New Zealand Aluminium Smelters Limited Climate Change Approach

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1. Abstract

The reality of Climate Change is becoming increasingly accepted, and concerns about the implications of it are becoming widespread. Businesses are no different to any other citizens, in that the past few years have been a journey from denial to general acceptance of the science, and willingness to be part of the solution.

Climate Change is a serious global issue and New Zealand Aluminium Smelters Limited (NZAS) is keen to show leadership in responding to the issue. This has been demonstrated with significant Greenhouse Gas (GHG) emissions reductions since 1990. Since 1990 direct site CO_2-e emissions[1] have been reduced by 41%, while production has increased 26% (a greater than 50% reduction in GHG emissions on an intensity basis). NZAS is committed to reducing GHG emissions by a further five per cent over the next five years, despite the reductions becoming increasingly more difficult.

In 2005 NZAS signed a Framework for Agreement for a Negotiated Greenhouse Agreement (NGA) with the New Zealand Government. The agreement committed NZAS to a pathway to World's Best Practice and recognised NZAS' competitive at risk status as a major energy user in an export market.

It makes good business sense for NZAS to continue to contribute to emissions reduction targets. As a major energy user, greater energy efficiency enhances our international competitiveness, meaning that there is natural synergy between energy efficiency and profitability. Improved process control reduces GHG emissions and is a vital component of NZAS' production of the highest purity aluminium in the world.

Reducing onsite GHG emissions and improving energy efficiency are important parts of the Sustainable Development approach that NZAS is taking to address Climate Change. Other initiatives include contributing to aluminium recycling, energy efficiency in the community and light-weighting of vehicles.

The perception of the value of Sustainable Development initiatives has continued to evolve over the past few years and is increasingly taking on an important role in NZAS' business decisions. NZAS is measured not just by internal efficiency improvements but also by the perception of customers, investors and other stakeholders.

[1] CO_2-e denotes carbon dioxide equivalent gases. Six gases affecting Climate Change are included in the IPCC (Intergovernmental Panel for Climate Change) framework – each gas is normalised back to the equivalent global warming impact of one tonne of CO_2.

2. Introduction

Aluminium has a number of end-uses. NZAS aluminium is predominantly used in electrical applications such as memory discs and capacitors, transport applications such as wheels and aeroplane wings, construction such as windows and structural members, and in packaging foil.

The basis for all modern primary aluminium smelting plants is the Hall-Héroult Process, invented in 1886. Alumina is dissolved in an electrolytic bath of molten cryolite (sodium aluminium fluoride), at approximately 960°C, within a large carbon and refractory lined steel shell known as a "Reduction cell".

An electric current is passed through the electrolyte at low voltage, but very high current, (typically 185,000 to 220,000 amperes at NZAS). This provides the electrons necessary for the following reaction.

$$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$$

The electric current flows between a carbon anode (positive), made of petroleum coke and pitch, and a cathode (negative), made from graphitic carbon. Molten aluminium settles to the bottom of the Reduction cell, is siphoned off periodically, and then cast into various alloy specifications and shapes. A typical Reduction cell cross-section is shown in Figure 1.

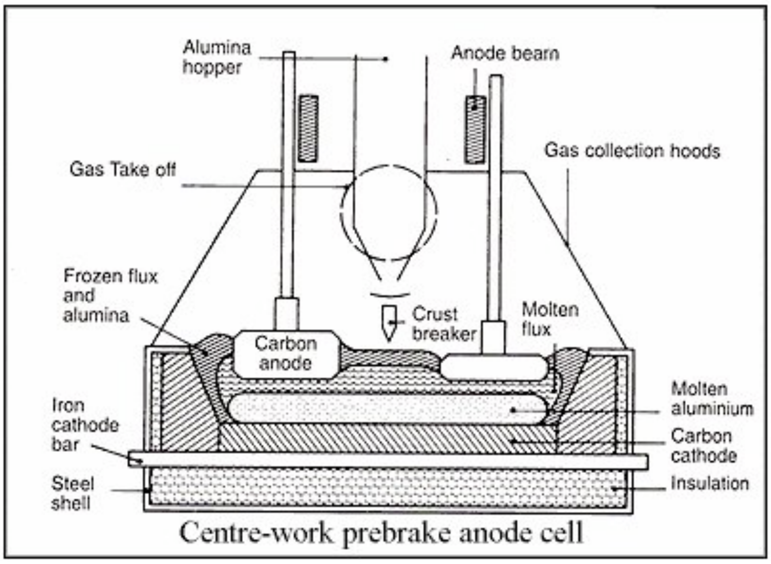


Figure 1: Cross Section of Reduction cell.

NZAS operates a plant at Tiwai Point, near Bluff, consisting of 672 Reduction cells, producing 350,000 tonnes per year of primary aluminium products. This production requires the approximate annual input of:

- 670,000 tonnes alumina,
- 150,000 tonnes carbon,
- 5,000,000 MWh of electricity.

Carbon dioxide is formed through the oxidation of carbon anodes in the electrolytic process and through burning of the anodes at elevated ambient air temperatures in the Reduction cell. Technological limits exist to reduce the carbon dioxide emissions from this process. Smelters operating at World's Best Practice consume 0.40 tonnes of carbon per tonne of Aluminium compared to the theoretical of 0.33 tonne/tonne. NZAS is currently operating at 0.424 tonne/tonne. The oxidation of carbon to carbon dioxide produces 80% of NZAS CO_2-e emissions.

The other major GHG emissions produced in the Reduction cell are Perfluorocarbons (PFCs). These gases are created during an 'Anode Effect' – a process condition where an insufficient amount of alumina is dissolved in the electrolyte, causing voltage to be elevated above the normal operating range. This results in the electrolytic reduction of the cryolite, into CF_4 and C_2F_6, rather than the desired reduction of alumina into aluminium. The PFCs have a high global warming potential – 6500 to 9200 times that of carbon dioxide. Anode Effects produce 10% of NZAS CO_2-e emissions.

The remaining 10% of NZAS CO_2-e emissions are produced by fuel combustion on site. Fuel is used to calcine carbon anodes, one of the inputs to the Reduction process, and in molten metal holding furnaces prior to final product casting.

NZAS has reduced its GHG emissions by 41% since 1990. This is shown in Figure 2. Most of this reduction has been achieved by better process control systems and improved operator response – especially with respect to alumina feed control (reducing Anode Effects).

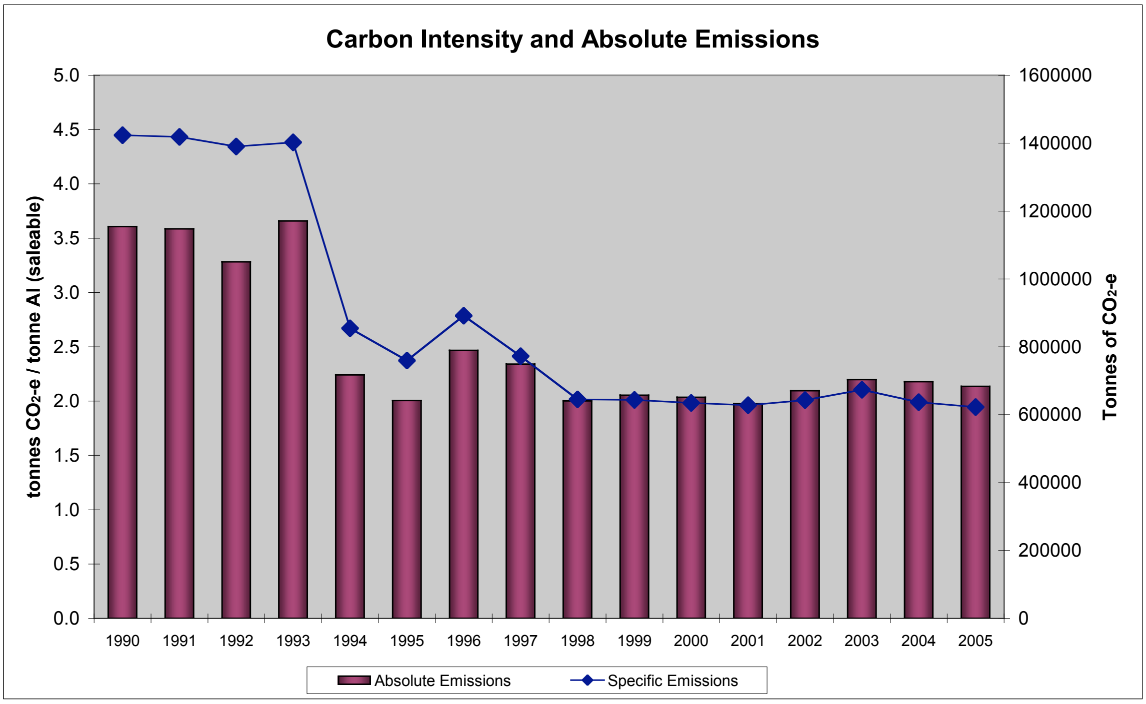


Figure 2: NZAS CO_2 emission reductions since 1990.

3. The Climate Change Challenge

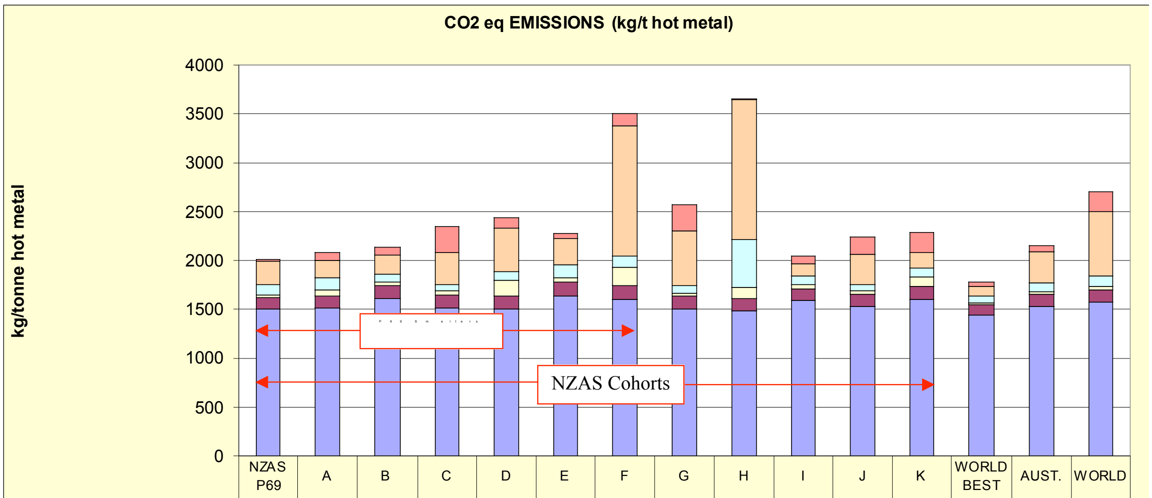
NZAS face a number of challenges with respect to Climate Change and have been striving to mitigate these since the 1990's. These challenges exist in the form of technical constraints in the aluminium smelting process and also in the changing perceptions of climate change by stakeholders – employees, the nation of New Zealand, customers, the local community of Southland and Shareholders.

3A. NZAS' Approach to the Technical Challenge

The greatest challenge for the NZAS operation is maintaining a reliable source of affordable, low or zero carbon emission power in the medium to long term. Electricity represents 40% of NZAS' costs, and because the London Metal Exchange sets the price of aluminium[1], there is limited capacity for NZAS to pass on the cost of increasing power price to customers.

NZAS is competing with smelters in countries with less stringent climate change and environmental policies and obligations. The cost of Climate Change policies will impact on NZAS' ability to remain competitive with international smelters. However, NZAS has taken a leadership role, understood and shown that in the pursuit of improved environmental performance, technical and operations performance improve hand-in-hand.

NZAS is technically constrained in achieving further significant emission reductions because of the gains it has already made to date, and the inherent limitations of smelting technology, which has not changed significantly since the 1880's. NZAS is close to World's Best Practice (WBP) for its technology and has the lowest level of GHG emissions of all cohort smelters worldwide[i].



	NZAS P69	A	B	C	D	E	F	G	H	I	J	K	WORLD BEST	AUST.	WORLD
As Other Site Fuels	30	81	80	275	108	51	120	265	8	81	180	213	47	74	198
As PFC Emissions	232	175	207	313	438	274	1329	556	1431	114	310	151	103	318	653
Baking Fuel	108	117	70	76	96	128	117	84	492	89	73	89	64	94	115
Packing Coke Loss	23	65	38	36	167	41	188	29	113	51	33	104	20	22	32
Pitch Pyrolysis (baking loss)	124	129	133	140	127	151	144	136	124	125	118	132	107	121	121
Anode consumption (electrolysis)	1498	1509	1611	1510	1501	1631	1600	1501	1486	1584	1533	1601	1439	1530	1576

Figure 3: CO_2 emissions from NZAS compared with other smelters.

[1] Aluminium is sold in a commodity market.

A number of projects on site have been successfully implemented to deliver this result and project based improvements continue to feature in the five year business improvement plan. During any given year NZ$5 to NZ$15 Million will be spent on improving energy efficiency and reducing CO_2-e emissions. Examples of these projects include:

- Modelling, trialling and plant modifications to optimise anode performance – improving electrical resistivity, Reduction cell fluid dynamics and improved resistance to oxidation.
- Modelling and installation of new design buswork to improve electrical resistivity.
- Optimisation of fuel combustion in furnaces.
- Significant Reduction cell control systems development and optimisation for alumina feed and resistance control.

3B. "Our People Managing Our Emissions"

NZAS employees play an important role in the goal to reduce NZAS GHG emissions.

NZAS was one of the first companies in New Zealand to sign a Voluntary Emissions Reduction Agreement with the New Zealand Government during the mid 1990s. Since then employee knowledge of Climate Change, and the impact NZAS has upon it, has grown.

Onsite management begins with an ISO14001 accredited measurement and management system for data collection of GHG emissions. NZAS believes that reporting and open, consistent communication of GHG emissions throughout the business is the key to drive on-site behavioural change towards Climate Change. GHG emission abatement opportunities and projects are included in site operational plans, in the annual planning cycle, and cascaded down to each area and employee on site. Each employee has GHG emission reduction targets built into their personal performance incentive plans and knows the impact they have on the site emission profile.

In a large part due to the skills of its employees, NZAS now produces the highest purity primary aluminium in the world. This has required an attention to detail and in-depth understanding of the process. This same attention has resulted in improved energy efficiency and GHG emissions reductions.

By implementing these initiatives Climate Change has entered into the language of the workforce and is a key performance and business driver.

3C. NZAS' approach to utilising New Zealand's Resources

NZAS uses 13% of the nation's electricity and must demonstrate its contribution to the New Zealand economy. NZAS' approach to Sustainable Development is the key in this regard. Ongoing sustainability depends on maintaining a record as responsible managers of the business and use of its resources.

New Zealand is facing electricity supply constraints. It has been suggested that a possible "solution" to this would be to shut down the NZAS operation. Closing down NZAS would grossly affect the Southland economy (NZAS contributes 18% of Southland GDP) and result in a loss of a NZ$1.4Billion export industry. There are also significant transmission issues in sending electricity from the South Island to the North Island. Further Renewable energy development in the South Island, with some of the most economic development sites in the world, would also be constrained.

This action would also shift production offshore and be detrimental to the global net impact on GHG emissions. This is illustrated in the Case Study below. Three likely offshore scenarios have been created to maintain production of 350,000 tonnes of Aluminium per year. These scenarios can be used to compare NZAS operating from 100% renewable hydroelectricity.

Case Study:

1. China Coal: Increasing Chinese smelting capacity by a smelter, operating at World's Best Practice. Power is supplied by Chinese coal fired power stations.
2. Middle East Gas: A new smelter in the Middle East, operating at World's Best Practice. Natural gas supplies power to the smelter.
3. Asia Hydro: A new smelter in Asia or South America (tropics), operating at World's Best Practice. A new hydroelectric dam supplies power to the smelter. This dam requires flooding – removing significant areas of forest – reducing carbon sequestration.

These three options reflect the geographic trends in regards to the installation of new smelting capacity[1].

Scenario (kt CO_2-e)	Fuel Emissions[2]	Carbon Emissions	PFC Emissions	Emissions from Electricity	Total Emissions
NZAS	73	555	58	-	686
China Coal	73	536[4]	6[5]	4,305[3,6]	4,920
Middle East Gas	73	536[4]	6[5]	3,118[6,7]	3,732
Asia Hydro	73	536[4]	6[5]	2,473[6,8ii]	3,087

Not taking into account any ethical issues associated with these scenarios, in particular the biodiversity and community impacts that result from hydropower, the lowest global GHG impact is caused by the scenario where aluminium continues to be produced at NZAS. As part of the global community NZAS' preference is to continue using low or zero emitting sources of electricity, but the availability of this power supply cannot be taken for granted. NZAS is becoming more innovative in thinking about its energy future and continues to consider a number of options.

[1] Of the 9838 kt of potential smelter expansions up to 2011, only 468 kt (or less than 5%) is planned for Western Europe Hydro sourced power. The majority is planned for Asia (43%) and the Middle East (29%), with the remainder in Eastern Europe, Africa and South America.
[2] It is assumed that all smelters operate similar ancillary equipment and therefore have similar fuel consumptions.
[3] Grid factor taken from WBCSD 2003 China Coal Emission Factor as 0.913 t CO_2-e / MWh.
[4] Assumes Worlds Best Practice Net Carbon Ratio of 0.4 kg / t Al.
[5] Assumes Worlds Best Practice Anode Effect Frequency x Anode Effect Duration of 0.015 minutes / cell / day.
[6] Assumes Worlds Best Practice DC Power of 12.9 DCKWh / kg Al; AC:DC Conversion of 98% and supplemental Works Feeder Power at 4%.
[7] Grid factor taken from WBCSD Middle East Gas as 0.648 t CO_2-e / MWh.
[8] Reference ii., Tucuruý´ (median emitter), 2,602,945 t C / year, capacity 4240 MW / year, 50% capacity factor.

3D. The Role of Aluminium in the Global Climate Change Problem

NZAS is also investigating options to offset the emissions generated in the smelting process, including life cycle attributes of aluminium, to reduce the total site GHG emission footprint. Aluminium gives a net-positive GHG lifecycle through its use in vehicles and aircraft. Approximately 60-75% of vehicle fuel use is weight related and given that the typical aluminum part is 40-50% lighter than a comparable steel part, significant opportunity exists for aluminium light-weighting of vehicles[1]. One kilogram of aluminium that replaces heavier materials in a car or light truck has the potential to eliminate 20kg of CO_2 over the lifetime of the vehicle. For other vehicles, such as trains, ferries and aircraft the potential savings are even greater. In this later example, NZAS now supplies 18,000 tonnes per year of high purity aluminium into the European aerospace industry.

Savings from the use of aluminium products in light-weighting of vehicles alone is globally growing at a rate that could offset emissions from the production of all primary aluminium metal within ten years as shown in Figure 4.

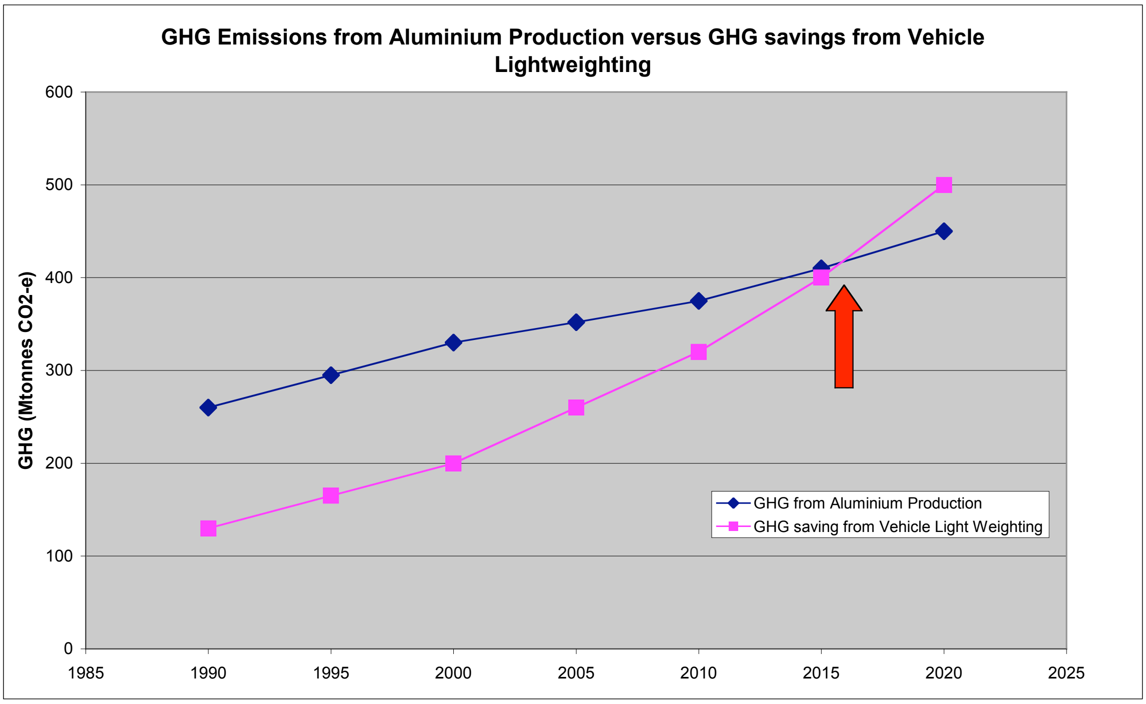


Figure 4: The growth in CO_2-e emissions due to Aluminium Smelting versus the CO_2-e emission savings from Aluminium Light-weighting of vehicles[iii,iv]

NZAS, and majority owner Rio Tinto, believe that the development of new smelting and power generation technologies will play a crucial role in reducing GHG emissions. Rio Tinto will continue to support research into new smelter technologies that will reduce GHG emissions. To date Rio Tinto Aluminium has invested nearly A$100 million in the development of a new "step change" smelting technology – the Drained Cathode Cell. Should it be successful, the new cell will reduce the energy intensity of the smelting process by around 11%.

Rio Tinto is also a major contributor to the AP6 partnership (Asia-Pacific Partnership on Clean Development and Climate). AP6 has a number of task force groups, one of which is the Aluminium

[1] Data provided by the International Aluminium Institute (IAI).

Taskforce. This Taskforce has the purpose of assessing best industry practice, aiding the development and deployment of new best aluminium smelter practice and enhancing aluminium recycling opportunities. Through Rio Tinto, NZAS has access to a significant resource to benchmark and learn about initiatives to further improve their approach to Climate Change and Sustainable Development practices.

3E. NZAS' Approach to the Value Stream - Recycling

Recycling is a cornerstone of Sustainable Development. The unique properties of aluminium enable it to be recycled indefinitely. Aluminium recycling benefits current and future generations by conserving energy and other natural resources required for primary production. The recycling of aluminium requires up to 95% less energy than that required for primary aluminium production, by not having the corresponding emissions, including greenhouse gases.

The global rate of recycling continues to increase as shown in Figure 5. Approximately 706 million tonnes of aluminium have been produced since the development of the Hall-Héroult process, of that it is estimated that three quarters of this metal is still in productive use.

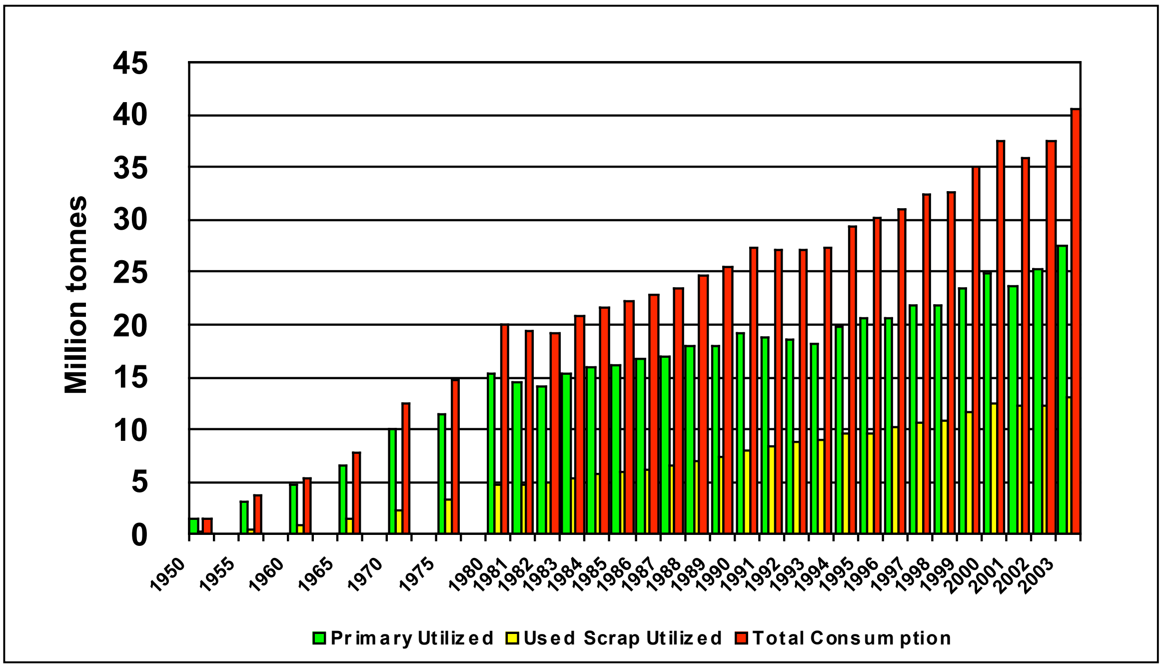


Figure 5: Primary Aluminium production, consumption and recycling rate growth[iii].

NZAS has been involved in aluminium recycling through owner Comalco New Zealand[1] for a number of years. This has included 'Cash for Cans' and in recent years extended to taking back clean extrusion scrap from customers to recycle into primary aluminium products. This initiative has resulted in recycled metal contributing to 3600 tonnes of NZAS total production output in 2005.

[1] Comalco New Zealand has recently changed name to Rio Tinto Aluminium New Zealand.

3F. NZAS' Approach to the local community - Partnerships

NZAS' closest neighbour is the Bluff community. NZAS works closely with neighbouring communities, engaging with them, developing partnerships and contributing to many local community programmes. The "Bluff Healthy Homes Project" demonstrates that NZAS' commitment to energy efficiency and greenhouse gas emissions reductions doesn't stop at the NZAS site boundary. NZAS, along with the Energy Efficiency Conservation Authority, sponsors the "Bluff Community Healthy Homes Project".

The project aims to retrofit all Bluff homes with high quality insulation products. Low income earners are eligible for free retrofits, with interest free loans from the Southland Community Trust available for other Bluff residents. NZAS provide financial backing and supports the teams of contractors in project safety and project management. The project has successfully reduced energy usage of over 200 homes to date, in addition to providing a warmer, healthier home environment for many Bluff families.

Interaction with the local community is on the basis of transparent reporting – this approach is key to maintaining an ongoing commitment by the community to the continuation of the NZAS operation.

4. NZAS Approach to Government Policy

The perception of the New Zealand public to Climate Change is changing fast. Meeting the challenge of Climate Change is an extremely complex exercise which requires a broad national consensus if it is to be successful. All sectors of the economy should make a contribution to GHG reductions, and there needs to be a portfolio of policy solutions to achieve a positive outcome from both an environmental and economic perspective. Sustainable Development must be considered in an environmental and economic sense. Long term, durable policy is required by shareholders to provide certainty in investment decisions.

NZAS believes that "Business as Usual" is not an option and therefore supports broad-based market mechanisms including international emissions trading to address climate change. These enable businesses to make the decisions on which options to take for least cost abatement of GHG emissions.

A NZ Emissions Trading Scheme (ETS) must be internationally linked, not rushed and designed to drive deployment of low emission technology. Many parameters exist in any trading scheme, and it is crucial to get them right to ensure that the scheme operates effectively. This will take time to develop and will require widespread consultation.

In the development of a New Zealand emissions trading scheme, consideration of competitiveness impacts on emissions intense firms and electricity market impacts, must be taken. Policies should recognise the real threat of carbon leakage that would result from policy not taking into account the competitive at risk status of firms.

With the policy in New Zealand developing rapidly, NZAS maintains that the best management approach is to be striving to reduce emissions and improve energy efficiency before policy or regulation forces this.

5. Conclusion

NZAS accepts the science behind climate change and it follows that it, like all corporations, bears a responsibility to not only its shareholders but also to the broader community to address the issue and reduce its emissions.

As a major energy user, NZAS recognises the responsibility it has to shareholders, community and the environment, to reduce its Greenhouse Gas emissions. This is a responsibility that must be shared across all sectors of the New Zealand economy. Governance is about operating and managing the business in a sustainable manner – as perceived by all stakeholders.

NZAS continues to work with all stakeholders in being a part of the solution to Climate Change through:

- Addressing the technical challenges of the Aluminium Reduction process,
- Involving employees in the improvement process,
- Engaging in international networks to access new technology,
- Investigating and implementing offset projects – particularly recycling and vehicle light-weighting,
- Developing local community partnerships – to increase energy efficiency of homes.

NZAS is looking to engage constructively with all stakeholders to develop and adopt solutions and measures to reduce GHG emissions, contributing to meeting New Zealand's international obligations and thereby enabling us to continue to be part of the New Zealand community into the future.

6. References

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[ii] M. Aurelio dos Santos, L. Pinguelli Rosa, B. Sikar, E. Sikar and E Oliveira dos Santos, Gross greenhouse gas fluxes from hydro-power reservoir compared to thermo-power plants, Energy Policy 34 (2006) 481–488, Table 9
[iii] International Aluminium Institute Website, www.world-aluminium.org, August 2006
[iv] Helms, H. and Lambrecht, U. "The Potential Contribution of Light-Weighting to Reduce Transport Energy Consumpption", Int. J LCA Case Studies 2006