alcan management systems and procedures, including policy, roles, responsibilities, accountability, procedures, guidelines, education and training, information management and processes.
- Technical opportunities:
  - Lighting, cooling and other equipment use;
  - The use of high efficiency motors versus standard variable speed drives;
  - Monitoring motor "current" draw for signs of reduced performance from fouling of pumps, pipe systems, conveyor pulleys, bearings etc;
  - Assess compressor output related to load requirements; and
  - Install metering for energy consumption and set benchmark consumption targets (mostly electricity and gas, but may include diesel or other energy types) in each section of plant.

9.4.6 Bus Service

To reduce the dependency on car use and the consumption of fossil fuels, Alcan Gove provides a free bus service to transport refinery employees and contractors to work each day. The majority of the workforce uses this service which will continue after the refinery expansion. A bus service will also be available to transport the construction workers from the accommodation village to the refinery during the construction phase.