energy efficiency
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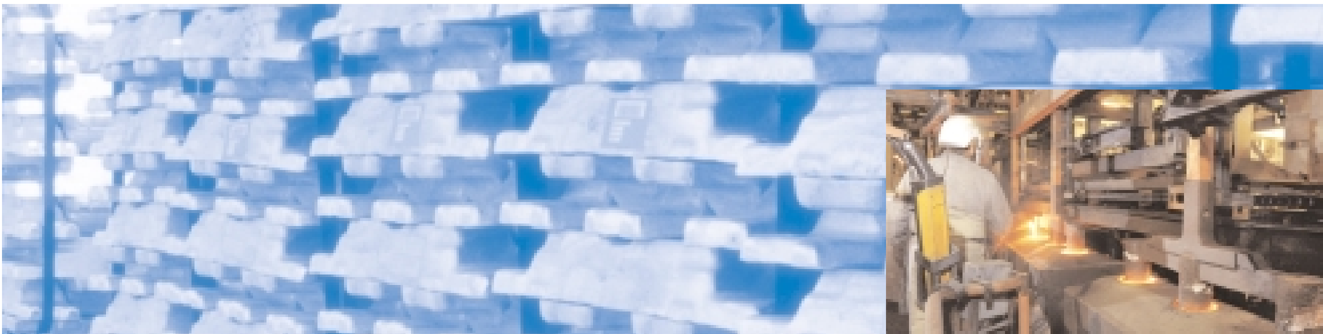
Energy efficiency best practice in the Australian aluminium industry

summary report



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A Commonwealth Government Initiative

July 2000

INDUSTRY SCIENCE RESOURCES

Energy efficiency best practice in the Australian aluminium industry

summary report

Industry, Science and Resources
Energy Efficiency Best Practice Program

July 2000

A Commonwealth Government Initiative

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Introduction

In November 1997 the Prime Minister, in ***Safeguarding the Future: Australia's Response to Climate Change,*** announced a range of initiatives. One of those initiatives, the Energy Efficiency Best Practice Program, aims to contribute to greenhouse gas abatement through more efficient use of energy in Australian industry. This program commenced in July 1998.

The Energy Efficiency Best Practice Program provides assistance to industry to identify cost-effective opportunities for continuous improvement in the efficient use of energy.

A key element of the Energy Efficiency Best Practice Program is a series of sector studies of selected industries with particular importance to the Australian economy.

Through its representative body, the Australian Aluminium Council (AAC), the aluminium industry agreed to participate in an energy efficiency best practice sector study.

The aluminium sector study set out to:

- assist the industry in identifying current energy use performance and the potential for improved energy efficiency;
- assist the industry in developing an energy efficiency improvement plan and implementation strategy;
- provide the industry with tools to improve energy efficiency performance;
- provide an energy use database for use by the industry; and
- provide industry with international benchmarking data.

This report was prepared for Industry, Science and Resources by Hannagan Bushnell, Redding Energy Management (REM), ACIL Consulting and Alumination Consulting in 1999–2000. It provides a summary of *Energy efficiency best practice in the Australian aluminium industry sector* study, May 2000.

Australian aluminium industry profile

Australia is the world's largest producer and exporter of bauxite and alumina and the fifth largest producer of aluminium. Australia's semi-fabricated products industry is relatively small by international standards but world competitive in specific markets, most notably in the manufacture of sheet products used in the Asian beverage can industry and extrusions for the building industry.

Statistical summary

PRODUCTION (Tonnes)	1974	1984	1994	1995	1996	1997	1998
Bauxite	19 994 000	31 537 000	42 159 000	42 655 000	43 063 000	44 465 000	44 553 000
Alumina	4 899 000	8 781 000	12 819 000	13 161 000	13 348 000	13 384 000	13 537 000
Aluminium (Hot metal)	219 000	755 000	1 311 000	1 292 600	1 370 250	1 490 098	1 626 156
Secondary consumption	–	–	–	37 700	57 133	53 802	63 081
IMPORTS:							
Primary metal	–	–	–	4 900	11 500	4 158	6 732
Semi-Fabrications	–	–	–	40 100	44 881	61 413	61 581
EXPORTS:							
Primary metal	53 000	476 000	974 000	927 000	1 066 168	1 107 725	1 282 175
Semi-Fabrications	6 000	57 000	94 000	109 000	79 794	98 694	117 318
TOTAL CONSUMPTION	177 600	258 600	350 000	311 900	340 300	366 236	376 855
Per capita consumption (kg)	13.3	16.6	19.6	17.3	18.6	19.8	20.1
Domestic shipments:							
Ingot	37 800	58 600	76 700	76 400	73 100	76 100	77 969
Rolled products	80 300	94 600	98 500	93 400	84 700	83 800	86 729
Extrusions	49 300	72 400	96 400	89 200	86 300	87 900	94 414

Source: Australian Aluminium Council 1999

Economic impact

In 1998-99 the Australian bauxite, alumina and aluminium industry generated export earnings of $6.3 billion, representing 7% of total merchandise export earnings. It is the country's second largest commodity exporter behind coal (ABARE 1999).

Domestic processing of Australian bauxite, at around 90% of total production, is much higher than for most of the country's other major resource commodities. Some 24% of alumina produced in Australia is further processed into aluminium metal.

The refining of bauxite into alumina increases its value by a factor of ten. Smelting increases its value a further ten times. Semi-fabrication into rolled or extruded products has a value-adding effect of between two and ten times.

The Australian aluminium industry generates a gross product per person employed of $191 000 (ACIL 2000).

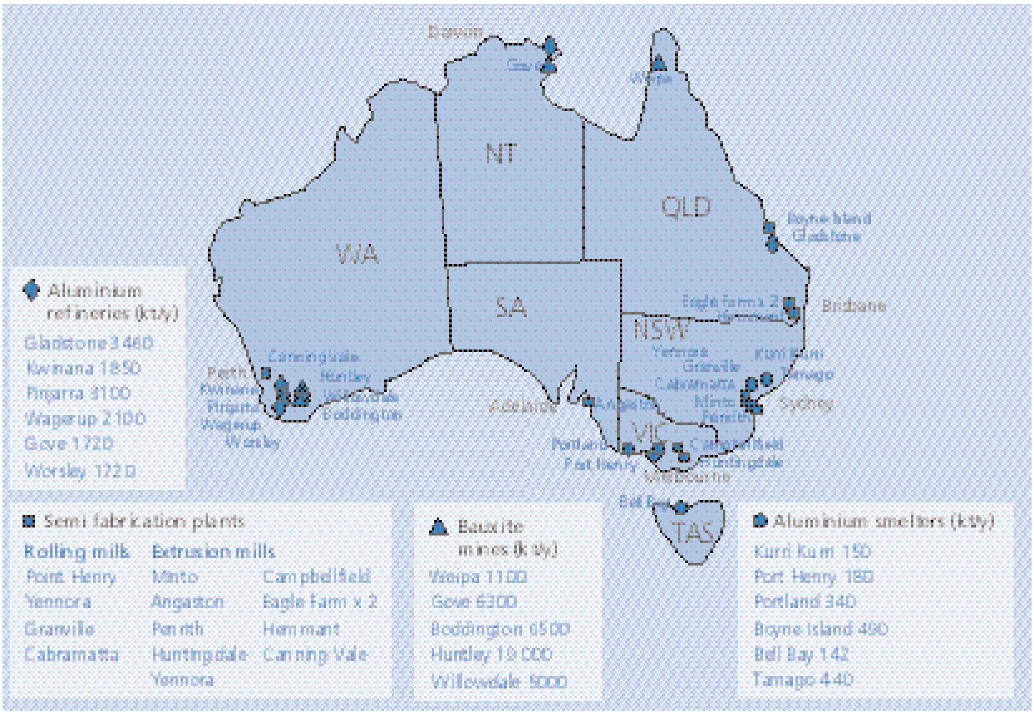
Geographic location

The Australian aluminium industry operates in every Australian State and the Northern Territory, predominantly in regional and rural areas.

Aluminium sector study participants

The aluminium sector study was undertaken in collaboration with the AAC and the companies listed below.

The Australian aluminium industry is fully integrated, with participants in all stages of the industry from bauxite mining to final



Source: ACIL and Hannagan Bushnell

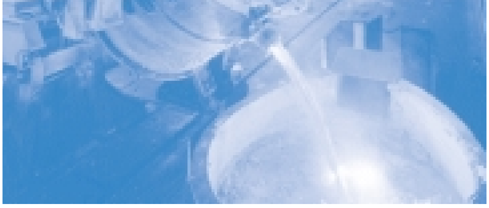
fabrication and casting of aluminium products and components.

The Australian industry consists of five bauxite mines, six alumina refineries, six primary aluminium smelters, 12 extrusion mills and four rolled products plants. (It should however be noted that the industry is currently undergoing considerable restructure.) The industry directly employs more than 16 000 people, with a flow-on effect to over 50 000 people employed in service industries.

For the purposes of this study, the industry was broken into three subsectors, reflecting natural ownership and operational relationships. These were mining/refining, smelting and semi-fabrication. The semi-fabrication subsector was further broken down into rolling and extrusion. The casting subsector was not included in the study but data on casting was included in ***Energy efficiency best practice in the Australian aluminium industry sector study, May 2000.***

Study methodology

Working groups consisting of the major operating companies within each of these subsectors were convened and charged with identifying the major energy use processes within their respective subsectors and with developing strategies for continuous energy efficiency improvement.



Mine	Operating company	Capacity tpa	State
Huntly	Alcoa World Alumina	19 000 000	WA
Willowdale	Alcoa World Alumina	5 000 000	WA
Jarrahdale	Alcoa World Alumina	No mining*	WA
Boddington	Worsley Alumina	6 500 000	WA
Weipa	Comalco Limited	11 000 000	QLD
Gove	Nabalco	6 300 000	NT
Refinery			
Kwinana	Alcoa World Alumina	1 850 000	WA
Pinjarra	Alcoa World Alumina	3 100 000	WA
Wagerup	Alcoa World Alumina	2 100 000	WA
Worsley	Worsley Alumina	1 720 000	WA
Gove	Nabalco	1 720 000	NT
Gladstone	Queensland Alumina	3 460 000	QLD
Smelter			
Bell Bay	Comalco Limited	142 000	TAS
Boyne Island	Comalco Limited	490 000	QLD
Kurri Kurri	Capral Aluminium	150 000	NSW
Point Henry	Alcoa World Alumina	180 000	VIC
Portland	Alcoa World Alumina	340 000	VIC
Tomago	Tomago Aluminium	440 000	NSW
Rolling mill			
Yennora	Kaal Australia	120 000	NSW
Point Henry	Kaal Australia	80 000	VIC
Granville	Capral Aluminium**	na	NSW
Cabramatta	Capral Aluminium**	na	NSW
Extrusion mill		**No of presses**	
Angaston	Boral	1	SA
Campbellfield	Capral**	2	VIC
Canning Vale	Capral**	1	WA
Eagle Farm	Gjames	3	QLD
Eagle Farm	Capral**	2	QLD
Hemmant	Capral**	1	QLD
Huntingdale	Crane	2	VIC
Minto	Capral**	3	NSW
Penrith	Crane	3	NSW
Somersby	Shapemakers***	1	NSW
Yennora	Capral**	2	NSW

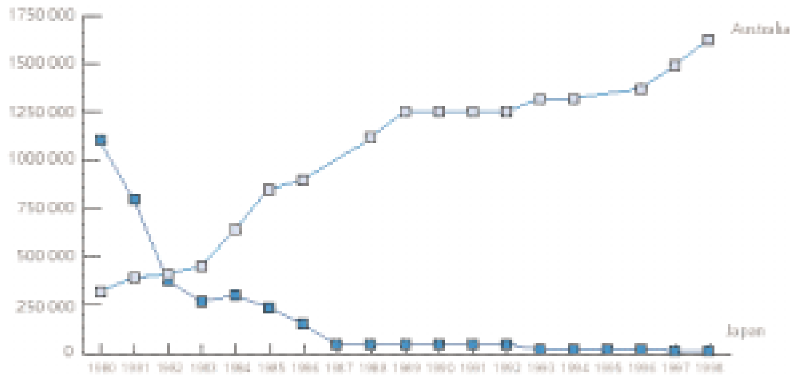
Source: Energy Efficiency Best Practice Survey. Commissioned by ISR and undertaken by ACIL, Hannagan Bushnell and REM, 1999.

* *Alcoa's Jarrahdale mine ceased production in 1998. However since the survey was conducted for the 1998 calendar year it has been included in the study.*

** *did not participate in the Study*

*** *small specialist extruder, was not asked to participate in the study.*

Australia and Japan historical aluminium production



Source: Australian Aluminium Council

A comprehensive energy-use survey was developed to determine specific energy consumption for each site.

Companies took differing approaches to completing the survey. Some used in-house resources while others undertook external energy audits. To ensure consistency, participants were asked to complete the questionnaire in a way consistent with conducting an external energy audit.

Energy use in the Australian aluminium industry

Alumina refining and primary aluminium production is energy intensive. The aluminium industry is the single largest industry sector consumer of electricity in Australia, accounting for about 15% of industrial consumption. It is also a large consumer of natural gas, fuel oil, coal and distillate in alumina refining and bauxite mining.

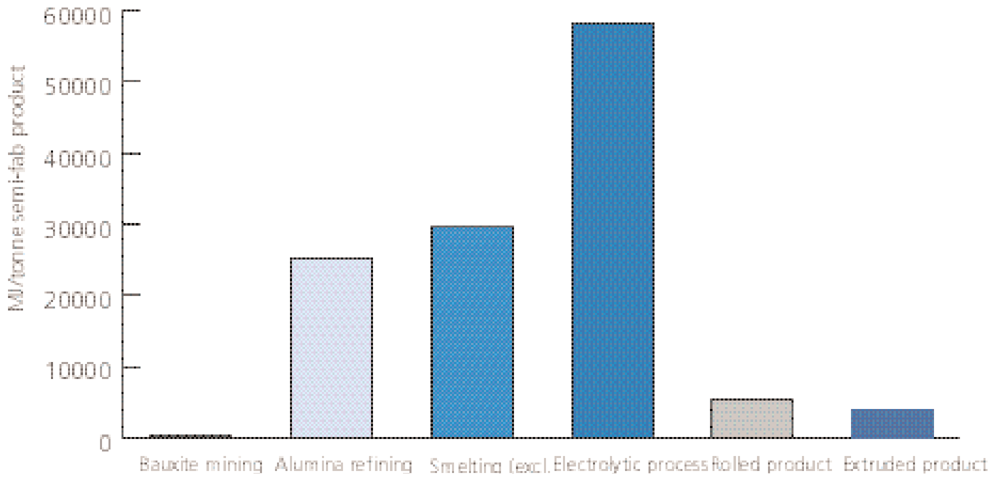
Investment decisions within the industry are largely based on being able to secure long-term competitively-priced supplies of raw materials, energy and labour.

Competitive energy supply is particularly important because it is the least mobile of the industry's raw materials and accounts for a large proportion of costs, particularly in the subsectors of refining and smelting where energy accounts for about 23% of costs (ACIL, Hannagan Bushnell, REM Survey 1999).

Australia's abundant low-cost energy resources drove significant capital investment in the aluminium industry through the 1980s and into the 1990s. The figure below illustrates the loss in smelting capacity in Japan over the past two decades and a simultaneous increase in smelting capacity in Australia.

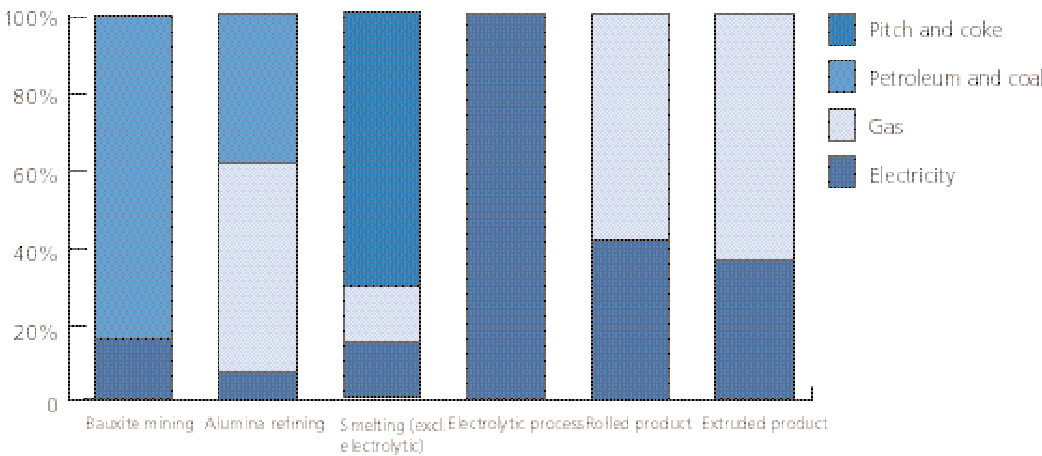
Australia and Canada are the only developed nations that have seen a significant increase in their respective aluminium industries in the past 20 years. Energy prices have been a major contributing factor.

Specific energy consumption per tonne of semi-fabricated product



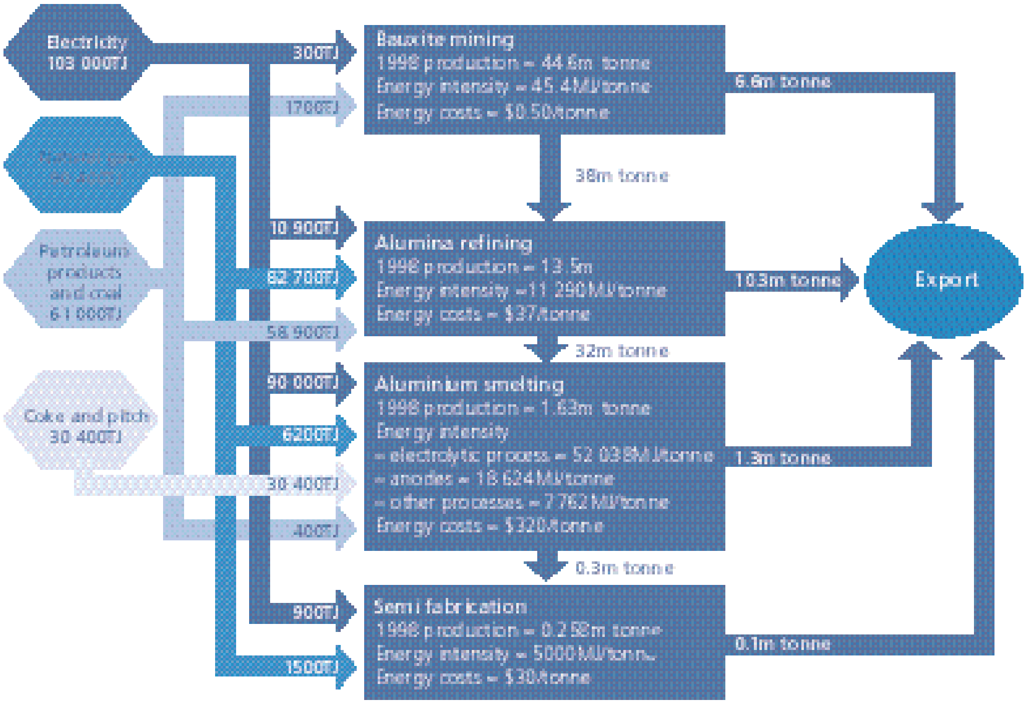
Source: Energy Efficiency Best Practice. Commissioned by ISR and undertaken by ACIL, Hannagan Bushnell and REM, 1999.

Specific energy consumption – By Fuel Type

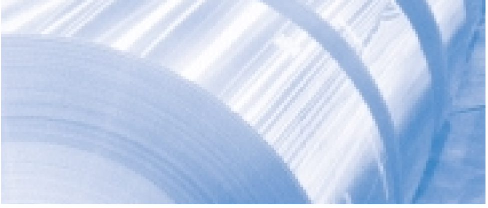


Source: Energy Efficiency Best Practice. Commissioned by ISR and undertaken by ACIL, Hannagan Bushnell and REM, 1999.

Product and energy flows in the Australian Aluminium Industry



Source: Energy Efficiency Best Practice. Commissioned by ISR and undertaken by ACIL, Hannagan Bushnell and REM, 1999. Industry production figures are AAC reported figures for 1998.



Results of the study

Energy efficiency performance and benchmarking

International data collected enabled benchmarking of the Australian refining, smelting and semi-fabrication subsectors against overseas counterparts on the basis of specific energy consumption per unit of production (bp-SEC). Data available for bauxite mining was not of benchmark quality.

Bauxite mining

Aluminium is the second most abundant element in the earth's crust after oxygen. It is generally accepted that internationally traded bauxite should contain at least 40% aluminium oxide. However lower grade ores are successfully mined and processed in Western Australia. In Australia, bauxite is mined exclusively using the open-cut method.

Australia has extensive reserves of bauxite within existing mining leases, as well as significant undeveloped deposits.

Australian bauxite deposits are characterised by very low stripping ratios, about 0.3:1 in the case of Weipa and Gove, and as low as 0.13:1 in the case of Alcoa and Worsley in Western Australia. Stripping ratios in the other major bauxite producing nations, such as India and those in South America, are typically in the range of 1.2:1.

After removing the top-soil and overburden, ore breaking is undertaken by the drill-and-blast method, or ripping. Ore is then excavated using front-end loaders or hydraulic excavators and hauled by trucks. Crushing of the ore usually takes place at the mine-site before the bauxite is transported to a refinery or to a port for export.

Australian miners produced approximately 44.6 million tonnes of bauxite in 1998, about 90% being further processed into alumina by local refiners.

Average energy consumption for bauxite mining in Australia was found to be 45MJ/t of ore with a 50% variation between highest and lowest values in specific consumption.

International benchmarking for bauxite mining was not undertaken because of lack of suitable data. However, because of the low stripping ratios and relatively soft homogeneous ores typical of most Australian bauxite deposits it is expected that energy intensity within Australian bauxite mines would compare favourably with those in the other major bauxite producing countries. The differences in ore quality and haulage (both distance and method) are the prime reason for the variation in energy per tonne mined among mine sites in Australia.

Total energy used in bauxite mining in Australia in 1998 was 2PJ, costing the industry $20 million. Energy cost per tonne of bauxite as mined is $0.50.

While there are very significant differences among sites and companies in their mining and refining operations (for example, type of equipment, operational methods and mining conditions), and recognising the limitations of the data gathered in the energy survey, some appreciation of the importance of the energy saving opportunities can be inferred from the identification of best practice in Australian operations. For example, if all mining sites operated at the energy efficiency of the lowest-energy-using bauxite mine

(40MJ/tonne), a reduction of about 11%, representing $2 million a year, might be achieved.

Opportunities that were identified for energy efficiency improvement in bauxite mining include:

- *design and gradients of haul routes;*
- *logistical planning of mine face activity* to minimise haul distances;
- *optimisation of blasting and ripping techniques* from the perspective of reducing milling requirement;
- *increased use of cost-effective solar applications;*
- *fuel recording and maintenance practices* (condition monitoring) that optimise the fuel efficiency of haul trucks, including:
  - low-cost engine upgrades and comparison between different truck types,
  - recording of fuel use to provide information which is used to determine when particular trucks should be sent for dynamometer testing and servicing to restore fuel efficiency to design levels, and
  - driver performance in relation to fuel efficiency; and recording and monitoring of
- *Research and development (R&D) support* to haul truck manufacturers to develop larger, lighter, more fuel-efficient vehicles.

Alumina refining

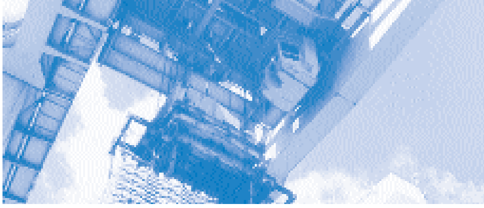
Bauxite is refined into alumina using the Bayer Process. First the bauxite is ground and dissolved in sodium hydroxide (caustic soda) at high pressure and temperature in a process called digestion. The resulting liquor contains a solution of sodium aluminate and undissolved bauxite residues. The residue or 'red mud' sinks gradually to the bottom of the tank and is removed (clarification). The sodium aluminate solution is then pumped into a tank called a precipitator. Fine particles of alumina are added to seed the precipitation of alumina particles as the liquor cools (precipitation). The particles sink to the bottom of the tank and are removed, filtered and washed. A high temperature calciner is then used to drive off moisture and chemically combined water (calcination). The result is a white powder called alumina.

It takes about two tonnes of alumina to produce one tonne of aluminium.

Over 90% of the world's alumina is used for making aluminium. The balance is used in the chemical, refractory and abrasives industries.

The majority of energy consumed in alumina refineries is in the form of steam used in the main refining process. In Australia this steam is produced by burning either gas, coal or fuel oil. Energy is also consumed in significant quantities in the form of gas or fuel oil in the calcination process. Electrical energy is used throughout the refinery in a range of core and auxiliary processes. Most refineries co-generate steam and electricity in a dedicated power plant and some export excess electricity.

Average specific energy consumption for Australian alumina refineries was found to be about 11 000 MJ/t of alumina, with a range



between lowest and highest of 30%. Total energy used by the alumina refining industry in 1998 was 160PJ at a cost to the industry of $485 million. Energy cost per tonne of alumina produced was $37 approximately.

Australian refineries dominate the low end of the global cost curve and are very low in energy intensity by world standards, primarily because of their high productivity.

Average specific energy consumption for Australia's refining industry is within 2% of world's best practice, against a world range of 36% from highest to lowest. Significant capacity expansion since 1998 (the year of the survey) is believed to have improved the average specific energy performance of the Australian refining sector.

In the same way as an estimation of the potential for energy saving was made for the mining sector, the equivalent calculation would suggest a 16% reduction in refining energy use might be possible (the best refining operation achieving 9 458 MJ/t), representing a possible saving of $78 million from total energy costs of about $485 million a year.

It must be emphasised that these indicative, inferred energy saving opportunities are not targets and nor do they represent theoretical optimums — particularly as the costs of achieving these savings have not been taken into account, and no account has been taken of the limit in investment capital and the alternative investment opportunities open to the companies. Further data would be required to identify, and subject to economic assessment, the determinants of the observed differences in performance.

Productivity is the major driver for Australian plants, with all running at full capacity and pushing to maximise tonnage through modified operations and/or expansions. Total energy costs are internationally competitive but they may not be the primary source of the cost advantages over other producing countries.

Opportunities for energy efficiency improvement in alumina refining include:

- *improved thermal efficiency:* Thermal energy efficiency improvements in individual processes such as heat exchange into slurries, alumina calcination, and evaporation. The development of advanced optimisation strategies to improve the balancing of energy usage against other factors. As in the chemical industry, the alumina industry is increasingly using pinch analysis techniques.
- *improved co-generation energy efficiency:* Natural gas is increasingly being used both for calcination and for steam generation. Co-generation plants offer significant operational, cost, and energy efficiency advantages. All refineries in Australia have co-generation systems built around the requirement for large quantities of process steam. There may be opportunities for improving overall energy efficiency in refinery operations by reconfiguring central steam plants to optimise the combined production of steam and power.
- *improved compressed air systems:* The production and generation of compressed air is widely recognised as an area where there are opportunities for improvement in a wide range of industries including the aluminium industry. It is expected that the best practice program will address this across a number of industry sectors, and it is proposed that the aluminium sector be included.

Case study – Alcoa Western Australian Refineries

Alcoa of Australia Ltd is installing process control software from Honeywell at the Pinjarra refinery in Western Australia. The system is called robust multi-variable predictive control technology (RMPCT), and it has provided Alcoa with a significant improvement in efficiency in the bauxite digestion process.

RMPCT is Honeywell's premier advanced control software. It is designed to learn from, and compensate for, the dynamics of a process including changes in operating mode, through-put, feed quality or other types of process disturbances while tracking optimisation or operator-entered targets and honouring process constraints. This robust process controller enables optimisation of processes over a wider range of operating conditions, resulting in higher utilisation factors.

Alcoa has a global alliance with Honeywell, which is the preferred vendor for process control technologies in all Alcoa refineries worldwide. Honeywell's RMPCT software provides a control tool in a generic format that can be customised for application into most of the refineries' processes. Initially it has been installed into the digestion trains but there is scope to expand it into other areas.

To set up the RMPCT process controls, 'step tests' were completed where a step change was introduced into one of the controllable variables, such as the flow into one of the digesters, and the outcomes were monitored. Mathematical models were developed for the digestion process. The mathematical models were then used within the RMPCT software to optimise a number of outputs, to maximise the amount of alumina produced and to minimise energy inputs.

Since the installation of the RMPCT software into the bauxite digestion process in November 1996 a significant improvement in process efficiency has been realised with consequent financial savings. The software took about eight months to set up and had a pay-back period of about six months.

Currently Alcoa is doing a feasibility study of applying RMPCT to the grinding circuits at the Wagerup refinery. For this Honeywell is offering a version of RMPCT called 'Smart-Grind'. The company is also looking at controlling the calciners at the Kwinana plant with this software.

Aluminium smelting

Aluminium is smelted from alumina using the Hall-Héroult Process invented in 1886. The process involves dissolving alumina in an electrolytic bath of molten sodium aluminium fluoride. Direct current electricity is passed through the electrolyte at low voltage and high current. The electric current flows between a carbon anode, made of petroleum coke and pitch, and a cathode, formed by a carbon or graphite lining of the container which is known as a ‘pot’. The anodes are consumed as part of the electro-chemical reaction. Molten aluminium is deposited at the bottom of the pot where it can be siphoned off.

There are two main types of aluminium smelting technology – Söderberg and pre-bake. The principal difference between the two is the type of anode used. Söderberg technology uses a continuous anode which is delivered to the pot as a paste, and which bakes in the pot. Pre-bake technology uses anodes that are pre-baked and suspended in the pot. When the anode has been consumed it is replaced.

All Australian smelters use a variation of pre-bake technology known as centre worked pre-bake technology (CWPB). This technology provides for computer controlled precise alumina feeding and anode control.

Australian aluminium smelters are fully integrated with anode production, smelting and ingot casting all occurring on site.

Average specific energy consumption for the Australian smelting sector is approximately 78 400 MJ/t of aluminium, with a variation of around 24% between the highest and lowest energy user. Of this about 52 000 MJ/t is in the form of electricity used in the electrolytic process, the detailed study of which is outside the scope of this report. Further, about 18 000 MJ/t is embodied in the coke and pitch used to produce the anodes, which is outside the control of the industry.

The central electrolytic cell process and the material consumption of carbon in the anodes were excluded from the scope of this study as neither is amenable to short-term process change, and they comprise major research investigation areas in their own right. The study concentrates on the ancillary energy use of 8 400MJ/t of aluminium.

Total energy used by the aluminium smelting industry in 1998 (excluding coke and pitch) was 128PJ at a cost to the industry of approximately $520 million. Energy cost per tonne of aluminium produced was approximately $320, of which about 10% is ancillary energy use and the subject of this study.

On average, only the smelters in the African region achieve a lower specific electricity consumption than Australian smelters. Further, the Australian average is better than the world average in the electrolytic process by about 3% – and better than the European average by about 6% and the US average by about 5%.

While there are differences among sites and companies in their operations, and recognising the limitations of the data gathered in the energy survey, some appreciation of the importance of the energy saving opportunities can be inferred from the identification of best practice in Australian operations.

Case study – Tomago fume system, Hunter Valley

The Tomago smelter is assessing the use of variable speed drives (VSD) for motor/flow control. A feasibility study for this project was completed by EnergyFirst, the energy management division of EnergyAustralia. A $2 million investment was indicated with a pay-back period of about two years. Detailed trials are now under way using variable voltage/variable frequency (VV/VF) converters from different manufacturers to evaluate the savings, the mechanical and electrical performance, and the attributes of the converters.

Case study – Haulage to Kurri Kurri Smelter, Hunter Valley

Haxton Haulage hauled coal, alumina and coke to the Kurri Kurri smelter in a fleet of 23 articulated trucks. Through close monitoring and recording of fuel usage, various strategies for reducing fuel consumption were trialled, including low-cost engine upgrades and comparisons among different truck types. Recording of fuel use also provided information that was used to determine when particular trucks should be sent for dynamometer testing and servicing to restore fuel efficiency to design levels. Driver performance in relation to fuel efficiency could also be recorded and monitored. Fuel consumption was estimated to have been reduced by about 13%.

For example, if all sites operated at the energy efficiency of the lowest energy using smelter (6 331MJ/tonne in the non-electrolytic activities, and excluding coke and pitch production), energy use might be reduced by 18% representing $9 million, from total energy costs of about $52 million a year. Again it must be emphasised that these indicative, inferred energy saving opportunities are not targets; nor do they represent theoretical optimums – particularly as none of the costs of achieving these savings has been taken into account, and no account has been taken of the limit in investment capital and the alternative investment opportunities open to the companies.

Opportunities for energy efficiency improvements in the smelting subsector include:

- *improved smelter fume systems:* Power requirement for the fume treatment is determined largely by the choice of technology and factors such as the filter bag area and the pressure drop across the bags. In some cases there is potential for better sealing of the cell and reducing the overall draught requirement for fume capture. Some plants have also implemented two-stage draught rates that can be uprated while cell hooding is removed for routine operations like anode change. There are likely to be opportunities at some smelters to retrofit high energy efficiency drive systems to fans and to optimise the design of fume transport and control equipment.
- *improved compressed air systems:* Opportunities to improve energy efficiency exist in the smelting subsector in the same way that they do in the refining subsector.
- *improved anode plant operations:* Apart from feedstocks the major area of energy consumption in the anode plant is the use of gas for anode baking. The range

between highest and lowest for specific gas consumption for anode baking at individual smelters is 27%. Most Australian smelters have already achieved significant reductions in anode bake energy, in two cases as high as 30%, but there may still be scope for further improvements (AAC 1994).

- *improved casthouse operations:*
  As casthouse operations and product mixes vary widely among smelters, it is expected that specific opportunities for improvement in energy efficiency will need to be pursued individually at each smelter. For some of the smelters where extrusion billet is produced, homogenisation is one area where improvements may be made.

Semi-fabrication

The starting point for semi-fabrication is either cast ingot or billet. Both rolling ingot and extrusion billet are alloyed, usually at the smelter, with a variety of elements to improve the mechanical and physical properties of the semi-fabricated products.

The extrusion process uses cast cylindrical billets as its raw material. The billets are sawn to typical lengths of 50cm–80cm and heated to 450–500°C. A die of the required design is also heated to the same temperature and fitted to an extrusion press. A hydraulic ram then forces the hot aluminium to flow through the die. Finally the extrusions are cut to length before being annealed.

Rolling ingot is cast, usually at the smelter and typically into rectangular blocks of seven to eleven tonnes. The ingot is scalped after casting to provide a smooth surface finish.

The ingots are preheated to about 500°C to improve their metallurgical properties. Preheating reduces alloy segregation and provides a more homogeneous ingot. The ingot is then repeatedly passed through a hot reversing mill to bring down its gauge. Hot rolling is usually carried out at a temperature above the recrystallisation temperature of the metal to prevent strain-hardening.

The major energy consuming processes in aluminium semi-fabrication are: preheating of the billet or ingot and any die or tooling; mechanical deformation through the extrusion press or rolling mill; and heat treatment to achieve the required mechanical and physical properties. Energy is also used in a variety of auxiliary processes.

Of the two rolled aluminium products companies in Australia, only one participated in the survey, making publication of detailed results not possible for commercial reasons. Uncertainty in international benchmarking data in the rolled products sector adds to the difficulty of energy-use comparisons.

In the extrusion industry, average energy consumption per tonne of extruded product was about 3 750MJ. Total energy used by the participating extrusion companies in 1998 was 144 038GJ costing about $1.1 million.

Detailed benchmarking data was obtained for extrusion operations in the United Kingdom (UK). While comparison is difficult because of large variations among individual extrusion plants in both the Australian and UK industries, the averages from the Australian survey for preheating, electricity use in extrusion presses, heat treatment and total specific energy consumption are all at the low end of the ranges presented for the UK.

There are significant differences among sites and companies in their operations. The extrusion businesses themselves cannot be compared, nor can the extrusion and rolling businesses in terms of energy efficiency. Nevertheless, in manufacturing operations of this general type, it is often found that 10% of energy costs might be saved with commercially viable investments in management and operating practices. A 10% improvement in energy use would reduce energy costs in the subsector by $0.6 million a year

Opportunities for energy efficiency improvement identified in the semi-fabrication subsector include:

- *die oven management (extrusion only).*
- *heat treatment.* Improvements in heat recovery and process optimisation.
- *automated process control.*
- *variable speed drives.* An opportunity may exist for the use of variable speed drives for presses and in rolling mills.
- *compressed air and lighting.* Similar opportunities exist in the semi-fabrication subsector for improving compressed air lighting systems as in the refining and smelting subsectors.
- *ingot heating.*

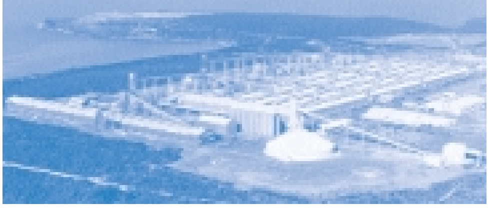
Energy efficiency improvement strategies

Based on the energy efficiency improvement opportunities identified in this study for each of the industry subsectors of mining, refining, smelting and semi-fabrication, energy efficiency improvement strategies were developed by the industry.

The strategies conform to a general scheme:

- an objective or objectives;
- a process to identify challenges and opportunities to help meet the objective(s), including the benchmarking of current operations (which this study has undertaken);
- a plan of action which recognises (and perhaps removes/mitigates) the constraints and takes advantage of the opportunities, and identifies responsibilities for the actions;
- a process for monitoring, reporting and evaluation of progress; and
- a loop to re-evaluate the strategy.

The final step in the study was the drafting of a sector-wide plan detailing implementation of the strategies. The industry is now considering future steps in implementation identified in this plan.



Conclusion

Australia has the lowest energy intensity aluminium industry in the world. While there are individual state-of-the-art operations recently begun or being built overseas that are lower in energy intensity, in each of its subsectors on average the Australian industry performs at least as well as the industry on average in competitor nations.

Maintaining this competitive advantage however remains a challenge. While extensions to existing operations and new greenfields plant will adopt the most energy-efficient options available, the Australian industry must compete for new investment capital with alternative investment locations.

The opportunities for energy efficiency improvement identified in the Aluminium sector study, together with the improvement strategies that have been developed, provide an important framework through which continuous improvement in energy efficiency can be pursued by the Australian aluminium industry.

References

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Abbreviations

AAC	Australian Aluminium Council
ABARE	Australian Bureau of Agricultural and Resource Economics
ACIL	ACIL Consulting
bp-SEC	Specific energy consumption per unit production
C	Celsius
cm	Centimetre
CWPB	Centre worked pre-bake technology
GJ	Gigajoule
kt/y	Kilotonnes per year
MJ	Megajoule
na	Not available
PJ	Petajoule
R&D	Research and development
REM	Redding Energy Management
RMPCT	Robust multi-variable predictive control technology
t	Tonne
TJ	Terajoule
tpa	Tonnes per annum
UK	United Kingdom
US	United States of America
VF	Variable frequency
VSD	Variable speed drive
VV	Variable voltage