Aluminum

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(Notes: General material on aluminum is included near the end of this chapter. It is also available on the Internet at www.nrcan.gc.ca/mms/scho-ecol/main_e.htm# aluminum. Abbreviations of company names used in this paper are listed in Table 10 along with known Internet addresses of those companies.)

Canada's rank in world production of primary aluminum:	Third
Installed capacity (March 2004):	2.72 Mt/y[1]

2003	Amount	Value (p)
Primary aluminum production	2.79 Mt	$5.6 billion
Exports (unwrought)	2.20 Mt	$4.8 billion
Exports (HS Chapter 76[2])	n.a.	$8.2 billion

n.a. Not applicable; (p) Preliminary.

World production of primary and recycled aluminum increased in 2003 to an estimated total of 35.6 Mt, compared to the past record of 33.8 Mt in 2002. Of this total, 27.9 Mt was primary metal, compared to 26 Mt in 2002.

Although the average London Metal Exchange (LME) price for primary aluminum was higher in 2003 compared to 2002 due to the increased value of the Canadian dollar, the value of the year's production in Canadian dollar terms was less than in 2002. In U.S. dollar terms, however, prices generally increased throughout the year, ending on a high (see table at top right and Figures 9 and 10).

PRIMARY ALUMINUM CASH PRICE, LME, 2001-03

	2001	2002	2003
		(US$/t)	
Year average	1 444 (66¢/lb)	1 349 (61¢/lb)	1 432 (65¢/lb)
Start of year	1 567 (71¢/lb)	1 324 (60¢/lb)	1 341 (61¢/lb)
End of year	1 335 (61¢/lb)	1 345 (61¢/lb)	1 592 (72¢/lb)
Year high	1 737 (79¢/lb)	1 438 (65¢/lb)	1 592 (72¢/lb)
Year low	1 243 (56¢/lb)	1 276 (58¢/lb)	1 315 (60¢/lb)

Prices in the spot alumina market continued to rise in 2003 as smelter expansions, particularly in China, placed increased demand on spot markets. *Metal Bulletin* has reported that spot prices for metallurgical-grade alumina started the year at US$175-$190/t, rose to US$330-$350/t by year-end, and subsequently rose to US$440-$460/t in early 2004.

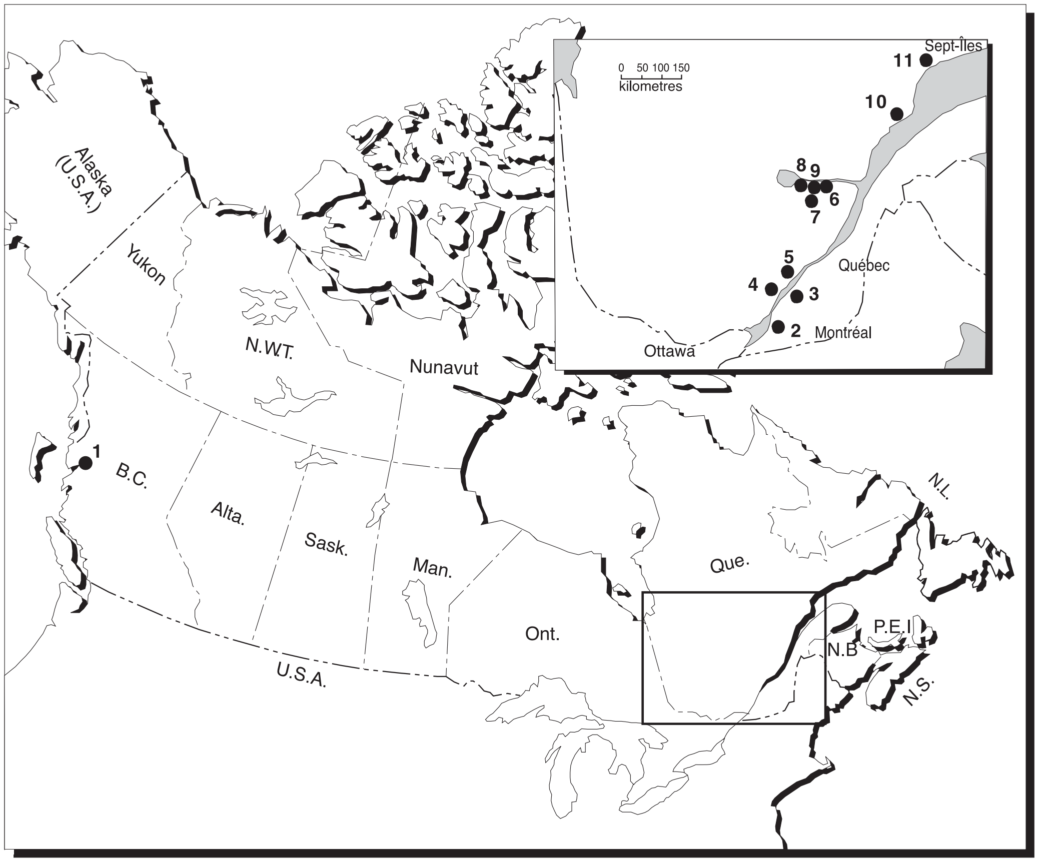
CANADIAN DEVELOPMENTS

Production of primary aluminum in Canada increased 3.1% to 2.79 Mt in 2003, compared with 2.71 Mt in 2002, ranking Canada third after China and Russia in terms of world primary production. Monthly Canadian production statistics can be obtained on Natural Resources Canada's Internet site at http://mmsd1.mms.nrcan.gc.ca/mmsd/data/default_e.asp.

The value of Canadian primary aluminum production in 2003 is estimated at $5.6 billion, down slightly (2%) from $5.7 billion in 2002. The increase in volume of production has only partly offset the decline in Canadian dollar terms caused by the increase in the Canadian dollar relative to the U.S. dollar.

Canada is the second largest aluminum-exporting country in the world after Russia. Canadian exports of primary smelter products in 2003 increased in quantity to 2.33 Mt valued at $4.807 billion (US$3.43 billion), compared to 2.13 Mt valued at $4.937 billion (US$3.14 billion) in 2002. Of this amount, unwrought exports to the United States totaled 1.79 Mt valued at $3.87 billion (US$2.76 billion) (see summary above and Table 1).

Figure 1
Aluminum Smelters, 2003



SMELTER	COMPANY	CAPACITY (t/y)
1. Kitimat	Alcan	275 000
2. Beauharnois	Alcan	50 000
3. Bécancour	A.B.I.	403 000
4. Shawinigan	Alcan	91 000
5. Lauralco Deschambault	Alcoa Lauralco	249 000
6. Grande-Baie	Alcan	198 000
7. Laterrière	Alcan	219 000
8. Alma	Alcan	400 000
9. Arvida, Jonquière	Alcan	253 000[a]
10. Baie-Comeau	Canadian Reynolds Metals (Alcoa)	438 000
11. Alouette	Alouette	244 000
		2 820 000

[a] Alcan announced that 90 000 t/y of this capacity will be closed (February to April 2004).

Reported Canadian use of aluminum metal at the first processing stage, including the use of recycled aluminum, was 1 019 713 t in 2002, up 6% from a revised figure of 964 609 t in 2001[3] (Table 3a).

Aluminerie Alouette Inc. has continued work on construction of a $1.4 billion expansion of its smelter from 244 000 t/y to 550 000 t/y. Preliminary work began in late 2002 and the first metal is expected in 2005. In addition to the 2500 construction jobs, the expansion will create 340 permanent new jobs at the smelter and 1500 indirect jobs in other areas of the province. Partners in this smelter are Alcan (40%), Aluminium Austria Metall Québec (20%), Hydro Aluminum (20%), Société générale de financement du Québec (SGF) (13.33%), and Marubeni Québec Inc. (6.66%). Further details are available on the company's web site at www.alouette.qc.ca.

On July 7, 2003, Alcan announced an unsolicited purchase offer for Pechiney to solidify its position as one of the world's largest aluminum and packaging companies. Alcan subsequently worked through the rest of the year on this acquisition and, in early 2004, announced that it had successfully completed the purchase of Pechiney shares. Work continues to fulfill conditions imposed by regulatory agencies regarding the takeover, including the sale of assets in the European Union and the United States. The resulting company creates additional value for all shareholders as the new company is expected to benefit from a broader product portfolio, technological leadership and enhanced market capability. Alcan has announced that it would locate its corporate headquarters for the packaging component in Paris and has further identified France as the headquarters for its European primary aluminum business component, including its global centre of excellence for new cell technology development in primary aluminum.

In January, Alcan announced that it was closing 90 000 t/y of capacity by the second quarter in an older part of the Jonquière smelter containing Söderberg technology. In the announcement, Alcan stated that its priority was to take care of the workers and minimize the impact, and that it did not envision lay-offs for any of the 550 affected workers. Nevertheless, workers at the plant were surprised by the announcement, concerned about the job losses in the region, and initially occupied the smelter, refusing to allow the company to start closing the plant. During negotiations with workers, Alcan agreed to provide additional funding for regional economic development initiatives.

Alcan announced that it was investing in a new spent potliner treatment plant based on a process developed by Alcan researchers. The plant will be constructed at the Jonquière complex in the Saguenay–Lac-Saint-Jean region of Quebec. The 80 000-t/y facility represents the first commercial application of Alcan's new low caustic leaching and liming process. Construction is scheduled to start in mid-2004 after completion of public hearings and receipt of permits.

Alcan's 275 000-t/y smelter at Kitimat, British Columbia, continued operating at a reduced rate of 240 000 t/y. Production rates had been reduced in 2001 due to low water levels in the Nechako Reservoir and had increased to the current rate in mid-2002. High prices for electricity have resulted in large increases in demand for power in the southwestern United States. Sales of surplus power by Alcan from the Kemano Dam to help meet that demand have created concern in the community over the potential for longer-term job losses in the production of aluminum as Alcan is a major employer in the region. Representatives of the District of Kitimat filed suit in the Supreme Court of British Columbia to prevent these sales of electricity in January 2004. (Additional information is available on the Internet at www.alcan.com and www.city.kitimat.bc.ca.)

Alcoa signed a Memorandum of Understanding with the Quebec government on March 5, 2003, on the expansion of the Deschambault smelter (Lauralco) located near Québec City. However, after provincial elections, the newly elected Quebec government indicated it would not proceed with that Memorandum. Alcoa wishes to expand the smelter from 250 000 t/y to a capacity of 570 000 t/y. Construction on the project was to have started in 2006 with production starting in 2008 and full capacity to be reached in 2013. Alcoa had agreed to create a minimum of 1250 jobs, most of which would be in the Quebec aluminum fabricating industry, and more than 250 jobs with the expansion of the Deschambault plant. In early 2004, negotiations were continuing between the Province and Alcoa.

Alcoa had also signed an agreement with the Quebec government in December 2002 on an upgrade to the 437 000-t/y Baie Comeau smelter. The agreement provided for the additional power required for the operation of new pre-baked cells, which will replace existing Söderberg technology and expand the capacity of the smelter. Construction of the $1 billion upgrade to the smelter began in 2003. The capacity of the smelter would increase by 110 000 t/y to 547 000 t/y in 2010. Due to uncertainties concerning the availability of power and other terms of the agreement, the company suspended renovations on the smelter in January 2004 although, in early 2004, negotiations were continuing between the Province and Alcoa.

Aluminerie de Bécancour, with a capacity of 390 000 t/y, is now owned by Alcoa (74.95%) and Alcan (25.05%) after its takeover of Pechiney.

In British Columbia, the Alberni Aluminium Corporation continued work on a proposal to build a 360 000-t/y aluminum smelter to be located near Port Alberni, Vancouver Island. Efforts continued to obtain a long-term power supply and to identify investors for the project. The proposed smelter would require 650 MW of power and new infrastructure, including power lines. Engineering and permitting studies were estimated to require up to three years for completion. Construction would take 34 months and, as a result, metal production would not occur before 2009. A total of 650 direct jobs and a substantial number of indirect jobs would be created with this proposed US$1.5 billion smelter.

Both Alcan and Alcoa are included in the Dow Jones Sustainability Index. Individually, they and their regional operations organize and participate in various social, community and environmental initiatives in Canada and around the world. (Visit www.alcan.com, www.alcoa.com and www.icsc.ca for current information.)

CANADIAN OUTLOOK

Although Canadian aluminum production capacity increased substantially during the latter half of the 1980s and early 1990s, it remained relatively stable until Alcan's new Alma smelter opened in 2001. Canada's production capacity increased slightly to 2.81 Mt/y at the end of 2003 as capacity creep[4] was reported in several smelters. With Alcan's closure of the Söderberg capacity at the Jonquière smelter in early 2004, it is expected that Canadian production will fall about 2% to 2.72 Mt in 2004.

The Alouette smelter expansion will pour its first metal in 2005 and is expected to reach full capacity by year-end. As a result, Canadian production is expected to increase to 3.1 Mt in 2006.

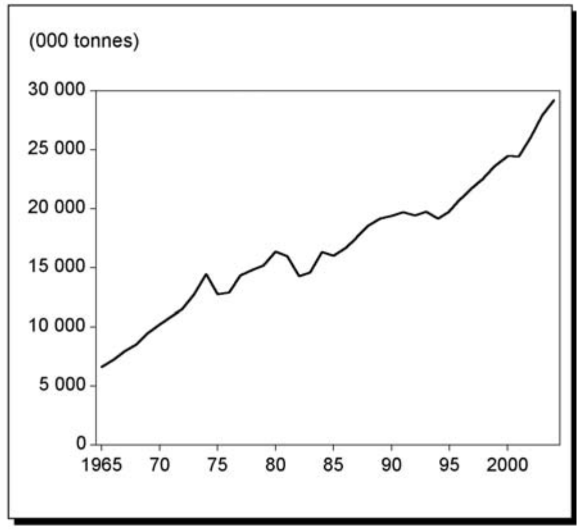
On a longer-term basis, potential modernization/expansions at the Baie-Comeau and Deschambault smelters may counter the expected closures of Canadian Söderberg technology that are expected to occur in the next decade.

PRODUCTION, USE AND INVENTORY

World production of primary aluminum increased 6.6% to 26 Mt in 2002 from a revised 24.4 Mt in 2001 (Table 8). World production is estimated to have risen by 7% to 27.8 Mt in 2003 and is expected to rise by a further 4.6% to 29.2 Mt in 2004.

The International Consultative Group on Nonferrous Metal Statistics reported that total world use of primary aluminum was 25.7 Mt in 2002, 6.9% higher than the revised figure of 24.0 Mt for 2001 (Table 9). On a longer-term basis, the average daily production rate has been growing at about 2% per year since 1980 (Figure 2); however, recent growth rates (except in 2001) have been much higher.

Figure 2
World Total Primary Aluminum Production, 1965-2004 (f)



Source: International Consultative Group on Nonferrous Metals Statistics.
(f) Author forecast for 2004.

Figure 3
Canadian Primary Aluminum Production, 1985-2010

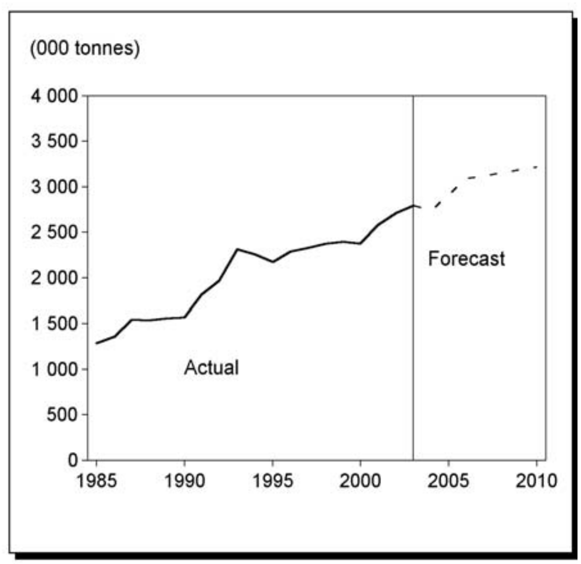
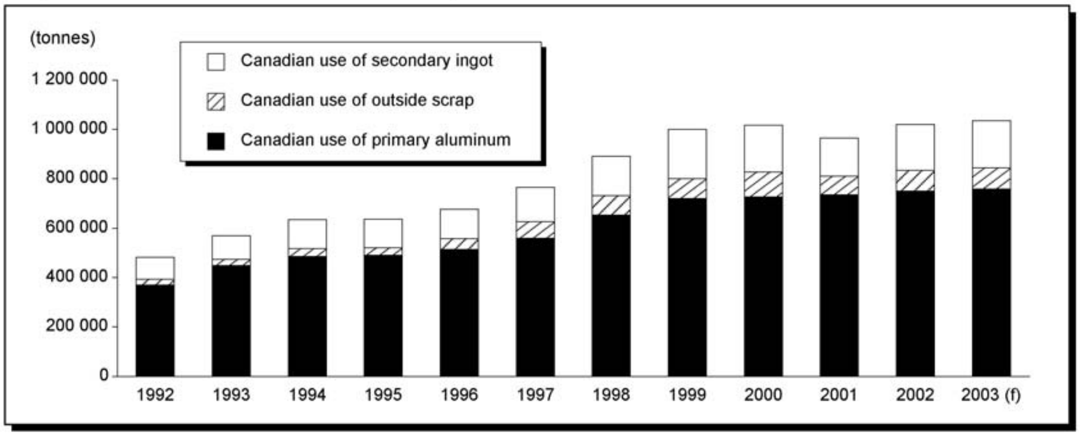
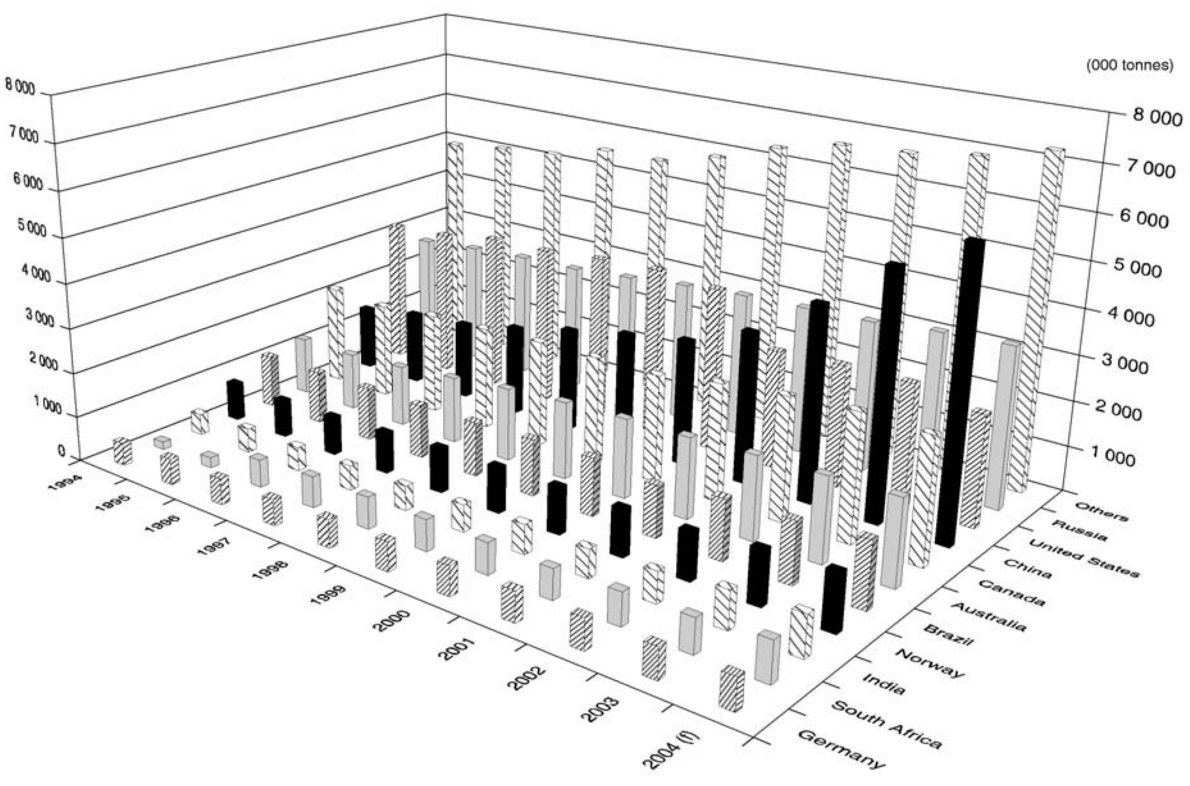


Figure 4
Reported Canadian Use of Aluminum, 1992-2003



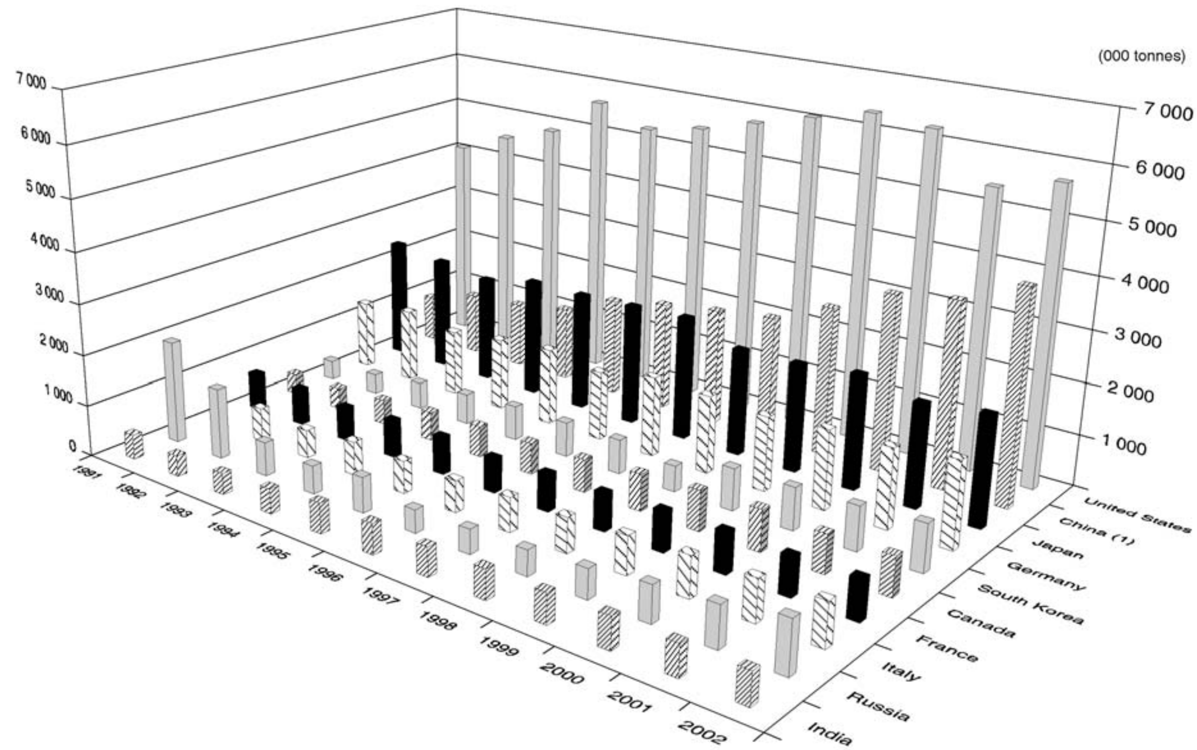
Source: Natural Resources Canada, Annual Survey of Aluminum Metal Use in Canadian Establishments.
(f) Forecast.
Notes: Export figures are obtained from Canadian government trade data. Data on metal use are obtained from responses to questionnaires sent to aluminum-using companies. In 2002, over 178 Canadian companies used primary, recycled and scrap aluminum. Companies surveyed include primary metal producing, recycling, casting, rolling, extruding and foundry operations.

Figure 5
Primary Aluminum Production, Top Ten Producers, 1993-2004
Total Estimated Production in 2003 = 27.9 Mt



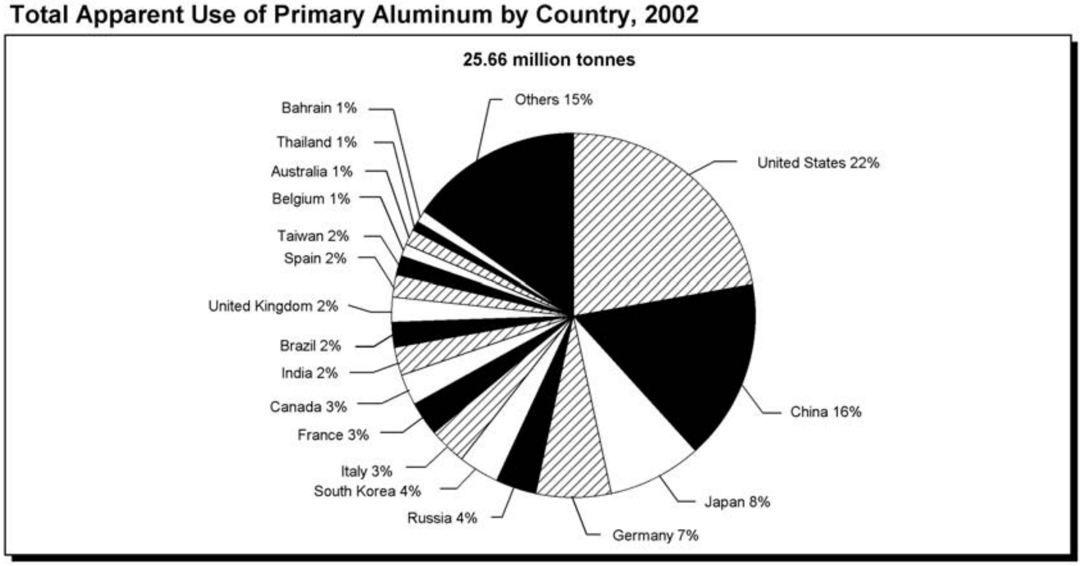
Sources: International Consultative Group on Nonferrous Metals Statistics; World Bureau of Metal Statistics; International Aluminium Institute; company reports and journals.
(f) Author forecast.

Figure 6
Apparent Use of Primary Aluminium, 1991-2002
Top 10 Contries = 72% of Total



Source: International Consultative Group on Nonferrous Metals Statistics.
(1) Starting in 1997, Hong Kong is included with China.

Figure 7
Total Apparent Use of Primary Aluminum by Country, 2002



Source: International Consultative Group on Nonferrous Metals Statistics.

The World Bureau of Metal Statistics (WBMS) reported that, in 2003, use of primary aluminum was 27.4 Mt. Asia was the region in the world with the largest aluminum use, accounting for over 40% of total world refined aluminum use. Europe accounts for 30% and North America accounts for about 25%. (WBMS has an Internet site at www.world-bureau.com.)

Production by International Aluminium Institute (IAI) members reached 21.9 Mt in 2003 (about 75% of world primary production). Members' primary aluminum production rate increased 3.9% during the year to 61 700 t/d in December 2003 from 59 300 t/d in December 2002. The average production rate for all of 2003 was 60 100 t/d, compared with an average of 58 100 t/d in 2002 (an increase of 3.4%). Members' aluminum production capacity increased from a revised 23.213 Mt/y at the end of 2002 to 23.795 Mt in December 2003. (The IAI has an Internet site at www.world-aluminium.org.)

IAI total inventories started the year at 3.0 Mt and remained relatively constant, ending the year at 2.97 Mt. In general, LME primary aluminum inventories increased throughout 2003, continuing a trend that started in 2000. High-grade inventories started the year at 1.2 Mt and, after dipping in May to 1.1 Mt, increased steadily to end the year at 1.4 Mt. Similarly, aluminum alloy stocks in LME warehouses in January 2003 were approximately 30 000 t and increased during the year to 63 000 t in December.

Combined IAI members' and LME aluminum inventories totaled 4.6 Mt at the end of 2003. This represents approximately 50 days of global supply/use.

The IAI also reported that members' refined[5] alumina production capacity increased from 53.615 Mt/y in December 2002 to 55.298 Mt/y in December 2003, while alumina production also rose from 49.785 Mt in 2002 to 52.555 Mt in 2003.

WORLD DEVELOPMENTS

China continues to expand production capacity. It became the largest producer of primary aluminum in the world in 2001, increased its production by about 28% in 2002 and a further 25% in 2003 when it produced 5.4 Mt, and is expected to increase production an additional 15% in 2004. This rapid increase in production has placed upward pressure on alumina prices globally and has increased power costs within China.

The Chinese government continues to place pressure on older smelters to close or modernize and, in late 2003 and early 2004, the Chinese government took measures to restrain phenomenal growth rates in various industries, including aluminum. Chinese primary aluminum production is expected to be above 6.2 Mt in 2004 (Figure 5, Table 8). Measures taken to curb growth rates include: policies to close older Söderberg smelters (government policy is for closure by the end of 2004); increased charges for power; reduction of the Value Added Tax (VAT) rebate on primary aluminum exports from 15% to 8%; and cutbacks on supplies of alumina from Chalco to smelters that do not follow government policy. In addition, higher raw materials prices, increased power costs and power shortages have been reported and are expected to slow the growth rate from the rates seen in 2001-03. Although high spot alumina prices (US$450-$500/t in early 2004, up from US$240-$270/t in early 2003) did help reduce the growth rate of expansion, the continued high prices, coupled with government initiatives, are expected to further delay some projects in China.

The European Union imposed (on March 1, 2004) a 5% duty on U.S. metal exports, including aluminum, as a counter-measure in connection with the World Trade Organization (WTO) dispute on U.S. foreign sales corporations. This duty has automatic increases of 1% per month to a total of 17%. The EU measure is in line with WTO authorization to apply counter-measures of US$4 billion following failure of the United States to eliminate illegal support subsidies to U.S. foreign sales corporations. (Additional information is available on the Internet at http://europa.eu.int/comm/trade/issues/respectrules/dispute/pr051103_en.htm and http://trade-info.cec.eu.int/doclib/html/114110.htm.)

In the northwestern United States, questions about power availability and cost continue to be issues for smelters. It is expected that production in 2004 will fall a further 10% to about 2.4 Mt due to the resulting financial pressures placed on these smelters to temporarily or permanently reduce production.

Expansions, proposals and studies for new mines, refineries and smelters have been announced in many countries. Nevertheless, global primary production is expected to grow by about 5% in 2004 with slightly higher growth in 2005. A partial listing of expected and potential changes is provided in Tables 11 and 12.

The Federation of Aluminium Consumers in Europe (FACE) continued its efforts to stimulate aluminum demand by promoting the use of aluminum, assessing the impact of new technologies, and reducing the costs of primary metal through tariff reductions. FACE was formed in 1999 and has approximately 40 members from European aluminum-using companies from 11 countries. As the EU uses more than double the amount of primary aluminum it produces, FACE estimates that the EU's 6% duty on unwrought aluminum imports costs European consumers US$475 million per year. In 2003, FACE continued its lobbying efforts within the EU for removal of this duty. (FACE has an Internet site at www.facealuminium.com.)

RECYCLING

The WBMS reports that Western World production of recycled aluminum metal increased to 7.7 Mt in 2003 from a revised 7.6 Mt in 2002. U.S. production, at 2.9 Mt, was the largest amount in any one country and represented almost 40% of recycled aluminum production worldwide. (The U.S. Geological Survey has an Internet site at http://minerals.usgs.gov).

Hydro Aluminium North America announced an upgrade of its facilities in the United States in Monett, Missouri, and in Ellenville, New York (www.hydro.com/en/press_room/news/archive/2003_04/ellenville_en.html). Hydro Aluminum's remelt network in the United States has a capacity of 400 000 t/y.

Reported Canadian use of outside scrap (scrap aluminum obtained from other companies) for direct use of scrap in the production of semi-finished or finished products was 83 565 t in 2002, up 11% from a revised 74 869 t in 2001, but down from the record 100 294 t reported in 2000. The reported use of aluminum metal, including scrap used in the production of recycled aluminum ingot, was 224 613 t in 2002, up from a revised 172 222 t in 2001. The reported use of purchased recycled aluminum ingot was 185 420 t in 2002, up from a revised 154 730 t in 2001 (Table 3b, Figures 4 and 5).

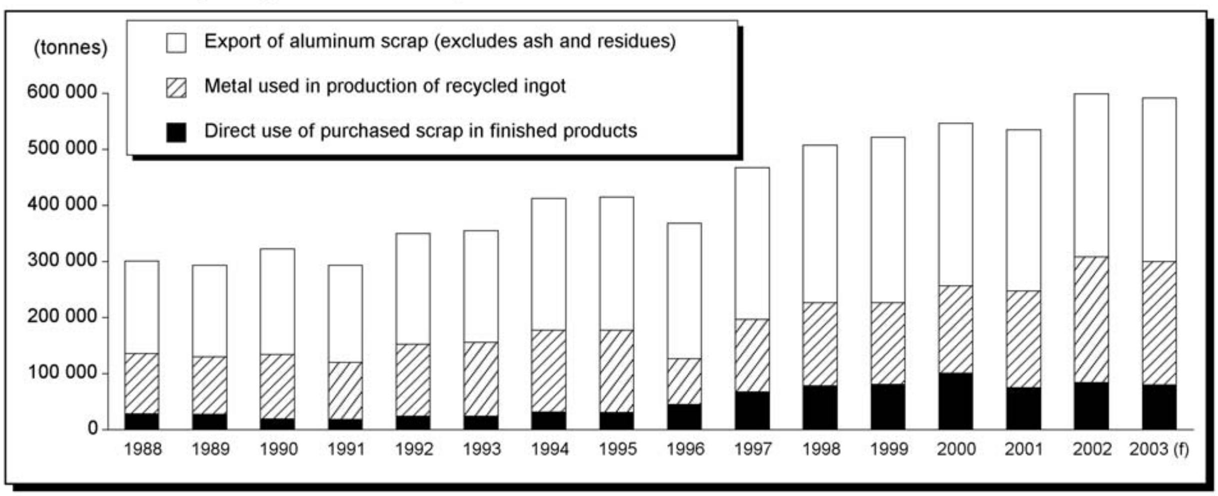
Statistics Canada, Natural Resources Canada and the Canadian Association of Recycling Industries (http://cari.recycling.org) are managing a process to improve Canadian recycling data. The existing data collection is being examined so that information presently collected can be integrated into a collection of statistics on recycling. In addition, work is also under way to determine the feasibility of obtaining new data regarding the composition and sources of discarded materials (www.recycle.nrcan.gc.ca/stats_e.htm).

Metals recycling information can be obtained through Natural Resources Canada's web site at www.recycle.nrcan.gc.ca/default_e.htm. The web site includes a listing of companies involved in recycling activities and provides an opportunity for recycling companies to add themselves to the list.

PRICES AND OUTLOOK

Primary-grade aluminum has established a longer-term price range of between US$1200 and $1800/t (US55¢ and 82¢/lb) since 1993. During 2003, London Metal Exchange (LME) cash settlement prices have trended upwards from about US$1300/t in early 2003 to reach above US$1700/t in early 2004. The 2003 average of US$1432/t (US65¢/lb) was 6% higher than the 2002 average of US$1349/t (US61¢/lb).

Figure 8
Canadian Recycling of Aluminum, 1988-2003



Source: Natural Resources Canada, Annual Survey of Aluminum Metal Use in Canadian Establishments.
(f) Author forecast for 2003.
Notes: Export figures are obtained from Canadian government trade data. Data on metal use are obtained from responses to questionnaires sent to aluminum-using companies. In 2002, 178 Canadian companies reported the use of primary, recycled and scrap aluminum. Companies surveyed include primary metal producing, recycling, casting, rolling, extruding and foundry operations.

Aluminum alloy cash settlement prices on the LME generally increased during 2003 and surpassed prices for primary material from early in 2003 to mid-May. Aluminum alloy settlement prices started 2003 at US$1337/t (US61¢/lb) and increased to end the year at US$1460/t (US66¢/lb). For 2003, alloy prices averaged approximately US$1402/t (US63¢/lb) compared to an average of approximately US$1234/t (US56¢/lb) in 2002 (Figures 9 and 10).

Prices in the spot alumina market continued to rise in 2003 as smelter expansions, particularly in China, placed increased demand on supplies. *Metal Bulletin* has reported that spot prices for metallurgical-grade alumina started the year at US$175-$190/t, rose to US$330-$350/t by year-end, and subsequently rose to US$440-$460/t in early 2004. Other published reports of alumina spot prices, particularly those within China, rose to well above US$500/t in early 2004, surpassing previous highs established in 2000. Long-term prices in Australia were reported to have fallen from A$315/t in 2001-02 to A$280/t in 2002-03 (www.doir.wa.gov.au/documents/mineralsandpetroleum/statsdigest0203.pdf), although that reduction is due mainly to currency considerations.

For alumina, IAI figures show that the alumina production capacity of its members is expected to increase from 55.3 Mt/y in December 2003 to 55.6 Mt/y in December 2004.

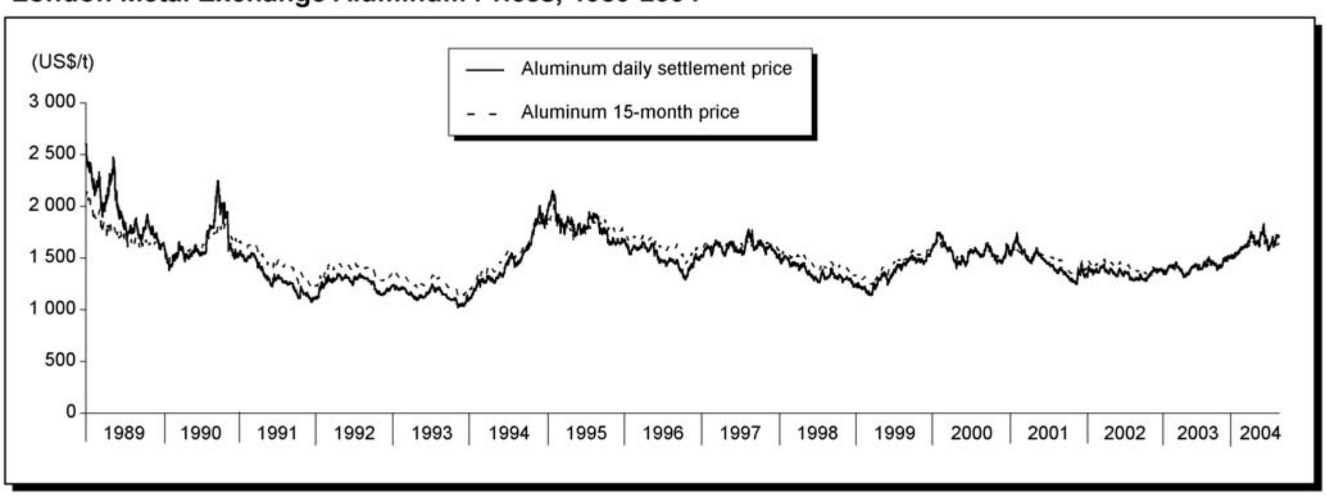
For primary aluminum, IAI figures show that the world primary metal production capacity of its members is expected to increase by about 4.4% to 24.3 Mt in December 2004 from 23.8 Mt at the end of 2003, with a lower increase (2.6%) in 2005.

Taking into account the projected increases from non-IAI members, world primary production is expected to rise by approximately 4.5% to about 29.2 Mt in 2004. This increase, combined with the 7% increase in 2003, is above the long-term growth rate. The projected increases in production suggested by Table 12 indicate that production will increase at a rate of about 5% in 2005 and by a similar amount in 2006. The declines in aluminum metal prices since 1994 appear to have provided support to increase the mid/longer-term growth rate in aluminum production and use.

Over the long term, the increasing production from larger, more efficient smelters is likely to continue the long-term trend to lower production costs and prices.

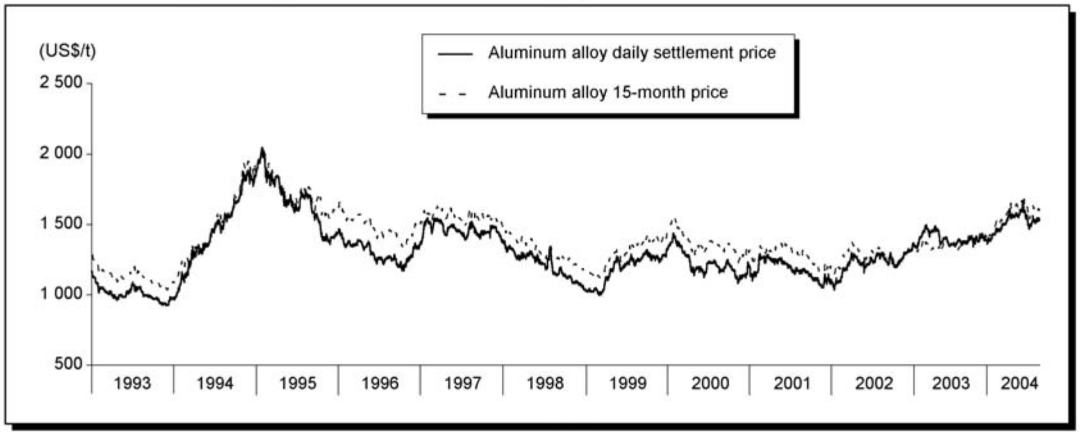
Canadian installed capacity for the production of primary aluminum at the beginning of 2004 was 2.8 Mt/y. However, with the closure of Alcan's Söderberg capacity at Jonquière, capacity fell to 2.7 Mt/y in April 2004. With the expansion at Alouette, capacity will rise to above 3 Mt/y in 2005, but increase thereafter only as a result of expected capacity creep. On a slightly longer-term basis, given the expected closures of other Canadian Söderberg capacity in the next decade and the absence of plans for new power supplies, it is likely that Canadian production capacity will level off at slightly above 3 Mt/y and production will fall thereafter unless brownfield expansions are undertaken.

Figure 9
London Metal Exchange Aluminum Prices, 1989-2004



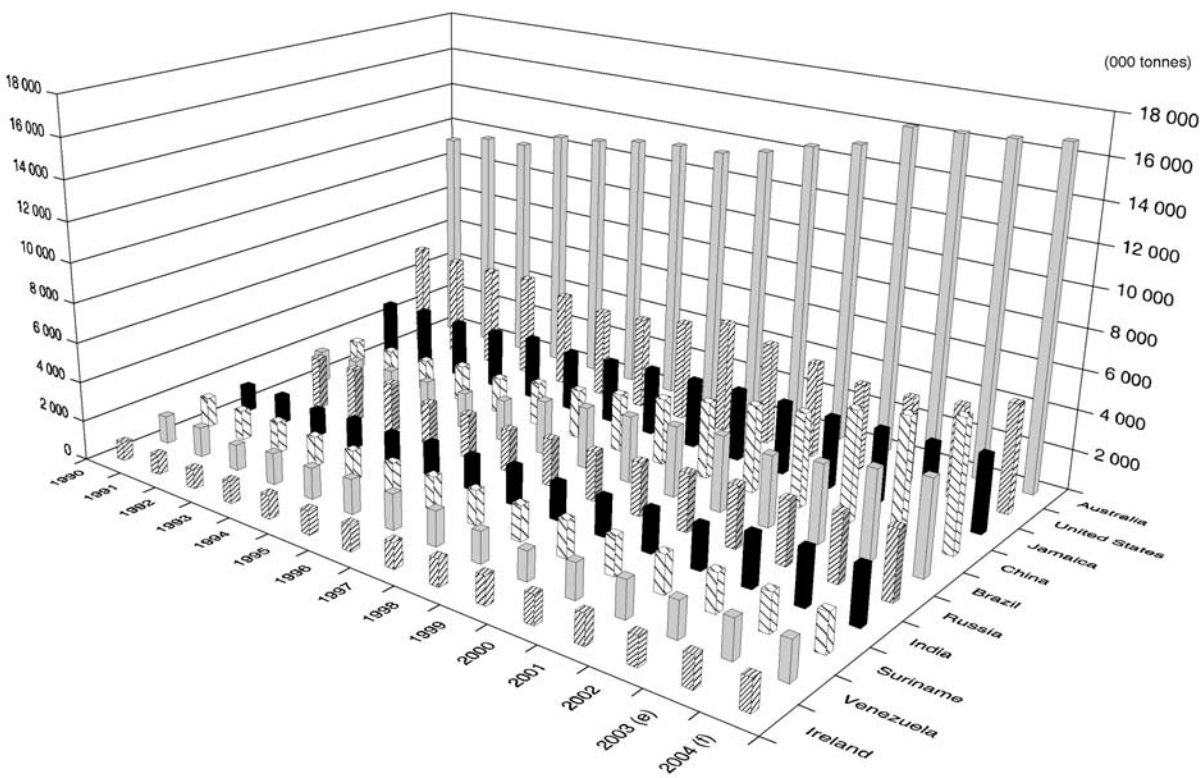
Sources: London Metal Exchange; Reuters; Metalprices.com.

Figure 10
Aluminum Alloy Prices, London Metal Exchange, 1993-2004



Sources: London Metal Exchange; Reuters; Metalprices.com.

Figure 11
Alumina Production, 1990-2004
Top 10 Producers = 84% of Total Production of 57.8 Mt in 2003



Sources: International Consultative Group on Nonferrous Metals Statistics; International Aluminium Institute; media reports.
(e) Author's estimate; (f) Author's forecast.

General Information

Background

Aluminum emerged as the wonder metal of the twentieth century and should continue to increase in importance during the twenty-first century. It outstrips all other metals in terms of amount produced and used, except for iron and steel. Aluminum's great versatility stems from its excellent properties. It is light, has great strength when alloyed, possesses a high degree of workability and conductivity, and has a pleasing appearance. Pure aluminum is a relatively soft, silvery white metal with a dull lustre that is caused by a thin coating of aluminum oxide.

Aluminum metal was first obtained in 1825 by a Danish physicist and chemist, Hans Christian Oersted, when he was investigating aluminum chloride. Alumina had earlier been recognized for its possible metallic content; Sir Humphrey Davy had tried to extract the metal in 1807. In 1845, a German physicist, Friedrich Whler, followed Oersted's achievement by producing small particles of aluminum and was the first to determine many of the metal's properties. Years later, Whler's method was improved upon by French scientist Henri Sainte-Claire Deville. His process marked the beginnings of an aluminum industry, although the cost of production was still too high to permit widespread use of the metal. In 1886, two men, Charles M. Hall of the United States and Paul-Louis Toussaint Héroult of France, independently and almost simultaneously discovered a practical method of producing aluminum by electrolysis. Although many improvements have been incorporated into the process, the world aluminum industry still uses the Hall-Héroult method of production.

Bauxite, the principal aluminum-bearing ore, contains aluminum oxide, the raw material from which aluminum metal is made. Most commercial bauxite deposits are located in tropical or sub-tropical regions of the world. On average, it takes about 4 t of bauxite to obtain 2 t of aluminum oxide, which in turn yields 1 t of metal.

The aluminum industry is different from some other metal-producing industries in that aluminum is refined before it is smelted. The first step in aluminum production is refining the bauxite ore to obtain the aluminum oxide. This is done by heating the bauxite in an autoclave (pressurized tank) and dissolving the aluminum oxide in a solution of caustic soda. Impurities settle out and the resulting liquid is treated so that crystals of alumina trihydrate are precipitated. The alumina trihydrate is then heated in kilns to temperatures from 900 to 1100°C to drive off the water in the alumina trihydrate, leaving pure aluminum oxide, or alumina, as it is usually called. Approximately half aluminum and half oxygen by weight, alumina is a fine white powder that looks something like confectionary sugar.

Using the Hall-Héroult process, the alumina is dissolved in reduction cells or "pots" that are filled with a molten electrolyte, or conductor; this is a sodium aluminum fluoride called cryolite. The cell is lined with carbon, and carbon anodes are suspended in the molten solution. With the cell lining acting as the cathode, an electric current is passed through the solution. The aluminum oxide is reduced to metallic aluminum, which sinks. In large operations, each cell can produce more than 1 t of aluminum per day.

The smelting process requires very large amounts of electricity. The industry has always developed in areas that were able to provide abundant hydro-electric power at reasonable costs. For this reason, Canada's first aluminum smelter was built at Shawinigan Falls on the Saint Maurice River in Quebec. This smelter was established by the Northern Aluminum Company Limited, now known as Alcan Inc. (Alcan). With clean and competitively priced electric power, Canadian producers are among the lowest-cost aluminum producers in the world. Canada is the second largest aluminum exporter in the world and the United States is by far the most important market for Canadian production.

The production processes for aluminum from bauxite are well documented in most encyclopaedia and many web sites such as www.aia.aluminium.qc.ca.

Changing Technology

Since its discovery in 1886, the Hall-Héroult method of smelting aluminum has been refined to reduce emissions and increase efficiency. Some of the recent gains have been obtained through the use of larger cells with higher electrical current density. In 2000, Pechiney (which has subsequently merged with Alcan) announced plans to offer its new AP50 technology, which will use 500 kA intensity in cells, up from that used (300+ kA) in AP30 technology. Pechiney expected this cell to achieve current efficiency of 95-96% and to reduce both operating and capital costs.

Research is ongoing into new methods of production. For example, over the last few years, announcements have been made and patents issued on new technological advances such as inert anodes and wettable cathodes that, when perfected, will further improve the process. Alcoa has been a leader in research for inert anodes and has indicated that it is conducting trials in commercial cells with its new anode materials. If successful, efficiencies could be increased by 10-20% and production costs could be reduced by 10-20% with less greenhouse gas generation. It may be several years before such technology becomes feasible on a wide scale. (Additional information is available on the Internet at www.alcoa.com or www.oit.doe.gov.)

In another example, the University of Ohio announced in 2000 that it had received patents to apply fuel cell technology to aluminum smelting. The process would use natural gas in zirconia tubes to directly reduce the alumina with significant power and emissions reduction. Additional research is required to perfect and apply this development to commercial smelters.

Aluminum Production in Canada

The Canadian aluminum industry differs from some other Canadian resource-based industries in that it does not mine its raw materials of bauxite or alumina in Canada. Canada has one producer of alumina that produces both metallurgical and chemical-grade alumina. All bauxite and all other alumina used in Canada is imported.

The Aluminium Association of Canada is a non-profit organization supported by Canada's aluminum producers: Alcan Inc., Alcoa Inc. and Aluminerie Alouette Inc. The Association serves as a link between the Canadian aluminum industry, aluminum users, the public and governments. The Association's Internet site, located at www.aia.aluminium.qc.ca, has information on aluminum and links to Canada's primary aluminum producers.

Occurrence, Characteristics and Uses

Aluminum is the most abundant element in the earth's crust (estimated at 8%). Aluminum does not occur naturally in its native (metal) or pure state, but is found in oxides, hydroxides, halides, sulphates, silicates, and as complexes with organic matter.

Both igneous and sedimentary rocks can contain up to 20% aluminum, predominantly in the form of aluminum silicates. Aluminum-containing silicates are also a major component of soils (contained in clay minerals, sand and rock fragments), glacial tills and the underlying bedrock. The aluminum content of "C" horizon soils and glacial tills averages approximately 8% and ranges from 3.5% to more than 10%. Although other minerals can be, and are, used for aluminum production, aluminum oxide, combined with water and other impurities and known as bauxite, is the main ore of aluminum.

Aluminum compounds move through the environment by both anthropogenic (human) activities and natural processes. The quantity of aluminum moved by natural processes far outweighs the direct anthropogenic redistribution of nonmetallic aluminum in the environment. The chemistry of aluminum in the environment is complex and dependent on many factors. The mobility and subsequent transportation of aluminum ions and compounds are dependent on various factors, including the geological weathering environment, chemical speciation (form), soil-water interaction, other elements and compounds present, and the composition of the underlying bedrock. The mobilization of aluminum compounds in the environment by human activity results predominantly from often distant activities that produce acidic precipitation. In general, a lowering of pH may result in the increased mobility of some forms of aluminum.

Pure aluminum is a silver-white, malleable, ductile metal with one third the density of steel. Aluminum's dull lustre results from a thin coating of oxide that forms instantly when it is exposed to air. The oxide, which adheres tightly to the metal, accounts for aluminum's resistance to further oxidization. Gram for gram, aluminum has twice the electrical conductance of copper. Aluminum is also an efficient conductor of heat and a good reflector of light and radiant heat.

Combining metallic aluminum with other metals produces alloys with enhanced characteristics and increased versatility. The most common metals used in aluminum alloys are copper, magnesium, manganese, silicon, lithium and zinc. Aluminum's tensile strength, hardness, corrosion resistance, and heat-treatment properties improve when alloyed with one or more of these metals. The tensile strength of some copper-aluminum alloys, for example, can exceed that of mild steel by as much as 50%.

The substitution of aluminum for heavier materials in automobile manufacturing helps reduce weight while maintaining vehicle size. Fuel use and, consequently, greenhouse gas emissions are decreased. The lowered weight can also increase safety by reducing stopping distances and improving cornering. Transportation uses are one of the fastest-growing areas of aluminum use, growing at a rate of about 4%/y. This demand will likely be fuelled by petroleum price increases and by the number of government and joint government-industry initiatives around the world to focus attention on ways to reduce the weight of vehicles. Current and past initiatives include: the Canadian Lightweight Materials Research Initiative (CLiMRI) (http://climri.nrcan.gc.ca), the Partnership for a New Generation of Vehicles (PNGV), the Auto Aluminum Alliance (www.uscar.org), the Aluminum Association Inc.'s Auto and Light Truck Group (www.autoaluminum.org) and the United States Automotive Materials Partnership (USAMP), and the European Council for Automotive Research and Development Agreement (EUCAR).

Recycling

Recycled aluminum is often referred to as "secondary" aluminum. While this latter terminology reflects a use beyond the primary use and production, the term is confusing to many people as aluminum can be recycled many times and recycled aluminum meets the specifications of new material for that application. The use of "secondary" has thus been replaced in NRCan publications by "recycled."

When used in most applications, the aluminum metal is not destroyed or consumed by the application. The metal and the energy inherent in the scrap and used products, both industrial and consumer, remain valuable resources. The recycling of aluminum requires less than 5% of the energy used to make the original metal. As a result, energy represents only 2% of an aluminum recycling smelter's operating cost compared to 22-30% for a primary smelter. As an example, the recovery of 2 kg of aluminum from used material (compared to primary production) saves more electricity than that used in one day in an average Canadian home using an alternative heat source. (Details on Canadian household energy consumption are available on the Internet at http://oee.nrcan.gc.ca.)

The automotive industry is the largest user of recycled aluminum, using some 80% of recycled production. As requirements and demand for lighter vehicles increase, it is likely that demand for recycled aluminum and automotive alloys will also increase significantly.

There has been a general increase in recycled aluminum production attributable to the increased use of aluminum globally and continued improvements in scrap collection systems and the recycling of consumer products. The World Bureau of Metal Statistics reports Western World production of recycled aluminum on a monthly basis (www.world-bureau.com).

Canadian companies recycle aluminum from both post-consumer materials and scrap produced in production and manufacturing processes. Significant quantities of recycled aluminum, in scrap, ingot or liquid metal form, are used in the production of semi-finished and finished products. In addition, there is significant trade in scrap between Canada and other countries. Canada is a net exporter of scrap.

Although there are no major facilities in Canada to remelt used aluminum beverage cans (UBC) and reform the metal into new can sheet, UBCs are collected and shipped to facilities in other countries. Details on the significant amounts of aluminum recycled in Canada are included in the tables at the end of this chapter.

Prices

Aluminum is traded on the London Metal Exchange (LME) and on various other markets around the world. As a result, price levels are relatively easily known. Aluminum metal prices can be obtained from various newspapers, news services, and journals such as *Metal Bulletin*, as well as from the LME Internet site at www.lme.co.uk and from http://metalprices.com.

Large users of aluminum often invest in smelters on a joint-venture basis, taking a share of the metal proportional to their ownership for their own use. These arrangements and others, such as long-term supply agreements between non-related producers and users (such as those between the primary producers and the automotive industry), can provide a certain measure of price stability and certainty for both producers and large users. Through these initiatives and by focusing on value-added downstream operations to produce metal products with higher margins, primary producers can stabilize the short-term volatility of primary aluminum prices to reduce the risk in investment decisions. One side effect of this longer-term planning is that production may be allocated and can make the availability of metal unpredictable on a short-term basis to users with unforeseen needs or to those without such sources.

Many large companies produce their required bauxite and alumina internally and there is no organized market for these materials. Other companies without internal supplies generally purchase needed bauxite and alumina on long-term contracts. Alumina prices are often fixed at a percentage of the LME metal price. Only a small portion of world production is sold on a cash or spot basis.

AVOIDING GREENHOUSE GAS EMISSIONS THROUGH ALUMINUM RECYCLING[6]

General

A number of Canadian groups and authors have estimated associated greenhouse gas emissions (GHG) from the production of Canadian primary aluminum and the GHG savings resulting through recycling. With aluminum production, however, such calculations are complicated by a number of factors including: different plant technologies; several types of process emissions, including carbon dioxide from anodes and perfluorocarbon emissions; and emissions relating to energy use.

This section has been written to help clarify understanding and to promote informed discussion in the context of recycling activity discussions using some recent studies and data.[7] It is intended only to provide a basic ballpark estimate and some background; it is not intended to provide detailed calculations of the emissions or to be a full life-cycle analysis.[8]

Boundary conditions of such calculations are important. To clarify the relative position of Canadian producers in the global situation, the two boundary conditions used in this paper are global and Canadian. The wider boundary approach reflects the reality of the market and the fact that the production and use of aluminum is based on extensive trading activities on a global scale.

In the production and use of aluminum, technology and methods continue to change on both an industry-wide basis and a same-plant basis. Emissions at the same-plant level and the intensity of emissions globally are reduced from year to year. Increasingly there are deliveries of liquid aluminum to users, and the use of direct chill casting to produce semi-fabricated shapes saves steps in the overall manufacturing process and in the energy formerly required to remelt ingot. As a result, both energy use and process emissions have been declining from year to year and are expected to continue to fall for each tonne of aluminum produced.

The IAI has published papers on the life-cycle inventory of production of automotive aluminum. The IAI analysis is based on 1998 data assembled by an industry survey. The study is representative of 82% of worldwide alumina production and 89% of worldwide primary aluminum smelting, including Canadian operations. This work was updated in 2003 to provide additional detail on the global factors.[7]

The six activities in making automotive aluminum are: bauxite mining, alumina refining, anode production, smelting, fabrication and recycling. While one can recover as much as 95% of much of this energy with recycling, the energy used in fabrication of specific shapes (work energy in rolling, extruding, etc.) is not recoverable (unless the product/shape is re-used in its original form). As these studies include energy from the remelting of ingot energy/emissions from fabrication (which is avoided in large Canadian operations), emissions beyond the primary ingot stage are not considered in this discussion.

The IAI study assigned carbon dioxide equivalents (CO_2e) for each activity for each of the following: process, electricity, fossil fuel, transport, ancillary and perfluorocarbons (PFCs). Table I below summarizes the CO_2e emitted in the primary aluminum production chain from mine to metal.

From Table I, it is estimated that in 1998 for every 1 t of primary aluminum produced, the average global GHG impact was about 12.7 t CO_2e. (Note: Each year this emissions number is expected to diminish slightly due to the increased efficiencies and reduced emissions from newer smelters.)

Canadian Primary Production

Emissions in Canada

The Canadian aluminum industry benefits from having access to hydro-electric power. This means that the GHG impact of producing primary aluminum in Canada is much lower than in many other countries. An August 2002 unpublished report for the Aluminium Association of Canada (AAC) indicates that Canadian emissions were 3.94 tonnes of CO_2e for every tonne of pure aluminum produced in 2000. However, it is understood that this figure excludes the GHG impacts of bauxite mining, refining of bauxite to alumina, and transportation. (Note: Canadian-sourced emissions would be expected to have been slightly higher in 1998 and lower in 2001 due to increased production from modern smelters.)

Canadian Emissions on a Global Scale

Using the bauxite mining, refining and transport emission numbers from Table I would increase the primary production emissions of 3.94 t of CO_2e in Canada by 2.16 t of emissions elsewhere, resulting in a total emission intensity from mine to primary ingot of approximately 6.1 t of CO_2e per tonne (in 1998).

TABLE I. PRIMARY ALUMINUM PRODUCTION, AVERAGE GLOBAL GHG EMISSIONS,[9] 1998 DATA

	Bauxite Mining	Alumina Refining	Anode Production	Smelting	Primary Casting
	(kg of CO_2e/t of pure aluminum)				
Process	–	–	388	1 626	–
Electricity	–	58	63	5 801	77
Fossil fuel	16	789	135	133	155
Transport	32	61	8	4	136
Ancillary	–	84	255	–	–
PFC	–	–	–	2 226	–
Total	48	991	849	9 789	368
Factor used[10]	5.168	1.925	0.441	1	1
Total[11]	248	1 907	374	9 789	368
Cumulative Total		2 155	2 530	12 319	12 687

– Nil.

International Recycling Of Automotive Aluminum

The IAI report is based on surveys that covered 52% of recycled automotive aluminum worldwide production. The IAI report identified five process stages: shredding and de-coating, ingot casting, shape casting, extruding, and rolling. As discussed, aluminum fabrication is not included in this analysis. The impact of recovering aluminum scrap is also not addressed.

One difficulty with the determination of GHG impacts for recycling aluminum is that different types of aluminum scrap (e.g., automotive, used beverage cans, siding/sheet) have varying associated losses in recycling and different energy requirements. Since the IAI report considers automotive products only, Table II data are not representative of all aluminum products.

TABLE II. RECYCLED ALUMINUM PRODUCTION, GLOBAL GHG EMISSIONS[12]

Stages	Shred and De-Coating	Ingot Casting
	(kg of CO_2e/t of pure aluminum)	
Electricity	57	70
Fossil fuel	81	222
Transport	2	28
Ancillary	–	–
PFC	–	–
Subtotals	140	320
Total		460

– Nil.

As indicated in the table above, the recycling of automotive aluminum scrap generates an estimated 460 kg of CO_2e for every tonne of recycled product. Note too that there are varying losses in material in the recycling process with saleable and useful by-products that are not considered here.

Canadian Recycling

Canadian recycling operations are assumed to be at least equivalent to this global average in this calculation, but are expected to be more efficient. In the Canadian context, it is important to note that Canada recycles, exports and imports significant amounts of aluminum scrap, and produces finished and intermediate products from both recycled aluminum and scrap. Used aluminum beverage containers collected in Canada (51 737 t in 2001[13]) are generally melted and put into new can stock sheet in the United States or offshore. However, it must also be noted that Canada produced approximately 225 000 t of recycled aluminum in 2002 and about an additional 80 000 t of scrap were used directly in production of products.

Observations/Conclusions

The aluminum industry updates technology each year as new smelters are built and older ones are closed. In addition, operating practices change each year and emissions are reduced with new and improved practices and changed production levels and methods in all smelters. Also, operating practices vary and older smelters with good practices can have less emissions per tonne of aluminum than a newer smelter.

In Table III below, a summary of the approximate GHG emissions savings from the recycling of automotive aluminum is calculated with a mix of 1998 and 2002 data. Since recycling also has a GHG emissions impact, the estimated value (0.46 t of CO_2e for automotive aluminum in 1998) is subtracted from the production numbers as shown to identify the "net savings in recycling" aluminum scrap.

TABLE III. AVOIDED ALUMINUM GHG EMISSIONS BY RECYCLING[14]

Boundaries	Estimated Emissions	Recycling	Net Savings in Recycling of Primary Aluminum
	(kg of CO_2e/t of pure aluminum)		
Global primary production (with Canadian emissions)	12.69	-0.46 =	12.13
Canadian primary production (includes average emissions from foreign mining and processing operations)	6.1[15]	-0.46 =	5.64

Emissions from the recycling of aluminum depend on the source of the aluminum recycled, the grade of aluminum produced, and a host of other factors. The data are not well known for many products.

On a global basis, the generation of "GHG emissions savings" of CO_2e tonnes per tonne of recycled aluminum produced from recycled primary products is estimated to be about 12.1 t (net after recycling) in 2002. Given Canada's international trade flows in aluminum ingot and scrap, this global figure provides a more realistic profile of potential savings than one in which the boundary is limited to Canada only.

If the boundary conditions include Canada only, an estimated 5.6 t of CO_2e are saved for every tonne of Canadian primary aluminum recycled (net of recycling emissions).

The numbers used in this document should be considered as estimates only, based on available information. Any calculation of GHG savings from recycling has limitations that must be noted.

Limitations of This Analysis

The GHG estimates developed in this document are based on a number of assumptions and on numbers taken from various reports. These estimates are intended to "fill the gap" until a detailed life-cycle assessment of Canadian aluminum is conducted and published.

Points to note include:

- The IAI report concerns cast automotive aluminum only. The recycling of other aluminum scrap will have different energy components and melt losses.
- Recycling may involve variable losses depending on the scrap source. There are saleable and useful by-products. These factors have not been included in the analysis.
- The IAI study's GHG impact for primary ingot casting (Table I, 368 kg of CO_2e) is higher than recycled ingot casting (Table II, 320 kg of CO_2e) due simply to the variability of facility data reported.[16] Liquid metal can also be used to cast products directly from either primary or recycled aluminum smelting operations, further saving emissions from remelting ingot (and complicating any calculations).
- It appears that the GHG impacts of chemicals (such as lime and caustic soda) used in the refining processes may be excluded from the IAI analysis.[17]
- The input factors used to adjust the contribution of materials towards the production of 1 t of aluminum are based on the IAI report, March 2003, page 5 (see endnote 7).
- The reported Canadian emissions figure is assumed to exclude bauxite mining and transport. It is also assumed that the global (IAI) figures for these two stages can be applied to material imported into Canada.
- The Canadian emissions levels published by different organizations have wide variations between reports, and numbers may be different from industry submissions to governments.
- While the GHG impact of transport is included in bauxite mining, similar impacts for recovery operations (prior to the shred and de-coat stage) are not assessed.
- The aluminum industry changes the mix of technology each year as new smelters are built and as older ones are modernized or closed. Operating practice also changes each year and emissions are reduced with new and improved practices and changed methods in all smelters. As a result, emissions figures are declining on an annual basis and should be used as broad guidelines only for anything other than the year of the data used in the calculation. See, for example, PFC emissions at www.world-aluminium.org/environment/climate/climate_change2.html.
- Canadian smelters (as well as others) continue to reduce PFC generation, not just by replacing old smelters, but also by improving existing smelters. A 70% reduction in PFC emissions from existing smelters has been achieved since 1990, and some of the lowest PFC-emitting plants in the world are smelters that are over 20 years old. The improvements continue.
- The average global emissions from aluminum are lowered with the inclusion of Canadian data.

ENDNOTES

1 This capacity excludes Söderberg capacity in the Jonquière smelter, operating in 2003, which closed in April 2004. (Alcan announced January 22, 2004 - see http://www.alcan.com/web/publishing.nsf/Content/Alcan+to+Halt+Production+at+its+60-Year-Old+Jonqui%C3%A8re+S%C3%B6derberg+Alumi num+Smelter+in+Quebec.)

2 In the classification of export statistics, Harmonized System Chapter 76 includes codes for identifiable aluminum products, including primary metal, semi-fabricated products and products made of aluminum. See Table 1 for a listing of the main codes. Export data can be obtained at http://strategis.gc.ca/sc_mrkti/tdst/engdoc/tr_homep.html or from Statistics Canada at www.statcan.ca/trade/scripts/trade_search.cgi.

3 NRCan Canadian aluminum use data for 2002 are from survey-based responses from 178 Canadian companies using primary and recycled aluminum in scrap, ingot or liquid metal form. Scrap used in the production of recycled ingot is not included in "use."

4 Capacity creep results from incremental expansion from removing bottlenecks in existing plants.

5 Aluminum is different from some other metals in that it is refined before it is smelted.

6 Robert Sinclair assisted with the writing of this paper. Thanks are due to a number of other people including Alain Dubreil, The Aluminum Association of Canada, Christian Van Houtte and Pat Atkins (Alcoa Inc.), who provided comments on an early version of this paper. Send any comments to wwagner @ nrcan.gc.ca (text only, no attachments, with a contextual subject heading).

7 "Aluminium Applications and Society: Life Cycle Inventory of the Worldwide Aluminium Industry with Regard to Energy Consumption and Emissions of Greenhouse Gases," May 2000, (www.worldaluminium.org/iai/publications/documents/full_report.pdf); and "Life Cycle Assessment of Aluminium: Inventory Data for the Worldwide Primary Aluminium Industry, March 2003, Five Winds International (www.world-aluminium.org/iai/publications/documents/lca.pdf).

[8] A number of organizations have workbooks showing methodology for such calculations. Several examples include: The World Business Council on Sustainable Development (WBCSD) (see www.wbcsd.ch, specifically www.wbcsd.ch/web/publications/ghg-protocol-revised.pdf), the World Resources Institute (WRI) (www.ghgprotocol.org/about.htm) and the Intergovernmental Panel on Climate Change (www.ippc.ch). For life-cycle analysis, see the International Organization for Standardization at www.iso.ch. It should be noted that emissions in aluminum smelters are a function of operating practices as well as technology. As a result, emissions from some older smelters may be lower than in some newer smelters containing upgraded technology.

[9] Based on IAI, May 2000, pp. 7, 36 and 40. See Endnote 7. While emissions from primary aluminum are considerable, especially if hydrocarbons are used as a source of electricity, it is noted that even at global average emissions, the IAI reports that "Each kilogram of automotive aluminium replacing traditional higher density materials can save a net 20 kilograms of CO_2 equivalents due mainly to the efficiencies of lightweighting."

[10] IAI, March 2003, p. 5. See Endnote 7.

[11] Calculated based on above data sources.

[12] IAI May 2000, p. 40. Note that this is automotive aluminum. Other scrap would have different values. See Endnote 7.

[13] "Aluminum Used Beverage Container Recovery in Canada – 2001," prepared by CM Consulting for the Aluminum Association of Canada, August 2002.

[14] Global numbers have been declining annually as changes are made. Canadian average emissions would be expected to have decreased in 2001 with the addition of a large, new, modern smelter at Alma. As a result, although these numbers approximate savings from recycled aluminum for 2000, they would be lower for subsequent years.

[15] This assumes that the average of mining, refining and transport emissions (done outside of Canada) is added to obtain the total emissions of Canadian aluminum.

[16] Personal communication with International Aluminum Institute, October 23, 2003.

[17] The additional impact of this factor is expected to be relatively small compared to the overall numbers.

Notes: (1) Most information in this review was current as of March 31, 2004. (2) Lorraine Ralph of the Minerals and Mining Statistics Division prepared Tables 1, 3a and 3b, and she and others in that Division have provided assistance with trade data. (3) Various Internet sites have been identified in this article. Please note that Natural Resources Canada has no control over the content of the web sites of other organizations, which may be modified, updated or deleted at any time. (4) This and other reviews, including previous editions, are available on the Internet at www.nrcan.gc.ca/mms/cmy/com_e.html.

Note to Readers

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TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU Conventional Rate (1)	Japan WTO (2)
2606.00.00	Aluminum ores and concentrates	Free	Free	Free	Free	Free	Free
2818.20.00	Aluminum oxide, other than artificial corundum	Free	Free	Free	Free	4%	Free
7601.10	Unwrought aluminum, not alloyed	Free	Free	Free	Free	6%	Free
7601.20	Unwrought aluminum alloys	Free	Free	Free	Free	6%	Free
7602.00	Aluminum waste and scrap	Free	Free	Free	Free	Free	Free
76.03	Aluminum powders and flakes	3.5-5%	Free	Free	Free	5.1-5.3%	3%
76.04	Aluminum bars, rods and profiles	Free-5%	Free	Free	Free	7.5%	7.5%
76.05	Aluminum wire	Free-4%	Free	Free	Free	7.5%	7.5%
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	Free-6.5%	Free-5%	Free	Free	7.5%	Free-2%
76.07	Aluminum foil of a thickness not exceeding 0.2 mm	Free-6.5%	Free-5%	Free	Free	7.5-10%	7.5%
76.08	Aluminum tubes and pipes	Free-5%	Free	Free	Free	Free-7.5%	7.5%
7609.00	Aluminum tube or pipe fittings	5.5%	3%	Free	Free	7%	3%
76.10	Aluminum structures (excluding prefabricated buildings of heading no. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	6.5%	5%	Free	Free	6-7%	Free-3%
7611.00	Aluminum reservoirs, tanks, vats and similar containers, for any material, of a capacity exceeding 300 litres	Free-6.5%	Free-5%	Free	Free	6%	3%
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material, of a capacity not exceeding 300 litres	6.5%	2.5-5%	Free	Free	6%	3%
7613.00	Aluminum containers for compressed or liquefied gas	6.5%	5%	Free	Free	6%	3%
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	4.5%	3%	Free	Free	6%	3%
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	6.5%	Free-5%	Free	Free	6%	Free
76.16	Other articles of aluminum	Free-6.5%	Free-5%	Free	Free	6%	3%

Sources: Canadian *Customs Tariff* , effective January 2004, Canada Border Services Agency; *Harmonized Tariff Schedule of the United States* , 2004; *Official Journal of the European Union* (October 30, 2003 Edition); *Customs Tariff Schedules of Japan, 2003.*
(1) The customs duties applicable to imported goods originating in countries that are Contracting Parties to the General Agreement on Tariffs and Trade or with which the European Community has concluded agreements containing the most-favoured-nation tariff clause shall be the conventional duties shown in column 3 of the Schedule of Duties. (2) WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADIAN ALUMINUM PRODUCED AND TRADED, 2002 AND 2003

Item No.		2002		2003	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION		2 708 910	5 700 000	2 791 915	5 600 000
EXPORTS					
26.20.40	Ash and residues containing mainly aluminium				
	United States	48 515	27 904	44 259	25 215
	South Africa	–	–	–	–
	Switzerland	155	73	–	–
	Other	207	119	–	–
	Total	48 877	28 096	44 259	25 215
2818.20	Aluminum oxide (excluding artificial corundum)				
	United States	51 432	48 529	49 574	45 403
	Germany	–	–	28	118
	Israel	63	62	–	–
	Other	28	33	74	114
	Total	51 523	48 624	49 676	45 635
7601.10	Unwrought aluminum, not alloyed				
	United States	629 027	1 404 015	866 791	1 783 875
	South Korea	45 516	107 837	57 522	127 823
	United Kingdom	8 719	18 812	61 013	115 052
	Netherlands	187 611	392 573	51 549	100 676
	Italy	12 528	28 308	30 022	59 848
	Japan	15 771	37 456	16 742	37 305
	France	21 346	45 216	16 958	32 347
	Germany	37 505	83 103	10 647	20 440
	Belgium	12 708	26 545	2 310	3 905
	Mexico	35 458	80 558	2 388	2 924
	Norway	10	28	1 000	2 004
	Hong Kong	883	1 972	910	1 854
	South Africa	–	–	506	1 018
	Thailand	40	89	–	–
	Other	495	1135	803	1805
	Total	1 007 617	2 227 647	1 119 161	2 290 876
7601.20	Unwrought aluminum alloyed				
	United States	984 087	2 376 646	924 347	2 084 485
	Japan	79 915	194 210	100 386	229 578
	Mexico	29 960	55 652	40 191	89 283
	South Korea	14 517	35 616	19 377	44 959
	Netherlands	1 511	3 557	9 511	21 156
	Israel	3 414	8 337	7 548	16 798
	United Kingdom	4 950	13 721	4 413	11 091
	Turkey	247	651	1 978	4 527
	Turks and Caicos Islands	–	–	1 775	4 015
	Ireland	1 652	4 243	1 369	3 276
	Germany	41	64	868	1 949
	Colombia	1 559	3 927	640	1 543
	French Polynesia	–	–	461	1 184
	France	704	2 073	192	423
	Syria	241	577	187	420
	Hong Kong	2 207	5 288	190	410
	South Africa	461	4 225	–	–
	Other	97	285	417	1 000
	Total	1 125 563	2 709 072	1 113 850	2 516 097
	Total unwrought aluminum exports	2 133 180	4 936 719	2 233 011	4 806 973

TABLE 1 (cont'd)

Item No.		2002		2003	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7602.00	Aluminum waste and scrap				
	United States	266 776	446 007	248 567	383 388
	Japan	3 654	7 620	15 114	33 381
	China	17 814	24 509	24 350	32 662
	Taiwan	1 158	1 899	1 553	2 421
	South Korea	872	1 423	54	58
	Other	617	915	1 599	1 749
	Total	290 891	482 373	291 237	453 659
76.03	Aluminum powders and flakes	126	627	63	401
76.04	Aluminum bars, rods and profiles	88 697	413 790	79 501	349 424
76.05	Aluminum wire	116 364	296 815	154 510	372 870
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	364 985	1 120 497	356 163	1 035 063
76.07	Aluminum foil not exceeding 0.2 mm	51 318	270 259	51 806	243 410
76.08	Aluminum tubes and pipes	4 495	28 858	5 264	29 607
76.09	Aluminum tube or pipe fittings	919	10 499	992	10 192
76.10	Aluminum structures and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	..	380 976	..	338 211
		(number)	**($000)**	**(number)**	**($000)**
76.11	Aluminum reservoirs, tanks, vats, and similar containers, for any material	426	881	189	1 020
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material	580 168 555	102 882	569 799 415	95 011
76.13	Aluminum containers for compressed or liquefied gas	633 156	2 470	823 864	2 690
		(tonnes)	**($000)**	**(tonnes)**	**($000)**
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	14 372	47 642	17 387	54 979
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	..	63 729	..	66 395
76.16	Other articles of aluminum	..	209 017	..	205 016
	Total exports	..	8 444 754	..	8 135 778
IMPORTS					
2606.00	Aluminum ores and concentrates				
	Brazil	1 112 748	56 488	1 421 033	42 560
	Guinea	836 187	40 488	800 239	24 417
	Ghana	514 483	19 581	391 779	11 543
	Australia	234 375	7 330	280 425	10 038
	United States	35 206	5 220	23 363	4 581
	Guyana	16 193	1 145	38 888	2 295
	China	2 722	404	10 051	1 112
	Greece	18 280	773	25 801	983
	Bermuda	6 680	1 482	–	–
	United Kingdom	966	76	–	–
	Other	85	71	19	7
	Total	2 777 925	133 058	2 991 608	97 536

TABLE 1 (cont'd)

Item No.		2002 (tonnes)	2002 ($000)	2003 (tonnes)	2003 ($000)
IMPORTS (cont'd)					
2620.40	Ash and residues containing mainly aluminum				
	United States	5 699	5 113	6 775	5 652
	Greece	505	336	–	–
	Total	6 204	5 449	6 775	5 652
2818.20	Aluminum oxide (excluding artificial corundum)				
	Australia	1 877 625	488 043	1 834 180	446 510
	United States	1 215 745	317 306	1 129 341	294 200
	Jamaica	810 324	236 279	918 586	231 717
	Brazil	65 809	24 186	230 349	58 437
	Germany	7 666	5 324	3 085	6 389
	China	7 080	2 449	6 211	2 015
	Japan	1 108	763	1 009	774
	Austria	1 831	1 183	427	720
	France	737	917	517	644
	Netherlands	. . .	. . .	136	133
	United Kingdom	557	618	26	64
	Venezuela	26 172	6 898	–	–
	Suriname	33 409	7 898	–	–
	Other	835	760	55	116
	Total	4 048 898	1 092 624	4 123 922	1 041 719
2818.30	Aluminum hydroxide	5 660	6 481	8 449	7 313
7601.10	Unwrought aluminum, not alloyed				
	United States	23 702	56 214	22 846	49 065
	Ghana	–	–	1 344	2 886
	Australia	500	1 195	400	891
	France	55	169	36	107
	Germany	18	6	22	43
	Gabon	–	–	18	39
	South Africa	2	3	20	38
	Peru	–	–	18	36
	Other	63	136	3	7
	Total	24 340	57 723	24 707	53 112
7601.20	Unwrought aluminum, alloyed				
	United States	163 772	315 279	109 230	241 750
	Netherlands	558	1 142	776	2 031
	Russia	4 168	9 559	781	1 708
	Ukraine	376	654	847	1 437
	United Kingdom	905	2 108	296	776
	Brazil	294	696	320	729
	Germany	325	739	239	546
	Cayman Islands	–	–	157	322
	Switzerland	–	–	94	177
	China	20	40	57	147
	Norway	2	6	16	46
	Spain	196	494	5	19
	Australia	202	475	6	10
	Other	904	2854	405	1662
	Total	171 722	334 046	113 229	251 360
	Total unwrought aluminum imports	196 062	391 769	137 936	304 472
7602.00	Aluminum waste and scrap	138 042	197 912	139 697	218 254
76.03	Aluminum powders and flakes	1 943	8 237	1 660	6 591
76.04	Aluminum bars, rods and profiles				
7604.10	Of aluminum, not alloyed				
	United States	4 110	23 524	2 943	16 056
	Belgium	1 067	5 624	1 064	5 236
	China	1 238	4 520	243	909
	Germany	79	499	74	489
	Canada	274	1 856	63	315
	Malaysia	–	–	68	314
	Russia	106	388	72	235
	Italy	49	261	37	191
	United Kingdom	23	112	17	110

TABLE 1 (cont'd)

Item No.		2002		2003	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
	Spain	8	36	19	109
	South Africa	8	76	14	78
	Taiwan	15	104	12	66
	Denmark	11	84	7	53
	France	1	7	6	33
	Hong Kong	3	13	8	33
	Netherlands	17	101	5	29
	Sweden	–	–	4	17
	South Korea	7	26	2	10
	Austria	266	681	. . .	. . .
	Other	28	165	2	12
	Total	7 310	38 077	4 660	24 295
7604.21	Of aluminum alloys				
to 7604.29	United States	26 000	129 296	26 836	123 470
	China	5 119	21 006	11 838	38 770
	South Korea	2 099	7 547	1 043	3 428
	Canada	39	238	366	2 355
	Germany	234	1 729	247	2 025
	Russia	230	1 003	398	1 472
	Italy	145	1 066	174	1 417
	France	219	1 291	126	817
	Israel	35	197	221	776
	United Kingdom	156	988	95	647
	Sweden	54	568	49	503
	Taiwan	46	212	83	389
	Austria	11	82	51	282
	Mexico	38	262	42	258
	Hong Kong	2	9	36	200
	India	37	117	62	188
	Brazil	10	55	40	172
	Malaysia	18	158	46	137
	Finland	6	39	16	129
	Belgium	87	423	23	126
	Spain	5	22	16	96
	Switzerland	16	109	14	91
	Netherlands	1	9	14	87
	Hungary	3	10	15	50
	Slovenia	2	8	8	45
	Japan	48	223	10	42
	Other	70	237	11	64
	Total	34 730	166 904	41 880	178 036
76.05	Aluminum wire	10 357	37 470	11 793	38 378
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	462 581	1 676 582	463 345	1 477 455
76.07	Aluminum foil not exceeding 0.2 mm	52 945	261 412	60 470	256 538
76.08	Aluminum tubes and pipes	14 154	73 897	13 075	64 143
76.09	Aluminum tube or pipe fittings	7 006	46 535	5 987	39 926
76.10	Aluminum structures and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	. .	121 348	. .	120 186
		(number)	**($000)**	**(number)**	**($000)**
76.11	Aluminum reservoirs, tanks, vats and similar containers, for any material, etc.	516	1 570	280	966
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material	1 437 722 740	253 547	1 198 990 978	178 045
76.13	Aluminum containers for compressed or liquefied gas	104 125	22 125	198 299	16 699

TABLE 1 (cont'd)

Item No.		2002		2003	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	887	3 395	1 091	3 529
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	. .	98 841	. .	102 871
76.16	Other articles of aluminum	. .	296 694	. .	264 536
	Total imports	. .	4 933 927	. .	4 445 258

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ALUMINUM SMELTER CAPACITY

Company	As of December 31, 2003
	(t/y)
Alcan Aluminium Inc.	
Quebec	
Grande-Baie	198 000
Arvida, Jonquière	(a) 253 000
Alma	400 000
Shawinigan	91 000
Beauharnois	50 000
Laterrière	219 000
British Columbia	
Kitimat	275 000
Alcoa Inc.	
Quebec	
Aluminerie de Baie-Comeau	438 000
Aluminerie Lauralco Inc.	249 000
Aluminerie de Bécancour Inc.	
Quebec	
Bécancour	403 000
Alcoa, 74.95%	
Alcan (Pechiney), 25.05%	
Aluminerie Alouette Inc.	
Quebec	244 000
Sept-Îles	
Alcan, 40%	
Aluminium Austria Metall Québec, 20%	
Hydro Aluminium, 20%	
Société Générale de Financement du Québec, 13.33%	
Marubeni Québec Inc., 6.66%	
Total Canadian capacity	2 820 000
Total Alcan, 59.74%	1 684 552
Total Alcoa, 35.07%	989 049
Total other, 5.19%	146 400

Source: Natural Resources Canada.
(a) Alcan announced that 90 000 t/y of this capacity will be closed February to April 2004.

TABLE 3a. USE (1) OF ALUMINUM METAL (4) IN CANADA AT FIRST PROCESSING STAGE, 1999-2002

	1999 (a)	2000 (r,a)	2001 (r,a,6)	2002 (a,5)
	(tonnes)			
METAL USED IN CASTINGS				
Permanent mould	129 574	132 891	102 018	87 294
Sand	4 442	4 460	4 210	4 487
Die and other	205 781	208 722	181 419	220 587
Total	339 797	346 073	287 647	312 369
METAL USED IN WROUGHT PRODUCTS				
Sheet, plate, coil and foil	229 139	214 775	225 033	240 155
Extrusions, including tubing	234 843	230 063	232 127	240 311
Other wrought products (including rods, forgings and slugs)	153 936	184 392	180 215	187 359
Total	617 918	629 229	637 375	667 826
METAL USED IN OTHER PRODUCTS				
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste and other uses	41 526	41 204	39 587	39 519
Total used	999 242	1 016 506	964 609	1 019 713
Aluminum metal used for the production of recycled aluminum (2)	145 959	155 728	172 222	224 613

	Metal Entering Plant			On Hand at December 31			
	1999	2000	2001 (p)	1999	2000	2001	2002 (p)
Primary aluminum and alloys	733 569	(r) 733 232	746 222	21 340	17 476	15 608	17 671
Recycled aluminum (7)	198 370	(r) 191 326	155 042	5 415	6 672	8 030	8 558
Aluminum scrap and aluminum content of drosses and skimmings (8)	253 985	(r) 279 190	274 092	13 833	13 971	13 752	9 441
Total	1 185 925	(r) 1 203 748	1 175 356	40 588	38 120	37 391	35 671
Aluminum shipments (3)				33 674	34 525	(3) 272 952	(3) 288456
Production of recycled aluminum, scrap and aluminum content of dross and skimmings				. .	. .	233 067	280 063

Source: Natural Resources Canada.
. . Not available; (r) Revised; (p) Preliminary.
(a) Increase in number of companies being surveyed; therefore, the closing inventory of the previous year does not equal the opening inventory of the current year.
(1) Available data as reported by users. (2) Aluminum metal used in the production of recycled aluminum is not included in usage totals. (3) Aluminum metal shipped without change. Does not refer to shipments of goods of own manufacture. (4) Aluminum metal refers to primary aluminum and alloys, purchased recycled aluminum, and outside aluminum scrap.
(5) For 2002 this table is compiled from Natural Resources Canada's annual survey, "Use of Aluminum Metal" from data for 178 Canadian users. (6) Some totals prior to 2001 contained runaround aluminum scrap. In 2001 runaround scrap was removed where known from totals.
Note: Numbers may not add to totals due to rounding.

TABLE 3b. USE (1) OF ALUMINUM METAL (2) IN CANADA, BY TYPE AT FIRST PROCESSING STAGE, 1990-2002

	1990 (a)	1991 (a)	1992 (a)	1993 (a)	1994 (a)	1995	1996 (a)	1997 (a)	1998 (a)	1999 (a)	2000 (r,4)	2001 (r,a,5)	2002 (a,4)
TYPE OF ALUMINUM METAL USED IN PRODUCTS OTHER THAN RECYCLED ALUMINUM													
Primary aluminum and alloys	351 877	355 010	369 185	447 997	485 845	490 000	512 865	558 139	653 320	719 124	726 187	735 011	750 728
Purchased recycled aluminum	82 763	73 461	87 896	95 774	117 710	114 961	119 515	138 852	158 355	199 429	190 026	154 730	185 420
Outside aluminum scrap	18 617	17 768	24 009	25 084	31 469	30 441	44 555	67 447	78 298	80 689	100 294	74 869	83 565
Total used in products other than in recycled aluminum	453 257	446 239	481 089	568 854	635 024	635 402	676 935	764 438	889 973	999 242	1 016 506	964 609	1 019 713
TYPE OF ALUMINUM METAL USED IN RECYCLED ALUMINUM (3)													
Primary aluminum and alloys	x	x	x	x	x	x	x	14 650	x	10 879	10 074	x	x
Outside aluminum scrap	x	x	x	x	x	x	x	113 865	x	135 081	145 654	x	x
Total used in recycled aluminum (3)	115 112	101 503	127 818	131 174	145 661	146 987	81 629	128 515	147 847	145 959	155 728	172 222	224 613

Source: Natural Resources Canada.
(p) Preliminary; (r) Revised; x Confidential.
(a) Increase in number of companies being surveyed.
(1) Available data as reported by users. (2) Aluminum metal refers to primary aluminum and alloys, purchased recycled aluminum, and outside aluminum scrap. (3) Aluminum metal used in recycled aluminum is not included in "Total used in products other than in recycled aluminum" above. (4) For 2002 this table is compiled from Natural Resources Canada's annual survey, "Use of Aluminum Metal" from data for 178 Canadian users. (5) Some totals prior to 2001 contained runaround aluminum scrap. In 2001, runaround scrap was removed where known from totals.
Note: Numbers may not add to totals due to rounding.

TABLE 4. AVERAGE ALUMINUM PRICES

Year	Month	LME Cash Settlement (1)		*Metals Week* U.S. Markets (1)
		(US$/t)	(US$/lb)	(US$/lb)
ANNUAL AVERAGES (2)				
1992		1 255	0.57	0.58
1993		1 139	0.52	0.53
1994		1 477	0.67	0.71
1995		1 806	0.82	0.86
1996		1 506	0.68	0.71
1997		1 600	0.73	0.77
1998		1 358	0.62	0.66
1999		1 361	0.62	0.66
2000		1 549	0.70	0.75
2001		1 444	0.65	0.69
2002		1 350	0.61	0.65
2003		1 431	0.65	0.68
MONTHLY AVERAGES				
2002	January	1 369	0.62	0.65
	February	1 369	0.62	0.64
	March	1 405	0.64	0.66
	April	1 370	0.62	0.66
	May	1 343	0.61	0.65
	June	1 354	0.61	0.66
	July	1 338	0.61	0.65
	August	1 292	0.59	0.62
	September	1 304	0.59	0.63
	October	1 311	0.59	0.63
	November	1 372	0.62	0.66
	December	1 375	0.62	0.66
2003	January	1 378	0.63	0.66
	February	1 422	0.65	0.69
	March	1 389	0.63	0.68
	April	1 332	0.60	0.65
	May	1 398	0.63	0.67
	June	1 410	0.64	0.66
	July	1 436	0.65	0.67
	August	1 456	0.66	0.67
	September	1 416	0.64	0.67
	October	1 474	0.67	0.70
	November	1 508	0.68	0.72
	December	1 555	0.71	0.74

Sources: Natural Resources Canada; *Metals Week.*
(1) Highest grade sold. (2) Primary ingots, minimum 99.7% purity.

TABLE 5. AVERAGE ALUMINUM ALLOY (RECYCLED) PRICES

Year	Month	LME Alloy (1) Cash Settlement (US$/t)	(US$/lb)
ANNUAL AVERAGES			
1993		1 005	0.46
1994		1 453	0.66
1995		1 656	0.75
1996		1 303	0.59
1997		1 461	0.66
1998		1 204	0.55
1999		1 191	0.54
2000		1 217	0.55
2001		1 172	0.53
2002		1 234	0.56
2003		1 400	0.63
MONTHLY AVERAGES			
2002	January	1 083	0.49
	February	1 172	0.53
	March	1 248	0.57
	April	1 246	0.57
	May	1 206	0.55
	June	1 236	0.56
	July	1 271	0.58
	August	1 250	0.57
	September	1 235	0.56
	October	1 228	0.56
	November	1 295	0.59
	December	1 335	0.61
2003	January	1 384	0.63
	February	1 456	0.66
	March	1 454	0.66
	April	1 405	0.64
	May	1 383	0.63
	June	1 353	0.61
	July	1 372	0.62
	August	1 382	0.63
	September	1 389	0.63
	October	1 398	0.63
	November	1 383	0.63
	December	1 438	0.65

Sources: Natural Resources Canada; *Metals Week*.
(1) Alloy ingots, meeting LME specifications.

TABLE 6. WORLD MINE PRODUCTION OF BAUXITE, 1997-2002

	World Rank in 2002	1997	1998	1999	2000	2001	2002 (p)
				(000 tonnes)			
Australia	1	44 465.0	44 553.0	48 416.0	53 802.0	53 285.0	54 024.0
Guinea	2	19 250.0	(r) 16 678.8	17 419.1	17 991.9	(r) 17 191.7	17 480.5
Brazil	3	11 162.8	11 961.1	14 371.5	(r) 14 379.2	(r) 13 388.1	13 147.9
Jamaica	4	11 987.3	12 646.4	11 688.5	11 126.5	(r) 12 370.4	13 118.9
China	5	9 000.0	6 400.0	7 100.0	7 900.0	(r) 8 650.0	9 990.0
India	6	5 985.0	5 980.1	6 712.2	7 562.1	7 863.9	9 647.3
Venezuela	7	4 966.8	4 825.6	4 166.5	4 360.7	(r) 4 584.9	5 190.8
Russia	8	3 988.0	4 092.0	4 513.0	5 000.0	4 805.0	4 497.5
Kazakhstan	9	3 416.0	3 436.8	3 606.5	3 729.6	3 685.1	4 376.6
Suriname	10	3 877.2	3 931.1	3 714.6	3 610.3	4 393.7	4 001.6
Greece	11	1 876.6	1 823.0	1 882.5	(r) 1 966.0	(r) 1 986.0	2 372.0
Guyana	12	2 467.3	2 266.7	2 359.3	2 689.5	(r) 2 011.3	1 639.3
Indonesia	13	808.7	1 055.6	(r) 1 142.5	(r) 1 175.4	(r) 1 275.6	1 283.5
Ghana	14	519.2	442.5	353.1	424.6	715.5	795.8
Hungary	15	742.6	(r) 908.9	(r) 935.2	1 046.5	1 000.0	720.0
Serbia and Montenegro	16	470.0	226.0	500.0	630.0	610.0	611.5
Iran	17	245.0	336.0	(r) 439.4	(r) 485.1	(r) 273.7	323.6
Turkey	18	369.5	458.0	207.7	458.5	242.0	287.4
United States	19	200.0	200.0	200.0	200.0	200.0	200.0
France	20	169.0	170.0	170.0	185.0	(r) 185.0	174.0
Bosnia and Herzegovina	21	–	–	–	(r) 20.7	(r) 77.0	113.0
Malaysia	22	279.1	160.3	223.7	123.3	(r) 64.2	40.0
Vietnam	23	30.0	30.0	30.0	16.0	20.0	20.0
Pakistan	24	4.9	5.0	11.2	10.4	3.7	12.2
Mozambique	25	8.2	6.1	7.9	8.1	8.6	9.1
Albania	26	4.5	4.1	4.6	3.0	3.0	3.0
Romania		127.5	161.9	–	–	–	–
Total world		126 420.2	(r) 122 759.0	(r) 130 175.0	(r) 138 904.4	(r) 138 893.4	144 079.5
% change from previous year		2.0	-2.9	6.0	6.7	0.0	3.7

Sources: International Consultative Group on Nonferrous Metals Statistics; World Bureau of Metal Statistics; media reports.
– Nil; (p) Preliminary; (r) Revised.

TABLE 7. PRODUCTION OF ALUMINA (HYDRATE), 1998-2004

	World Rank in 2002	World Rank in 2003	1998	1999	2000	2001	2002	2003 (e)	2004 (f)
					(000 tonnes)				
Australia	1	1	13 853.0	14 532.0	15 037.0	16 271.0	16 382.0	16 529	16 789
China	2	2	3 340.0	3 822.0	4 326.7	(r) 4 647.0	5 478.4	5 900	6 500
United States (1)	3	3	5 654.0	5 144.0	4 786.0	4 340.0	4 338.0	4 640	5 390
Brazil	4	4	3 322.1	3 515.1	(r) 3 754.1	3 519.7	3 855.4	4 355	4 680
Jamaica	5	5	3 440.2	3 569.6	3 600.1	3 542.4	3 630.6	3 685	3 840
Russia	6	6	2 465.4	2 657.1	(r) 2 865.0	(r) 3 046.4	3 131.0	3 300	3 400
India	7	7	1 855.0	1 930.0	2 107.0	2 170.0	2 580.0	2 730	2 800
Suriname	8	8	1 771.9	1 853.1	1 906.1	1 893.3	1 902.7	1 900	1 900
Venezuela	9	9	1 553.4	1 469.0	1 755.3	(r) 1 833.1	1 777.9	1 900	1 900
Ireland (1)	10	10	1 322.5	1 395.7	1 410.7	1 448.7	1 400.0	1 500	1 500
Kazakhstan	11	11	1 084.5	1 157.7	1 216.7	1 231.1	1 386.4	1 385	1 385
Ukraine	12	12	1 290.7	1 230.2	(r) 1 365.0	(r) 1 343.4	1 350.9	1 350	1 500
Canada	14	13	1 229.0	1 233.0	(r) 1 197.4	(r) 1 196.5	1 283.0	1 300	1 300
Spain	13	14	1 110.0	1 112.0	1 123.0	1 199.0	1 300.0	1 300	1 300
Italy	15	15	935.0	973.0	1 022.0	993.0	1 010.0	1 000	1 000
Germany	16	16	778.3	806.0	826.0	836.0	837.0	840	840
Greece	17	17	649.4	633.0	690.0	709.0	750.0	790	790
Japan	18	18	737.6	736.6	781.7	(r) 739.0	723.9	725	725
Guinea	19	19	500.0	568.5	(r) 540.9	674.3	698.0	723	750
France	20	20	520.0	556.0	600.0	598.0	585.0	590	590
Romania (1)	21	21	250.2	277.4	416.6	319.4	350.2	350	475
Hungary (1)	22	22	(r) 337.5	(r) 295.0	(r) 357.1	(r) 272.0	300.0	300	300
Serbia and Montenegro	23	23	152.5	156.0	186.1	200.7	230.0	230	230
Azerbaijan	27	24	–	76.0	(r) 63.0	(r) 87.5	91.0	215	450
Turkey (1)	24	25	156.8	159.1	155.4	(r) 146.0	152.9	150	150
Iran	25	26	–	–	–	–	102.0	100	100
Bosnia and Herzegovina		27	–	37.0	219.4	100.0	–	40	260
South Korea	28	28	–	–	–	(r) 25.0	25.0	25	25
United Kingdom	26		115.0	94.0	89.0	98.0	92.0	–	–
Total world			(r) 48 424.0	49 988.1	(r) 52 397.3	(r) 53 479.5	55 743.3	57 852	60 869
% change from previous year			4.5	3.2	4.8	2.1	4.2	3.8	5.2

Sources: International Consultative Group on Nonferrous Metals Statistics, International Aluminium Institute; media reports.
– Nil; (e) Author's estimate; (f) Author's forecast; (r) Revised.
(1) Calcined.

TABLE 8. WORLD PRODUCTION OF PRIMARY ALUMINUM, 1998-2004

	World Rank in 2002	World Rank in 2003	1998	1999	2000	2001	2002	2003 (e)	2004 (f)
			(000 tonnes)						
China	1	1	2 335.7	2 598.5	(r) 2 818.0	(r) 3 371.0	4 321.0	5 419	6 200
Russia	2	2	3 010.0	3 149.0	3 247.0	3 302.0	3 347.4	3 476	3 550
Canada	3	3	2 374.1	2 389.8	2 373.5	2 582.7	2 708.9	2 792	2 740
United States	4	4	3 712.7	3 778.6	3 668.4	2 637.0	2 705.1	2 703	2 450
Australia	5	5	1 626.2	1 719.3	1 761.5	1 784.1	1 836.0	1 855	1 875
Brazil	6	6	1 208.0	1 249.6	1 271.4	1 132.0	1 318.4	1 380	1 440
Norway	7	7	994.2	1 009.0	1 031.1	1 034.2	1 042.8	1 174	1 230
India	9	8	542.0	594.0	646.3	624.1	671.2	817	880
South Africa	8	9	692.5	(r) 686.9	(r) 682.6	(r) 653.8	703.7	738	860
Germany	10	10	612.4	633.8	643.5	651.6	652.8	660	670
Dubai	12	11	386.6	440.7	536.0	536.0	536.0	610	685
Venezuela	11	12	586.5	570.3	570.9	570.6	605.3	606	645
Bahrain	13	13	501.3	502.7	509.0	522.1	517.0	526	530
France	14	14	423.6	455.1	441.2	460.9	463.2	420	420
Mozambique	20	15	–	–	(r) 53.8	(r) 266.0	273.2	409	535
Spain	15	16	360.4	363.9	365.7	376.4	380.1	383	385
United Kingdom	16	17	258.4	(r) 269.7	305.1	340.8	343.8	349	365
New Zealand	17	18	317.5	326.7	328.4	322.3	333.9	334	335
Tadjikistan	18	19	195.6	229.1	(r) 268.0	(r) 289.1	307.6	319	325
Netherlands	19	20	(r) 263.7	287.4	301.7	293.2	284.4	295	300
Argentina	21	21	186.7	206.4	261.8	245.1	268.8	270	270
Iceland	22	22	173.4	221.5	225.7	242.6	263.7	266	269
Romania	25	23	174.0	174.1	179.0	(r) 181.8	187.1	200	250
Egypt	23	24	187.2	186.7	188.9	190.8	195.0	195	210
Indonesia	28	25	134.3	112.3	192.3	208.8	162.8	193	230
Italy	24	26	187.0	(r) 186.5	189.2	187.4	190.5	193	193
Iran	26	27	111.0	138.0	139.5	145.2	165.8	167	169
Greece	27	28	146.1	159.9	162.6	162.0	163.9	165	165
Slovakia	32	29	108.0	109.2	109.8	(r) 110.1	111.6	135	145
Slovenia	35	30	70.8	77.2	75.6	76.6	87.6	117	120
Serbia and Montenegro	30	31	76.7	80.9	95.5	108.1	116.5	116	116
Ukraine	31	32	106.7	(r) 115.4	(r) 119.3	106.1	112.5	114	115
Bosnia	33	33	38.0	70.0	94.5	(r) 96.0	103.5	105	105
Sweden	34	34	95.7	98.5	100.1	101.8	100.6	101	102
Cameroon	36	35	81.6	91.9	94.9	80.5	67.0	70	70
Turkey	37	36	61.8	61.7	61.5	61.7	62.5	63	63
Poland	38	37	51.5	51.6	55.5	54.6	58.8	60	60
Switzerland	39	38	32.1	34.4	35.5	36.2	40.0	41	42
Hungary	41	39	33.7	33.6	33.9	34.6	35.3	35	36
Azerbaijan		40						20	45
Ghana	29	41	56.1	114.2	155.5	162.3	132.4	20	–
Mexico	40	42	61.8	62.7	61.2	51.5	37.6	20	–
Japan	42	43	16.3	10.9	6.5	6.6	6.4	–	6
Nigeria			25.5	15.9	–	–	–	–	–
Suriname			27.1	6.6	–	–	–	–	–
Total world			(r) 22 644.5	(r) 23 674.2	(r) 24 461.4	(r) 24 400.3	26 021.7	27 938	29 201
% change from previous year			3.9	4.5	3.3	-0.2	6.6	7.4	4.5

Sources: International Consultative Group on Nonferrous Metals Statistics; World Bureau of Metal Statistics; International Aluminium Institute; media reports.
– Nil; (e) Author's estimate; (f) Author's forecast; (r) Revised.

TABLE 9. APPARENT USE OF PRIMARY ALUMINUM, 1998-2002

	World Rank in 2002	1998	1999	2000	2001	2002
				(000 tonnes)		
United States	1	6 100.0	6 372.0	6 275.0	5 420.0	5 720.0
China (1)	2	(r) 2 424.0	(r) 2 907.0	(r) 3 443.0	(r) 3 606.0	4 131.0
Japan	3	2 082.0	2 112.3	2 224.9	2 014.0	2 132.0
Germany	4	1 520.0	1 446.0	1 542.0	(r) 1 549.0	1 677.0
Russia	5	489.2	562.8	(r) 693.0	(r) 784.1	989.3
South Korea	6	505.7	813.9	822.5	849.6	920.5
Italy	7	674.0	734.6	(r) 780.3	(r) 796.0	825.7
France	8	(r) 725.9	(r) 770.6	(r) 782.3	(r) 746.0	762.0
Canada	9	720.6	777.2	799.5	(r) 742.5	747.3
India	10	566.5	569.5	602.4	589.2	603.8
Brazil	11	521.4	463.1	513.7	552.8	577.9
United Kingdom	12	579.0	581.0	588.0	560.0	560.0
Spain	13	435.5	494.0	525.6	507.8	532.6
Taiwan	14	300.7	464.1	501.6	321.3	407.2
Belgium	15	370.0	350.0	(r) 340.6	(r) 327.3	333.1
Australia	16	370.3	344.4	350.5	320.0	305.0
Thailand	17	128.4	155.3	195.2	227.0	249.8
Bahrain	18	200.3	226.2	239.2	261.0	248.2
Hungary	19	163.7	171.3	210.1	222.7	244.8
Turkey	20	180.7	169.4	211.2	175.7	239.2
Norway	21	(r) 224.8	(r) 215.4	(r) 230.9	(r) 225.4	233.0
Greece	22	212.7	212.5	230.0	217.5	221.6
Austria	23	159.8	142.6	168.2	201.0	207.9
South Africa	24	142.8	125.0	(r) 175.7	(r) 208.0	186.0
Venezuela	25	206.2	154.8	183.4	164.7	173.1
Poland	26	107.8	133.0	(r) 153.1	(r) 148.8	170.9
Netherlands	27	155.0	155.0	155.0	155.0	155.0
Switzerland	28	165.9	157.0	(r) 171.0	161.2	155.0
Malaysia	29	64.7	(r) 146.9	(r) 149.7	(r) 152.5	149.4
Indonesia	30	75.4	138.7	145.8	162.9	126.8
Sweden	31	(r) 157.8	(r) 153.8	(r) 167.9	(r) 128.1	125.0
Iran	32	103.1	123.2	116.8	120.0	120.0
Mexico	33	91.1	(r) 88.5	(r) 101.0	(r) 113.1	116.0
Romania	34	87.7	113.6	125.7	112.5	112.0
Czech Republic	35	78.9	65.7	77.6	88.3	106.0
Egypt	36	91.6	82.7	81.8	96.5	91.3
Portugal	37	68.3	82.0	78.0	66.9	78.0
Slovenia	38	74.6	75.5	81.7	96.1	76.4
Argentina	39	106.3	82.9	80.2	70.6	65.1
Denmark	40	(r) 38.6	(r) 38.4	(r) 41.5	(r) 43.4	55.0
Vietnam	41	15.6	(r) 17.4	(r) 21.3	(r) 36.7	54.4
Dubai	42	18.5	(r) 5.2	(r) 22.2	(r) 54.0	54.0
Ukraine	43	50.0	50.0	50.0	50.0	50.0
New Zealand	44	34.2	42.8	42.7	35.6	47.1
Israel	45	45.9	44.0	44.8	38.0	46.4
Other Asia	46	(r) 38.0	(r) 43.0	(r) 38.0	40.0	45.0
Croatia	47	24.0	29.5	(r) 29.4	(r) 37.7	40.6
Colombia	48	36.3	27.4	32.1	30.0	35.9
Finland	49	(r) 32.0	(r) 35.5	(r) 38.9	(r) 37.7	33.0
Philippines	50	24.0	33.6	32.8	25.2	28.5
Slovakia	51	22.2	34.1	36.4	34.9	27.5
Cameroon	52	24.9	22.0	(r) 24.2	(r) 25.1	27.3
Saudi Arabia	53	25.0	25.0	25.0	25.0	25.0
Other America	54	(r) 14.0	(r) 18.1	(r) 19.9	(r) 24.5	25.0
North Korea	55	20.0	20.0	20.0	20.0	20.0
Bangladesh	56	17.8	18.0	18.0	18.0	18.0
Chile	57	14.6	11.2	14.5	14.5	17.8
Ghana	58	16.0	16.0	16.0	16.0	16.0
Lebanon	59	20.9	14.2	16.0	15.6	15.7
Bulgaria	60	8.0	8.0	8.6	(r) 18.1	15.0
Serbia and Montenegro	61	19.2	13.1	16.0	(r) 18.1	12.3
Other Africa	62	10.0	(r) 10.0	(r) 10.0	(r) 11.0	11.0
Pakistan	63	15.0	9.4	10.0	10.0	10.0
Singapore	64	33.5	4.3	4.1	13.6	9.2
Belarus	65	9.1	9.0	9.0	9.0	9.0
Nigeria	66	7.0	7.0	7.0	7.0	7.0
Algeria	67	5.0	4.1	(r) 6.0	(r) 6.0	6.0
Morocco	68	3.7	3.5	5.7	5.7	6.0
Ireland	69	6.6	8.2	10.2	7.8	4.8
Tunisia	70	4.4	2.6	3.0	3.0	4.0

TABLE 9 (cont'd)

	World Rank in 2002	1998	1999	2000	2001	2002
				(000 tonnes)		
Iceland	71	3.0	3.0	3.0	3.0	3.2
Other Europe	72	1.5	2.0	2.0	2.0	2.0
Kazakhstan	73	1.7	2.0	2.0	2.0	2.0
Macedonia	74	5.6	2.5	2.4	1.8	1.1
Peru	75	2.5	0.9	1.3	1.1	1.1
Albania	76	1.0	1.0	1.0	1.0	1.0
Iraq	77	1.0	1.0	1.0	1.0	1.0
Cuba	78	1.0	1.0	1.0	1.0	1.0
World total		(r) 22 103.7	(r) 23 571.5	(r) 25 001.1	(r) 24 005.2	25 663.8
% change from previous year		-0.5	6.6	6.1	-4.0	6.9

Source: International Consultative Group on Nonferrous Metals Statistics.
(r) Revised.
(1) Starting in 1997, Hong Kong is included with China.

TABLE 10. ABBREVIATIONS OF COMPANY NAMES AND INSTITUTIONS USED IN THIS REPORT

Company	Abbreviation	Web Site Address
Atlantsal hf	Atlantsal	www.atlantsal.is
Alcan Inc.	Alcan	www.alcan.com
Alcoa Inc.	Alcoa	www.alcoa.com
Alcoa World Alumina and Chemicals	AWAC	www.alcoa.com
Aldoga Aluminium Smelter Pty Ltd.	Aldoga	www.aldoga.com
Aluar Aluminio Argentinio S.A.I.C.	Aluar	www.aluar.com.ar
Alumina Limited	Alumina Limited	www.aluminalimited.com
Alumina do Norte do Brasil S.A.	Alunorte	www.cvrd.com.br
Aluminerie Alouette Inc.	Alouette	www.alouette.com
Aluminerie de Bécancour Inc.	A.B.I.	www.alcoa.com
Aluminium Association of Canada	The Association	www.aia.aluminium.qc.ca
Aluminium Bahrain B.S.C.	Alba	www.albasmelter.com
Aluminum Corporation of China Limited	Chalco	www.chinalco.com.cn
Alumina Partners of Jamaica	Alpart	www.kaiseral.com
BHP Billiton	BHP	www.bhpbilliton.com
Bharat Aluminium Company Limited	Balco	www.balcoindia.com
Brunei Economic Development Board	BEDB	www.bedb.com.bn
Cambior Inc.	Cambior	www.cambior.com
Century Aluminum Company	Century Aluminum	centuryca.com
Columbia Ventures Corporation	Columbia Ventures	www.nordural.is
Comalco Limited	Comalco	www.riotinto.co
Companhia Vale do Rio Doce	CVRD	www.cvrd.com.br
Companhia Brasileira de Alumínio	CBA	www.aluminiocba.com.br
Corporaciòn Venezolana de Guayana	CVG	www.cvg.com
CVG Alcasa	Alcasa	www.aluminio.com.ve
Dubai Aluminium Company Limited	Dubal	www.dubal.ae
East Hope Group	East Hope Group	www.easthope.com.cn
Aluminum Company of Egypt	Egyptalum	www.egyptalum.com.eg
Elkem ASA	Elkem	www.elkem.com
Federation of Aluminium Consumers in Europe	FACE	www.facealuminium.com
Global Alumina Products Corporation	GAPCO	www.globalalumina.com
Hindalco Industries Limited	Hindalco	www.adityabirla.com
International Aluminium Institute	IAI	www.world-aluminium.org
Indian Aluminum Limited.	Indal	www.indal.com
KTD L.L.C.	KTD	www.ktdal.com
Saudi Arabian Mining Company	Ma'aden	www.maaden.com.sa
Minmetals Nonferrous Metals Co., Ltd.	Minmetals	www.minmetals.com
National Aluminium Company Limited	Nalco	www.nalcoindia.com
Noranda Inc.	Noranda	www.noranda.com
Norsk Hydro ASA/Hydro Aluminium a.s.	Norsk Hydro or Hydro Aluminium	www.hydro.com
Ormet Corporation	Ormet	www.ormet.com
Pechiney SA	Pechiney	www.aluminium-pechiney.com
Russian Aluminium (Russky Aluminii)	Russal	www.rusal.com
Sibirsky Aluminium	Sibirsky (Russian Aluminum)	www.sibirskyaluminum.com
Slovalco A.S.	Slovalco	www.slovalco.sk
Société Générale de financement du québec	SGF	www.sgfqc.com
Sterlite Industries (India) Ltd.	Sterlite	www.balcoindia.com
Siberian-Urals Aluminium Company	SUAL	www.sual.com
Tomago Aluminium Pty Ltd.	Tomago	www.tomago.com.au
The Aluminum Association, Inc. (USA)	Aluminum Association	www.aluminum.org
Grupo Votorantim	Votorantim	www.votorantim.com.br
Vietnam National Mineral Corp.	Vimico	. .

. . URL not available.

TABLE 11. BAUXITE AND ALUMINA PROJECTS

Country	Project/Company	Comments	Estimated Change (Alumina) t/y in 2003	Estimated Change (Alumina) t/y in 2004	Estimated Change (Alumina) t/y in 2005	Estimated Change (Alumina) t/y in 2006	Reference
Australia	Cape York Alumina project	Queensland government call for expressions of interest in new refinery.					http://statements.cabinet.qld.gov.au/cgi-bin/display-statement.pl?id=824&db=media
	Comalco Alumina Refinery - Gladstone	First stage of greenfield A$1.4 billion refinery in central Queensland under construction, production expected late 2004. Requires expansion of the Weipa bauxite mine to 16 Mt/y from 11.5 Mt/y. Potential to increase refinery capacity to 4 Mt/y.		200 000	1 200 000		CWS
	Gove alumina refinery - Alcan	Proposed expansion of refinery from 2 Mt/y to 3.5 Mt/y with associated expansion of mine. Environmental impact studies submitted to Northern Territory; environmental approval decision expected in mid-2004. Definitive feasibility study under way. Australian federal government granted special status to project. Expansion expected to be operational in 2007. Gove Optimization project under way expected to boost production by 100 000 t by the end of 2004.		60 000	40 000		www.alcangove.com.au/
	Wagerup - Alcoa/Alumina Limited	Decision pending on increase in capacity of refinery.					CWS
	Pinjarra - Alcoa	Planning with government approvals pending on increase in capacity of refinery to 4 Mt/y from 3.4 Mt/y.					CWS
	Worsley - BHP Billiton	Approved expansion of refinery by 250 000 t/y to 3.5 Mt/y. Capacity to be reached mid-2006.				125 000	CWS
Azerbaijan	Sumgait Non-Ferrous Metals plant/Gyandja refiney	Expansion of alumina refinery from 300 000 t/y to 450 000 t/y.	125 000	25 000			MB Jan. 21/03
Bosnia	Birac refinery	Refinery restarted in September.	40 000	260 000			MB Oct. 17/03
Brazil	Barcarena alumina refinery - Alunorte - CVRD Norsk Hydro and others	Expansion of 800 000 t/y completed in early 2003. Second expansion planned to 4.2 Mt/y from 2.4 Mt/y expected completion in 2006. Permits being sought for new 5-Mt/y bauxite mine (Paragominás) needed to provide bauxite for expansion.	500 000	325 000		900 000	CWS, MB Feb. 23/04, BNA Oct. 3/03, PR Newswire release
	Aluminio do Maranhao - Alumar	Study under way on potential expansion of capacity of the refinery from its current capacity of 1.3 Mt/y to 3.3 Mt/y.					MB, Mar. 9/04
	Juruti Mine - Para State - Alcoa	Studies for potential new mine and 1-Mt/y refinery.					BNA Feb. 2/04
China	Baise - Chalco/Minmetals/Guangxi	Discussions and MOU on possible new 400 000-t/y alumina refinery in Guangxi, with later expansion potential to 2 Mt/y.					PMW June 2/03 MB Jan. 6/03
	Chonqing - Nanchuan Minerals Group	Plans to increase new refinery capacity to 150 000 t/y from 70 000 t/y. Potential for expansion to 500 000 t/y.	30 000	40 000	80 000		MB Mar. 30/04, April 5/04
	Dongyangguang Co.	Plans new alumina refinery in Luoyang City, Hennan. Phase 1 to be 800 000 t/y expecting to double with planned startup in 2005.				800 000	PMW, Nov. 17/03
	East Hope Group - Henan	Proposal for a new 1-Mt/y alumina refinery in Henan.					MB June 26/03, Antaike Jan.-Feb./04
	Guangxi Guixi Huayin Aluminium Corp. - Chalco/MinMetals	Feasibility studies for a new 800 000-t/y refinery in Guangxi region. Construction could start in 2004.					MB Jan. 19/04, CWS
	Guizhou refinery	Construction started on 400 000-t/y expansion to 1 200 000 t/y.			400 000		Antaike, Feb./Mar./04
	Lianyungang City - Changxin International Trade Co. and Liancheng Aluminium	Agreement signed on the development of a 2.4-Mt/y refinery and 300 000-t/y smelter in Jiangsu Province.					PMW Nov. 24/03, MB Oct. 6//03
	Mianchi	Various proposals for new 600 000-t/y to 1-Mt/y refinery.					MB June 26/04
	Nanchuan Minerals	Started 70 000 t/y alumina refinery in September, with future expansions to 500 000 t/y.		50 000			MPW Sept./03
	Pingguo refinery	Expansion of capacity to 850 000 t/y from 400 000 t/y completed.	200 000	200 000			PMW July 7/03, MB Jan. 19/04, CWS
	Pingguo refinery joint venture with Alcoa - Chalco	Joint venture delayed. Construction to finish in 2003 for doubling the capacity of refinery to 850 000 t/y.					CWS
	Shandong Aluminium Co.	Expanding capacity to 1.1 Mt/y. Seeking investors and approvals for expansion of capacity from 1.1 Mt/y to 1.5 Mt/y by 2005.		100 000	100 000		PMW Dec. 8/03, Antaike, Feb./Mar./04
	Shanxi - Chalco	Construction started on new refinery with a capacity of 800 000 t/y. Completion expected 2005.			400 000	400 000	CWS

	Zhongzhou refinery - Chalco and others	Expansion by 300 000 t/y completed.		300 000			CWS
Guinea	Friguia refinery - Russian Aluminium	Detailed feasibility study for doubling capacity to 1.4 Mt/y. Study to be carried out by Hatch Associates and All-Russia Aluminium and Magnesium Institute (VAMI) and completed in 2004 with construction to start in 2005.					CWS
	Guinea Aluminium Products Co. (Gapco)	Potential new 2.8-Mt/y alumina refinery.					CWS
Guyana	Linden Mining Enterprises	Agreement in Principle for Cambior to assume management of bauxite operations.					CWS, BNA Jul. 4/03
	Russian Aluminum - Government of Guyana	Memorandum of Understanding to develop bauxite industry of					MB Feb. 12/04
India	Renukoot - Hindalco	Completed expansion and debottlnecking of refinery to capacity of 660 000 t/y. Work on further debottlnecking continuing.	80 000	70 000	30 000	30 000	CWS
	Lanjigarh, Orissa - Sterlite (Balco)	MOU with Orissa government on construction of new 1.4-Mt/y refinery with associated mine and 90 MW power generation. Production expected in 2008.					AMM June 10/03. Various Internet sources.
	Damanjodi - Nalco	Seeking permission to expand alumina capacity at Damanjodi to 2.1 Mt/y from 1.6 Mt/y and bauxite production to 6.3 Mt/y from 4.8 Mt/y.					http://pib.nic.in/release/release.asp?relid=65&kwd=NALCO
	Muri and Belgaum - Indal	Expansion of mines and refineries under way to a combined capacity of 1.2 Mt/y of metallurgical alumina from current 500 000 t/y.			200 000	500 000	CWS
	Utkal - Indal/Alcan	Bauxite mine and alumina refinery in Orissa. Initial refinery capacity 1.5 Mt/y; second stage to 3 Mt/y. Approvals received subject to addressing community concerns.					AMM Nov. 24/03, CWS
Indonesia	Alumina Tayan - PT Aneka Tambang	Proposal for a mine at Kalimantan and a new greenfield alumina refinery.					Company news release
Jamaica	Alumina Partners of Jamaica - Kaiser and Hydro Aluminium	Completed expansion of Alpart refinery from 1.45 Mt/y to 1.65 Mt/y in 2003.	30 000	180 000			CWS, AMM Nov. 25/03
	Kaiser Jamaica Bauxite Co.	A subsidiary jointly owned by Noranda and Century purchased Kaiser's 49% interest in Kaiser Jamaica Bauxite Co.					CWS
	Clarendon refinery - AWAC and Jamalco	Completed 250 000-t/y expansion of refinery at Woodside to 1.25 Mt/y. Study on potential doubling of refinery capacity under way.	25 000	225 000			CWS, PMW Dec. 1/03, MB Mar. 9/04, LMA Feb./04
Romania	BBG Alum Tulcea - Balli Group	Production raised from 400 000 t/y to 550 000 t/y in early 2004; plans to increase to 600 000 t/y by end of 2004.		125 000	75 000		AMM June 9/03, MB Mar. 8/04
Russia	Timan bauxite mine - Sual Group	Mine at Sredne-Timan in Komi Republic under expansion. Expected capacity to eventually reach 3 Mt/y of bauxite. Feasibility study on expansion of mine to 2.5 Mt/y with eventual expansion to 6.5 Mt/y. Possible new 1.4 Mt/y refinery and 300 000-500 000 t/y smelter to be associated with mine. Cooperation agreement with Pechiney in early 2003.					CWS, Interfax Mar. 27/03
	Achinsk Alumina Refinery - Rusal	Upgraded capacity from 1.35 Mt/y to 1.52 Mt/y.	170 000				CWS
Saudi Arabia	Az Zabirah Aluminium Project - Ma'aden	Feasibility study into a mine, 1.4-Mt/y refinery and 600 000-t/y smelter.					CWS
Suriname	Suralco Refinery - Alcoa/BHP Billiton	Expansion of refinery by 250 000 t/y to 2.2 Mt/y under way.			150 000	100 000	CWS
Ukraine	Nikolayev Alumina Refinery - RUSAL	Upgraded capacity to 1.3 Mt from 1.1 Mt/y, completed in March 2004.		150 000	50 000		CWS
United States	Burnside - Ormet Aluminum	Refinery re-opened in December.		550 000	50 000		Platts Nov. 3/03
	Gramercy - Kaiser	A subsidiary company jointly owned by Noranda and Century purchased Kaiser's refinery.					CWS
	Alcoa - Point Comfort	Alumina production increased to 2.3 Mt/y from 1.8 Mt/y at end of second quarter.	300 000	200 000			CWS
Vietnam	Dac Nong - China Non-Ferrous Corp./Chalco/Vimico	Memorandum of Understanding on a new pre-feasibility study to be conducted in 2004 for a potential new 1-Mt/y refinery and bauxite mine. Production for export and a possible smelter.					MB Dec. 5/03, Reuters Dec. 4/03
Venezuela	Bauxilium - CVG Bauxilum/Alcan	Refinery debottlenecking/expansion under way to 2.15 Mt/y from 1.95 Mt/y. Feasibility study on expansion to 3 Mt/y.		200 000			BNA Oct. 3/03, MB Mar. 10/04

Source: Natural Resources Canada, based on published reports.
Abbreviations: AMM - *American Metal Markets*; BNA - *Business News Americas*; CWS - Company's web site, see Table 10; LMA - Light Metals Age; MB - *Metal Bulletin*; PMW - *Platts Metals Week*.

TABLE 12. SMELTER PROJECTS

Country	Project/Company	Comments	Projected Change t/y in 2004	Projected Change t/y in 2005	Projected Change t/y in 2006	Potential Change Longer Term	References
Argentina	Puerto Madryn smelter - Aluar	Studies and government approval for expansion of smelter from 265 000 t/y to 400 000 t/y. Construction of power line expected in 2004.				235 000	CWS, BNA Oct. 8/03, Jan. 22/04
Australia	Aldoga Consortium	Proposed 420 000-t/y smelter near Gladstone, Queensland. Agreement with China Non-ferrous Foreign Engineering and Construction for engineering and supply contract for construction of smelter expected to start in 2004. Production expected to start 2006 with possible expansion thereafter. Agreement on bauxite and alumina cooperation, including possible 4-Mt/y refinery.			150 000	270 000	CWS
	Tomago smelter - Tomago Aluminium Pty Ltd.	Upgrading amperage to AP22; 70 000-t/y expansion in capacity to 530 000 t/y. Completion expected 2006.			20 000	50 000	CWS
Azerbaijan	Azerbaijan Aluminum - Sumgait	Restarted smelter in early 2003 with reduced capacity of 300 000 t/y. New smelter proposed with capacity up of 100 000 t/y.	25 000		50 000	50 000	MB May 22/03, Aug. 19/03
Bahrain	Aluminum Bahrain	Expansion with extension of existing and construction of new potline under way with capacity increase from 520 000 t/y to 830 000 t/y. Construction on new potline started 2003, metal expected early 2005 with full production in mid-2005. MOU with Alcoa on purchase of a 26% interest in smelter and provision of alumina. Potential sixth potline to expand capacity by a further 307 000 t/y.		250 000	60 000	300 000	CWS, PMW Jan. 19/04
Bosnia	Aluminij Mostar	Feasibility study under way for second potline to expand capacity from 110 000 t/y to 220 000 t/y by 2006 (Norsk Hydro).					MB July 31/03
Brazil	Alumar - Alcoa and BHP Billiton	Electrical outage in July reduced production by approximately 70 000 t. Smelter returned to full production at year-end. Potential expansion of capacity from 210 000 t/y to 270 000 t/y.	-70 000				CWS, BNA June30/03,PMW June 5/03
	Sorocoba smelter - Cia Brasileira de Aluminio	Expansion of smelter from 230 000 t/y in 2001 completed to 340 000 t/y in 2003. Capacity to reach 385 000 t/y in 2005.	50 000		45 000		CWS
Brunei	Brunei Darusssalam - BEDB and Alcoa	Feasibility study on a potential new smelter started 2003.					CWS
Canada	Alma smelter - Alcan	Construction of potlining centre.					CWS
	Alouette smelter expansion - Alouette Inc.	Expansion of smelter under way; completion expected 2005. Discussed in text.		90 000	210 000		CWS
	Baie-Comeau - Alcoa	Modernization on hold. Discussed in text.					CWS
	Deschambault smelter (Lauralco) - Alcoa	Expansion on hold. Discussed in text.					CWS
	Jonquière smelter - Alcan	Closure of 90 000-t/y Soderberg capacity.	75 000	15 000			CWS
Chile	Alumysa Proposed smelter - Noranda	Environmental and social studies for a proposed US$2.75 billion hydro-electric project and smelter near Puerto Aisen. Project on hold.					CWS
China	Baotou - Inner Mongolia - East Hope Group	Construction of first phase of 250 000 t/y started late 2002. Eventual capacity from 500 000 t/y to 1 Mt/y.	250 000			250 000	PMW Mar. 22/04, MB June 4/03
	Baotou Aluminium Group	Acquired by Chinalco. 50 000-t/y expansion to 200 000 t/y. Modernization of Soderberg capacity, with expected 90 000-t/y increase in capacity. Potential for further expansion with new 250 000-t/y smelter.	50 000	50 000	40 000	250 000	CWS, AMM June 19/03
	Fushun Aluminium Company	Second phase expansion by 50 000 t/y to 210 000 t/y completed in 2003.	10 000	40 000			MB Nov. 21/03
	Fujian Nanping Aluminium Co	New 73 000-t/y prebake smelter commissioned in July; closed 30 000-t/y Soderberg.	25 000				MB Jul. 8/04
	Huanghe Aluminium and Power Group	Expanded 70 000-t/y capacity starting production in December; total capacity now 125 000 t/y.	70 000				PMW, Nov. 24/03

	Jiaozuo Wanfang Aluminium Co.	Smelter expansion completed to 250 000 t/y in 2003.	85 000				AMM June19/03, MB Jul. 8/03, Interfax
	Lanzhou Aluminium Co.	Modernization and expansion of capacity by 15 000 t/y. Plans for a new 150 000-t/y smelter. Also, 2002 Agreement in Principle with Pechiney on technical cooperation and studies in 2003 for a proposed 260 000-t/y smelter and associated electrical generation facilities in Gansu Province' project on hold.	15 000				MB Aug. 14/03, Nov. 5/03, Dec. 8/03
	Linzhou Aluminium	Expanding capacity from 70 000 t/y to 105 000 t/y.	10 000	25 000			PMW, Dec. 1/03
	Manchi Aluminium Works	Expanding capacity from 60 000 t/y to 120 000 t/y.	60 000				AMM June 19/03, PMW Nov. 4/03
	Pingguo-Chalco joint venture with Alcoa	Waiting for approvals for proposed tripling of capacity of the Pingguo aluminium smelter from 130 000 t/y to 380 000 t/y. Power plant purchase approved by government.					AMM Sept. 17/03, Interfax Mar. 15/04
	Qingtongxia Aluminum Company	In 2003, Alcan received government approval and signed a definitive Joint Venture Agreement for a 50% interest in a modern 150 000-t/y smelter. Agreement also provides long-term power supply and for the purchase of up to an 80% interest in a new 250 000-t/y smelter currently under construction.		100 000	150 000		CWS
	Sanmenxia Tianyuan Aluminium Group Co. Ltd.	Completed 50 000-t/y expansion in mid-2003.	25 000				AMM June 19/03, MB Dec. 8/03
	Shangdong Aluminium Co.	Upgrading smelter completed. Plans for 15 000-t/y expansion by 2005.	10 000	15 000			PMW Dec. 8/03
	Shanxi - Shanxi Guanlu Co. Ltd.	Company started construction of 200 000-t/y expansion of smelter, final capacity of 320 000 t/y. First metal expected mid 2003.	70 000	130 000			PMW Sept. 9/02
	Shanxi smelter - Chalco/Shanxi Zhangze Electric Power Co.	New 280 000-t/y smelter planned for 2005 in Hejin with new 600-MW power plant. Received State approval.		100 000	180 000		CWS
	Nantun - Yankuang Group	New 140 000-t/y smelter to start production in August 2003. Planning for second smelter.	70 000				AMM April 29/03
	Yichang, Hubei smelter - Chalco	Letter of intent with partners on feasibility studies for a new 500 000-t/y smelter near Three Gorges Dam. Feasibility study completed and submitted to government for approval.				500 000	CWS, MB Jan. 6/03, PMW, June 6/03
	Yunnan Aluminium	Planned completion of 200 000-t/y smelter expansion by end 2004.	50 000	150 000			PMW Jan. 5/04
Dubai	Dubal	Work under way to expand capacity from 535 000 t/y to 710 000 t/y. Current capacity 685 000 t/y.	75 000	25 000			CWS
Egypt	Egyptalum	Expansion and modernization - progress slower than expected but work now under way. Capacity to be raised by 50 000 t/y by first quarter 2004 along with conversion of potline #5 to prebake technology.	40 000	10 000			CWS
Ghana	Volta - Kaiser	Closed remaining operating potline in April due to a lack of power.	-80 000	-20 000			PMW Dec. 29/03
Iceland	Atlantsal Ltd.	Feasibility and environmental impact studies and agreements on power for an originally proposed 360 000-t/y smelter. Smelter size reduced to 180 000 t/y.				180 000	CWS
	Fjardaal - Alcoa	Joint action plan and agreement with Icelandic government on new 322 000-t/y smelter (replaces the Noral project). Detailed design completed. Construction expected to start 2004, metal production in 2007.				320 000	CWS
	Norðurál - Century Aluminum Company	Century purchased smelter from Columbia Ventures. Energy contracts in place for expansion from 90 000 t/y to 180 000 t/y by 2006.			90 000		CWS, LMA Dec./03
India	Alupurram - Indal	Smelter closed in August 2003.	-10 000				CWS
	Angul - Nalco	Completed expansion to 345 000 t/y from 230 000 t/y in early 2004. Seeking approvals to expand to 460 000 t/y.	75 000	35 000		115 000	CWS, PMW, Jan. 5/04
	Hirakud - Indal	Smelter expansion to 65 000 t/y completed. Further expansion to 100 000 t/y under way.		35 000			CWS

TABLE 12 (cont'd)

Country	Project/Company	Comments	Projected Change t/y in 2004	Projected Change t/y in 2005	Projected Change t/y in 2006	Potential Change Longer Term	References
	Renukoot - Hindalco	Expansion of capacity by 120 000 t/y to 345 000 t/y completed in 2003. Further debottlenecking expected to increase capacity to 360 000 t/y in next two years.	25 000	5 000	10 000		CWS
Malaysia	Bintulu - Sarawak	Preliminary study for proposed 500 000-t/y smelter, based on new hydro-electric project at Bakun. First stage construction to start 2005 with production in late 2007.					MB Oct. 1/03, PMW Dec. 8/03, MB Jan. 12/04
	Perak State Development Corporation or Johor Corp./Malaysia Aluminum Smelting Co. (Charus Development Corporation and others)	Potential new smelter using Chinese technology to start construction in 2004. First stage 230 000 t/y with potential expansion to 690 000 t/y. Proponents seeking funding and approvals. Received licence from government for power plant.				230 000	PMW April 21/03, MB Oct. 1/03, Dec. 8/03, AMM Nov. 26/03
Mexico	Almexa Aluminio smelter	Smelter closed in August.	-20 000				BNA Sept. 25/03
Mongolia	TongliaoHuomei Hongjun Aluminium	Construction under way on new smelter with eventual capacity of 400 000 t/y. First phase (100 000 t/y) expected to be completed late 2004.	10 000	90 000	100 000	200 000	PMW, Dec. 22/03
Mozambique	Mozal - Billiton and partners	Expansion of capacity of the Mozal smelter completed to 500 000 t/y. Reached full production August 2003.	125 000				CWS
Norway	Årdal/Hoyanger - Hydro Aluminium	Soderberg technology to be phased out by 2006 at Årdal.				-72 000	CWS
	Mosjøen - Elkem	Modernization and expansion completed in mid-2003; capacity now 188 000 t/y compared to 120 000 t/y in 2002.	30 000				CWS
	Soeral Norsk Hydro/Alcan	Expansion of 44 000 t/y completed first quarter 2003.	10 000				CWS
	Sunndal - Hydro Aluminium	Capacity increasing from 173 000 t/y in 2002 to 330 000 t/y in 2004. Phase 2 expansion completed in 2003.	20 000	110 000			CWS
Qatar	Ras Laffan - United Development Co., Ferrostaal, and JGC Corp.	Consortium proposal for smelter in NE Qatar, has licence to build smelter, contract for gas supply. Smelter capacity 500 000 t/y. Production originally expected in 2006, may be delayed.					AMM Jan. 26/03, MB May 29/03
Romania	Alro smelter - Marco International	Expected completion of expansion to 300 000 t/y from 215 000 t/y in 2004.	50 000	35 000			MB Oct. 27/03
Russia	Kandalaksha smelter - Sual Group	Approvals received from government for construction of a new 230 000-t/y smelter. Technical and feasibility studies in 2004.					MB Feb. 20/04
	Komi smelter and refinery - Sual	Hatch Associates awarded contract for prefeasibility and engineering work on alumina refinery and smelter in 2002. Smelter capacity expected to be 300 000-500 000 t/y. Initial sitework started by Sual. Discussions on potential partnership with Alcoa.					CWS, Dow Jones Business News, Sept. 30/03
	Krasnoyarsk smelter - Russian Aluminium	Modernization replacement of Soderberg with prebake technology and expansion planned after feasibility study completed by company and Hatch Associates. Capacity to rise by 80 000 t/y to 990 000 t/y by 2007.			40 000	40 000	CWS, AMM Dec. 2/03, PMW Mar. 22/04, LMA Feb./04
	New smelter in Irkutsk Region - Russian Aluminium	Feasibilty studies for new smelter, 600 000 t/y. Construction would start in 2006 with completion in 2009.					CWS, AMM May 19/03
	Sayanogorsk - Russian Aluminium	Upgrading to boost capacity by 30 000 t/y in 2003. Modernization/ replacement of Soderberg with prebake technology and expansion planned after feasibility study completed by company and Hatch Associates. Planning for second phase increase in production by 290 000 t/y.	25 000		25 000		CWS, AMM Dec. 2/03, LMA Feb./04, PMW Mar. 22/04
	Uralsky smelter - SUAL Group	Potlines upgrade completed in 2003 to raise capacity by 35 000 t/y.	35 000				CWS
Saudi Arabia	Az Zabirah Aluminium Project - Ma'aden	Feasibility study on 1.4-Mt/y refinery and 620 000-t/y smelter based on local bauxite.					CWS
Slovakia	Ziar-nad-Hronom - Slovalco A.S.	Expansion/upgrade of smelter completed in mid-2003. Capacity increase of 34 000 t/y.	10 000				CWS

South Africa	Coega - Alcan and others	Proposed smelter near Port Elizabeth in South Africa. New US$2.2 billion 460 000-t/y AP50 smelter planned. Alcan reviewing Pechiney project, which had received environmental approval with initial contracts let for infrastructure. Alcan expects to make decision in 2004.				460 000	CWS
	Hillside smelter - BHP Billiton	Reached full capacity in December 2003.	120 000				CWS
United States	Columbia Falls Aluminum Co.	Closed two of last three operating potlines in March 2003.	-50 000				www.matr.net/article-6167.html
	Ferndale (Intalco) - Alcoa	One of two potlines closed (90 000 t/y) in November.	-90 000				CWS, AMM, April 23/03
	Massena smelters- Aloca	Cutbacks in production at two Massena smelters.	-60 000				CWS
	Hannibal - Ormet	Temporary closure of two of six potlines in December 2003.	-88 000				CWS
Venezuela	Alcasa - CVG	Modernization and restarting of potlines to production of 210 000 t/y. Expanding anode capacity and plans new potline with additional 240 000-t/y capacity. Contracts awarded in early 2003 with construction to start in 2004, production expected in 2006.	30 000			240 000	CWS, AMM June 19/03, Sept. 17/03, BNA May 22/03, Dec. 9/03
	Venalum - CVG	Re-opened two potlines in 2003, seeking financing for its plans - new potline (VI) with additional 136 000 t/y capacity.	30 000				PMW Jan. 5/04, BNA June 10/03, Dec. 11/03
Vietnam	Vimico	Feasibility study for mine/refinery/smelter completed in May; seeking government approval.					www.vfabric.com/Vietnews/03may09.htm
Total			1 192 000	1 290 000	1 170 000	3 383 000	

Source: Natural Resources Canada, based on published media reports.
Abbreviations: AMM - *American Metal Markets*; BNA - *Business News Americas*; CWS - Company's web site, see Table 10; LMA - Light Metals Age; MB - *Metal Bulletin*; PMW - *Platts Metals Week*.