



FOILING THE **ALUMINUM** **INDUSTRY:**

**A TOOLKIT FOR COMMUNITIES, ACTIVISTS,
CONSUMERS, AND WORKERS**
by **International Rivers Network**





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CONSUMERS, AND WORKERS**
By Glenn Switkes

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Introduction

Aluminum is a versatile material familiar to nearly everyone on the planet. It is used in the construction of auto engine blocks and airplane wings, in kitchen foils and pots and pans, for soft drink and beer cans and restaurant takeout trays, in window frames and electrical wiring, and for baseball bats and bicycles. Its low weight, resistance to corrosion, high conductivity of electricity and heat, and its strength, combined with its ability to be poured, pressed, or rolled into various shapes have afforded it an ever-growing presence in consumer items worldwide.

However, aluminum's apparent cheap economic cost and its omnipresence belie the high environmental costs of its mining and refining: forests destroyed, water contaminated with aluminum wastes, fertile valleys and pristine ecosystems submerged. The human costs of producing familiar aluminum items are also great: displacement of tribal peoples and agriculturalists, and serious impacts on community and worker health.

The conversion of bauxite, or aluminum ore, to primary aluminum is also the world's most energy-intensive industrial process, and aluminum producers use

more electricity than any other industry. The aluminum industry is also a significant contributor to global warming.

Two years ago, a series of plans for projects involving the construction of hydroelectric dams and aluminum processing plants came to the attention of International Rivers Network (IRN). The projects had several things in common. They involved building large dams in ecologically-sensitive regions to generate electricity for powering aluminum plants. They were being sited in countries where aluminum is not consumed in great quantities, and where project benefits would be enjoyed principally by consumers in the US, Europe, and Japan, while the impacts would be left behind. In most cases, the processing plants were slated for construction in countries far from the source of the raw materials needed to produce aluminum, such as bauxite ore and aluminum oxide (alumina), and the feasibility of the plants stemmed from their access to cheap energy and low-paid workers. Finally, the enormous aluminum complexes were being proposed and developed by some of the world's most powerful transnational corporations, companies that in their press releases purport to be models for sustainability.



*Molten aluminum
Photo: Aguirre/Switkes/Amazonia*

IRN began to analyze the probable impacts of these projects, and found that little information was available to affected populations, consumers, activists, and workers about the aluminum industry and the way it works—its gluttonous appetite for electricity, and the pollution and contamination generated by the aluminum production cycle. It was difficult for people we contacted to comprehend why these companies were intent upon building some of the world's largest industrial facilities in some of the world's most remote and beautiful places, and even

more difficult to understand what we as communities, consumers, and activists could do together to stop them.

In October, 2003, IRN helped organize the First International Strategic Roundtable on the Aluminum Industry, in São Luís, Brazil. Here Alcoa, BHP Billiton, and Alcan, three giants of the aluminum industry, operate one of the world's largest aluminum smelters, using electricity from an enormous hydroelectric dam in the Amazon. International activists, workers, and specialists presented lessons

learned from diverse experiences addressing the impacts of the aluminum industry, and a frank and forward-looking discussion of possibilities for common strategies took place. Some conclusions were consensual—activists needed more information with which to orient their local campaigns regarding aluminum development, and consumers in the US, Europe, and Japan needed to be educated regarding the impacts of their increasing consumption of aluminum products.

In order to provide the context for the next round of strategic discussions regarding tactics and strategies to halt or control the social and environmental impacts caused by aluminum production, International Rivers Network agreed to take on one of the recommendations of the activists taking part in the São Luís meeting—the creation of a “toolkit” on the aluminum industry, a publication to inform and orient activists and consumers alike.

This toolkit provides a variety of information fundamental to the understanding of the aluminum industry and how it works. Through case studies, we look at the experiences of global activists facing off against the aluminum industry, and their attempts to prevent the destruction of their land and communities, as well as practical suggestions on tactics that may be useful for activists. The toolkit also seeks to inform consumers about ways to lessen the impacts of their use of aluminum products, and to suggest strategies for limiting the expansion of the global aluminum industry and the social and environmental destruction this implies. The publication also indicates sources of information and contacts which can bring interested people and groups together in the search for solutions to the problems generated by aluminum companies.



Sundalsora aluminum plant, Norway Photo: DGB Bildungswerk

The Aluminum Industry Today and Tomorrow

Primary aluminum is produced in three stages. First bauxite ore is mined, then it is refined into aluminum oxide, or alumina, and finally it is smelted into aluminum ingots, using huge amounts of electricity.¹

Most of the leading aluminum companies are vertically integrated, and dominate all phases of aluminum production. The aluminum industry is very concentrated, three companies (Alcoa, Alcan, and Rusal) produce more than one-third of the world's primary aluminum. Alcoa alone is responsible for refining one-quarter of all alumina, the intermediary product required for the production of primary aluminum.² This concentration is increasing, as evidenced by Alcan's \$5 billion takeover of the French company Pechiney in 2004, Norsk Hydro's buyout of German VAW in 2001, and Alcoa's 2000 acquisition of Reynolds Aluminum.

Aluminum processing plants have migrated in recent years from the traditional industrial centers of the US, Europe, and Japan to new "greenfield" projects in the developing world, with access to cheap electricity and low-paid workers the principal motivation. Nearly one-quarter of global aluminum smelting capacity is still in North America, but US output has declined by 50% since 1999.³ Meanwhile,





China's production has tripled in the past decade, climbing to 20% of the world's output. China's annual production growth of 18% means it will soon overtake the United States to become the leading global producer of primary aluminum.⁴ Europe has 16% of global smelting capacity, and the countries of the former Soviet Union account for 13%.⁵

Besides China, the largest expansions in aluminum smelting in the coming decade are projected to take place in Russia, Bahrain, Australia, India, Iceland, Venezuela, Argentina, and Brazil.⁶ Important new smelters are also being planned in other countries including Malaysia, Iceland, Saudi Arabia, Qatar, Trinidad and Tobago, Kazakhstan, South Africa, Chile and Mozambique.⁷

As with most primary commodities,

the prospects for the aluminum industry are difficult to predict. Driven by increasing demand for aluminum in China's economic boom, prices for primary aluminum rose in March, 2005 to over \$1,800/ton, but then fell to \$1,530/ton by June, 2005.⁸ China's consumption of aluminum increased by 80% between 1999 and 2003, and most new aluminum production capacity today is being installed in China (by comparison, global aluminum consumption has increased by only 2.4% over the past decade).⁹ China now has 136 aluminum smelters, a number greater than in the rest of the world combined, although most of them are smaller plants.

Recently, the Chinese government has raised interest rates and eliminated tax rebates for aluminum exporters. Some analysts point to the decline in alu-

minum prices as a signal that these measures enacted to cool off China's overheating economy are having an effect.¹⁰

The international price of alumina has followed a similar pattern. In 2002-2003, in response to China's increased demand, alumina prices doubled to \$500 per ton. This triggered a rush by the world's leading aluminum companies to expand their alumina refining capacity. Although the price on the spot market later fell to \$300 per ton, alumina stocks are expected to remain tight through 2006.¹¹ The Aluminum Corporation of China (Chalco) is now second only to Alcoa as the world leader in alumina refining, producing 5.6 million metric tons per year.¹²

Most industry analysts predict that in the foreseeable future, China will remain an important consumer of aluminum, and will be the principal force driving global aluminum and alumina markets.

LINKS:

The Aluminum Association:

www.aluminum.org

International Aluminum Institute:

www.world-aluminium.org

European Aluminum Association:

www.eaa.net

Alcoa: www.alcoa.com

Alcan: www.alcan.com

BHP Billiton: www.bhpbilliton.com

Rusal: www.rusal.com

Hydro Aluminium: www.hydro.com

First Step:

Stripping forests for bauxite

The aluminum production cycle begins with the extraction of bauxite ore, which contains 45-60% aluminum oxide and is typically mined in open pits, requiring the complete removal of vegetation and topsoil. Four to five tons of bauxite are required to produce two tons of alumina, which in turn can be refined to produce one ton of primary aluminum.

The largest producers of bauxite ore are Australia (35% of the world's bauxite extraction), Brazil, Guinea, China, Jamaica, and India. Together, they account for nearly 90% of the world's bauxite. Guinea alone provides about half of the bauxite imported by the United States and Canada.¹³

After it is extracted from the earth, bauxite undergoes extensive cleaning and processing. A vast amount of waste rock results from the mining process, which has to be disposed of. Even if topsoil is restored after mining, the soil loses its ability to retain water, making it unfit for annual crops.



Quilombola woman making manioc flour, Trombetas River region, Brazilian Amazon

Photo: Carlos Penteado

STRIPPING THE AMAZON

The Mineração Rio do Norte (MRN) mine on the Trombetas River in the northern Brazilian rainforest accounts for 78% of Brazil's bauxite mining, and new mines are being planned at Paragominas (CVRD) and Juriti Velho (Alcoa), also in the Amazon. The MRN mine is owned by Companhia Vale do Rio Doce (CVRD), Alcoa, BHP Billiton, Alcan, Companhia Brasileira de Alumínio, and Hydro Aluminium (a subsidiary of Hydro, formerly Norsk Hydro). The MRN mine is now expanding its capacity from its current 11 million tons of ore per year to 16.3 million tons per year. MRN's mine was developed in large part on lands traditionally occupied by quilombolas, communities of descendents of escaped African slaves. MRN required the extensive stripping of soil, because the bauxite was found at a depth of 12 meters. The MRN mine contaminated Batata Lake, where 24 million tons of mine wastes were discarded.¹⁵ The lake also suffered from sedimentation caused by mining activities. Finally, the quilombolas convinced Brazilian environmental authorities to require the company to clean up the lake, an ongoing effort which, despite showing some positive results after more than a decade, is still far from complete, and will likely never restore Batata Lake to its prior condition.

More recently, residents of the Trombetas River region have described renewed conflicts with MRN, which has deforested wide areas to permit expansion of the mine.¹⁶ Local populations use the areas around the mine for gathering Brazil nuts, a valuable staple of their economy.

Alcoa's planned bauxite mine at Juriti Velho, in Pará state, is estimated to have reserves of 350 million tons.

The 20 communities living locally survive through sustainable extraction of forest resources for medicines, oils, and fruits, and by fishing. They have filed complaints regarding Alcoa's clearing of the rainforest and threats from armed guards who restrict the communities' access to a 65,000 hectare area Alcoa says it owns. 8,000 hectares of forests would be cleared for the Alcoa mine.

In a statement, Juriti Velho community leaders say "1,800 families live near the Great Lake (site of Alcoa's proposed mine and alumina plant) where there are still extensive areas of virgin forests, and where various endangered animal species are found. Once deforestation spreads, the area will become a desert."

Juriti residents have been meeting with Alcoa to ask crucial questions about the company's plans for the region, including the number of jobs that will be available for locals and the measures Alcoa will take to protect the environment, if the project moves ahead.

LINKS:

Comissão Pró-Índio de São Paulo (campaign for legalization of quilombola territories):

www.cpis.org.br (in Portuguese)

Projeto Manejo dos Territórios Quilombolas (information about the quilombola communities of the Trombetas River region):

www.quilombo.org.br/html/quilombo.html (in Portuguese)



Bauxite mine, Brazil

Photo: DGB Bildungswerk

LINKS:

Friends of the Earth mining campaign:

www.foei.org/mining/index.html

Mineral Policy Center/Earthworks:

www.mineralpolicy.org/ewa/intl_program.cfm

Mineral Policy Institute, Australia:

www.mpi.org.au

Mines and Communities:

www.minesandcommunities.org

Western Australian Forest Alliance:

www.wafa.org.au/articles/alcoa

Open-pit mining has effects on local fauna and flora and promotes soil erosion. With most bauxite mined in a belt extending throughout the tropics, bauxite mining is a significant cause of tropical forest destruction. The tropical areas where bauxite ore is found are also among the Earth's strongholds of biodiversity. Despite industry promises, rainforests cannot be restored to their prior biodiversity after mining activities cease.

In Jamaica, bauxite mining is the single largest cause of deforestation, affecting over 5,000 hectares of trees for mines and waste areas, and an unknown area of forests for access roads, leading to the entry into forests of illegal loggers. In Australia, Alcoa has deforested 13,500 hectares of endemic jarrah forests for its Huntly bauxite mine.¹⁴

BAUXITE MINING BRINGS VIOLENCE AGAINST INDIGENOUS PEOPLE

Proposed bauxite mines on Baphlimali hill and an aluminum smelter in the Kashipur region of Orissa, which has nearly 70% of India's bauxite, would displace tribal people (or "adivasis," the Sanskrit word for "original inhabitants"), who survive on shifting cultivation agriculture. The Indian constitution guarantees the rights of indigenous people over their natural resources and land.¹⁷ The bauxite mines of the Utkal project will cause the adivasis to lose land, and it is highly unlikely that compensation will be adequate to restore their livelihoods. The Norwegian development agency Norad estimates that, in all phases of the Utkal project, 60,000 people will be affected.

The Utkal project is intended to produce bauxite and alumina for export, and is being planned by India's Hindalco and Canada's Alcan (45%). Norsk Hydro (now Hydro Aluminium) pulled out of the project in 2001. The work of Norwegian environmentalists and church groups, joining forces with local activists and affected people, had an important impact on the company's decision, as did international indignation when in 2000, police fired upon a public protest killing three tribal members.¹⁸ However, violence against the affected communities continues, and in November 2004, baton-wielding police charged into a crowd of tribal and low-caste (dalit) protesters, injuring 16, and beating three women unconscious.¹⁹

Environmental studies for the project have not been made publicly available, but according to the environmental clearance conceded by the government, the company may dump mine overburden for the first five years. This will lead to siltation of streams, and damage of slopes and cultivable lands.

The alumina plant at Doraguda would produce one million tons per year over a 30-year period, and will directly affect 2,500 people of 24 villages of Kucheipadar, Hadiguda and Tikri Panchayat, who will be forced off their land for plant construction and waste disposal areas. Among the wastes generated by the alumina plant through the "stacking" of red mud wastes (see "Alumina refining" below), will be 150 tons of sodium hydroxide per day,

which could seep into rivers and streams, affecting drinking water, and causing cattle deaths and crop losses, as well as impacting aquatic life downstream. Power requirements of 80 MW will require burning 2,800-3,000 tons of coal per day, generating some 1,000 tons of ash per day, which will be dumped into an ash pond.²⁰

Advaxis continue their protests against the Utkal project, even in the face of police violence. Alcan't in India, a Canadian group, has attempted to convince Alcan to make environmental studies publicly available, and has protested at the Alcan corporate headquarters and at its shareholder's meeting. Companies are often very sensitive to public opinion and press articles criticizing their operations abroad.

LINKS:

Alcan't in India: www.saanet.org/alcant or www.saanet.org/kashipur (send a message to Alcan's CEO demanding they release the project EIA and name a joint commission to investigate the position of affected people)

Mines, Minerals and People (India):
www.mmpindia.org/indexmm.htm

Mining Watch Canada:
www.miningwatch.ca/publications/Utkal_Action_backgnd.html



Photo: Aaron Lakoff

Second 2 Step:

Alumina refining— white powder and red mud

The bulk of world bauxite production (approximately 85%) is used as feed for the manufacture of alumina, the intermediary product in the processing of aluminum. Through what is known as the Bayer process, bauxite ore is finely crushed and dissolved in a solution of sodium hydroxide (caustic soda, or lye) under high temperature and pressure.

Insoluble iron oxide, titanium, sodium, silica, and other oxides are filtered out as sludge called “red mud.” The solution is then clarified and sent to a precipitation tank where a small amount of aluminum hydroxide is added as a “seed” which facilitates crystallization of aluminum hydroxide and sodium hydroxide. The crystals are then washed, vacuum dewatered, and sent to a rotating kiln. The result is a fine, white powder called alumina (aluminum oxide).



Alunorte alumina refinery, Brazilian Amazon

Photo: DGB Bildungswerk



Red mud waste pond

Photo: DGB Bildungswerk

For every ton of alumina produced, between two and three tons of bauxite ore must be processed. The waste remaining after the process is disposed of as red mud. Disposal of red mud wastes which are highly caustic, often with a pH in excess of 13.2, is a significant environmental problem. Typically, red mud has been dumped in mined-out pits. Besides seeping into groundwater and streams, red mud increases the sodium content of neighboring water wells.

Experience in tropical regions, where most bauxite is found, demonstrates that heavy rainfall is a significant obstacle to the drying out of red mud ponds. In Jamaica, ponds failed to dry

out as predicted, and surface and groundwater contamination was tracked, likely caused by migration of caustic wastes from the ponds. Lined ponds have now diminished groundwater contamination.²¹

In 2001, residents of the region near Kaiser's (now Hydro Aluminium's) Alpart refinery in Jamaica closed the plant's railroad, in protest over inadequate compensation for damages from windblown alumina dust, spilled caustic soda, sulphur dioxide gases, and impacts to their water supply. A public health study found elevated incidences of asthma, sinusitis, and allergies near the plant. Udel Lloyd, a 73 year-old asthmatic said, "That's the Big Man

over there," gesturing toward Alpart. "What he want, he get. He make money for the government. Nobody in the government cares about us."²²

With environmental restrictions affecting red mud disposal in some countries, producers have turned to countries with weaker environmental laws to site their alumina refineries and waste disposal sites. Plans by Australian Comalco Aluminum Ltd. to ship bauxite ore to Sarawak for processing into alumina, and to dump 4.2 million kilograms of red mud per year, discharging contaminated waste water into watercourses, were suspended following protests by environmental activist groups.

LINKS:

Sahabat Alam Malaysia:
www.surforever.com/sam

Besides sealing waste ponds with liners and clay, other new techniques of red mud disposal include thickening of the mud and solar drying (using a stacking and drying method) to decrease the liquid content of red mud and to limit

its mobility, and techniques for reuse of the liquid fraction. Still, communities must ensure that best available technology is utilized, and that environmental authorities maintain strict monitoring of alumina waste ponds.

JAMAICANS DEMAND TO KNOW WHETHER THEIR WATER SUPPLIES ARE CONTAMINATED

Red mud resulting from Jamaican alumina operations was originally disposed of in un-lined ponds, resulting in percolation of caustic residues into underground aquifers. The 100-120 acre ponds destroyed fertile farm land. Designed to hold 5-7 years worth of tailings, the ponds never dried out after being filled, and had to be abandoned, in favor of new sites. More recent disposal sites were to have been lined with 12-14 inches of clay sealant, but this has still not been done in some areas.

Other impacts include air pollution from alumina refining, where gases, caustic aerosols, and corrosive dust is released into the atmosphere. Burning high-sulphur oils in the plant has released acidic gases, sulphur dioxide, and sulphur trioxide, leading to acid rain. A recent study linked pollution from alumina refineries to bronchial hyper-sensitivity in children. Local residents also blame exposure to pollutants from alumina plants for heart disease, speech

disorders, and convulsions. They are calling for Alcan and the Jamaican government to carry out water quality tests to determine whether ground and surface water has been contaminated.

Open letters to company and government officials, with copies to concerned organizations on the national and international level can be an effective way of publicizing a problem with the aluminum industry, and to make officials aware they are being monitored. Most often, the company will officially respond to the letter, opening the way to a dialogue which should be carried out with great care so that community leaders are not co-opted by official promises to take action.

LINKS:

Jamaican Bauxite Environmental Organization:
www.jbeo.com

AUSTRALIA'S WAGERUP ALUMINA PLANT SERVES A CHEMICAL COCKTAIL TO RESIDENTS, WORKERS

Hearings held in the Western Australian Parliament's Standing Committee on Environment and Public Affairs from 2001-2004 focused on emissions from Alcoa's Wagerup alumina refinery. Alcoa has called Wagerup "the most environmentally advanced alumina refinery in the world" and says it is considering expanding operations. But some 500 people living in proximity to the refinery told the parliament they had suffered irritation to their mucous membranes, skin, and eyes. Speculation pointed to the Wagerup liquor burner, used to burn off organic compounds contained in bauxite ore.²³

Witnesses also accounted that, during dry periods, wastes from the alumina plant blew through the air into their homes and yards. Through prolonged exposure, the residents reported chronic headaches, digestive upsets, and pain, particularly in the joints, a burning in their stomachs and throats, throat ulceration, nose bleeds, and a general feeling of lethargy, possibly caused by cumulative exposure to various compounds, a condition the committee termed "multiple chemical sensitivity."²⁴ Livestock were afflicted with chronic coughing and rashes, often leading to death.

In 2003, six workers at the plant were awarded compensation and Alcoa agreed to install pollution controls.²⁵ In December, 2004, Alcoa was fined \$47,000 for pollution

caused by bauxite residue dust. A member of a local resident group, Tony Hall, said "We're not that impressed by it. There's been over 5,000 complaints against this operation...(that's) chump change to that sort of a company."²⁶

Similar concerns have surfaced at Alcoa's Kwinana alumina refinery near Perth. At Kwinana, environmental authorities were outraged when evidence showed that Alcoa had doctored dust monitoring results from its red mud tailing ponds. Consequently, the company lost its best practice environmental license and with it, the right to self-monitor its operations.²⁷ Eight waste spills were also reported by Alcoa between June and November 2004.²⁸

Public hearings force the issue into the public arena, and obligate politicians to take a position. The negative side is that very often, these drag on without coming to a decisive conclusion. Hearings should be seen as one form of broader public pressure directed at the company.

LINKS:

Australian Aluminum Council (emissions from alumina plants): www.aluminium.org.au/npi/documents/Smelters.pdf

Western Australian Parliament's Standing Committee on Environment and Public Affairs report on the Alcoa Alumina Refinery at Wagerup:

[www.parliament.wa.gov.au/Parliament/commit.nsf/\(InqByName\)/Alcoa+Alumina+Refinery+at+Wagerup?opendocument](http://www.parliament.wa.gov.au/Parliament/commit.nsf/(InqByName)/Alcoa+Alumina+Refinery+at+Wagerup?opendocument)

Third Step:

Primary aluminum smelting— the highly polluting, energy-intensive process by which aluminum ingots are produced

The strong bonds between aluminum and oxygen in alumina make its refining into aluminum possible only by using enormous amounts of energy, more than is required in the production of any other metal, or in fact in any other industrial process. Through what is termed the Hall-Héroult process, alumina is placed within electrolytic cells, or “pots,” filled with molten cryolite (Na_3AlF_6). Within each pot, a positive electric current is passed through the cryolite by means of a submerged carbon anode at a temperature of over $1,200^\circ\text{C}$ (nearly $2,000^\circ\text{F}$). The oxygen atoms are attracted to the carbon anodes, and the molten aluminum can then be poured from the bottom of the pot.



Aluminum foundry

Photo: DGB Bildungswerk

Primary aluminum processing is the most polluting phase of the aluminum production chain, resulting in air emissions and solid wastes. Emissions from aluminum reduction processes include gaseous hydrogen fluoride and particulate fluorides, alumina, carbon monoxide, volatile organics, and sulfur dioxide from the reduction cells; and fluorides, vaporized organics and sulfur dioxide from the anode-baking furnaces. A variety of control devices such as closed cells and wet scrubbers are used to reduce emissions. Wastewaters

generated from primary aluminum processing are produced during clarification and precipitation though much of this water is fed back into the process to be reused.

Two types of anodes may be used during the reduction process, either an anode paste (called the Soderberg anode) or a pre-baked anode. The Soderberg anode produces residual gases, including fluoride, that are more difficult to collect as well as significant quantities of PAHs (polycyclic aromat-

ic hydrocarbons), including known carcinogens, such as benzo[a]pyrene (B[a]P). Studies show that the presence of PAHs in the ambient air may be associated with certain cases of bladder cancer in workers.²⁹ Smelters using Soderberg technology are slowly being phased out of operation.

The impacts of large concentrations of fluoride have been widely documented. It accumulates in the environment, affecting forests, grasses, livestock, and wildlife.³⁰ In mammals, fluoride poi-

MATERIAL INPUTS/POLLUTION OUTPUTS IN THE ALUMINUM PRODUCTION CHAIN³⁶

PROCESS	MATERIAL INPUT	AIR EMISSIONS	PROCESS WASTES	OTHER WASTES
Bauxite refining	Bauxite, sodium hydroxide	Particulates		Residue containing silicon, iron, titanium, calcium oxides, and caustic
Alumina clarification and precipitation	Alumina slurry, starch, water		Wastewater containing starch, sand, and caustic	
Alumina calcination	Aluminum hydrate	Particulates and water vapor		
Primary electrolytic aluminum smelting	Alumina, carbon anodes, electrolytic cells, cryolite	Fluoride - both gaseous and particulates, carbon dioxide, sulfur dioxide, carbon monoxide, and per-flourinated carbons (PFCs)		Spent potliners, K088
Secondary scrap aluminum smelting	Aluminum scrap, oil or gas, chlorine or other fluxes (aluminum chloride, aluminum fluoride, sodium and potassium chlorides, and fluorides)	Particulates and HCl/Cl ₂		Slag containing magnesium and chlorides
Secondary aluminum dross recycling	Aluminum dross, water	Particulates	Wastewater, salts	

ALUMINUM WORKERS PLAGUED BY HEALTH RISKS

The aluminum production chain poses health risks of various kinds to workers. Bauxite mining causes respiratory and skin problems, in addition to other injuries consistent with mining and heavy industries. Workers in alumina refineries are exposed to various chemicals, and many suffer what is termed "multiple chemical sensitivity." Workers in aluminum smelters are subject to the effects of fluoride poisoning.³⁷

Symptoms include osteosclerosis (hardening of the bones), sinus trouble, perforation of the nasal septum, chest pains, coughs, thyroid disorders, anemia, dizziness, weakness and nausea.³⁸ A variety of respiratory disorders affecting smelter workers have been termed "pot-line asthma."

An Australian study linked fluoride gas and the breathing in of dust at aluminum smelters with increased incidence of work-related wheeze and chest tightness.³⁹ In another Australian study, researchers found that smelter workers had a greater chance than the average Australian of contracting and dying from stomach, kidney, and prostate cancers. In 1999, Alcoa warned aluminum workers that they faced an elevated chance of contracting lung and bladder cancers as a result of coal tar pitch used in smelters.⁴⁰

International labor leaders met in 2003 in Canada to plan cooperation regarding health impacts of the aluminum industry. Particularly in developing countries, there is little information available about worker health issues, and most often insufficient monitoring by government environmental agencies.

soning can take the form of dental, skeletal, or systemic fluorosis. Absorbed fluorine is retained in dental and bone tissues, and may cause bone atrophy and dental fluorosis, whose main symptom is an orange-brown pigmentation in the teeth. Hydrogen fluoride can cause respiratory damage. Farm animals that have grazed regularly in pastures around smelters have been found to have these ailments. A 1993 study on effects of fluoride gas emissions on conifers showed that hydrogen fluoride has an effect on conifers up to one thousand times greater than other acid gases.³¹

The Akwesasne Mohawk indigenous nation (US, Canada border) has suffered the consequences of fluoride pollution from a Reynolds (now

owned by Alcoa) smelter upstream.³² Dr. F. Henry Lickers, biologist and director of environment for the Akwesasne nation says, "By 1972, we had effectively identified fluoride as being the problem, and it was coming from the [aluminum] plant in gaseous and particulate form, landing on vegetation on Cornwall Island and being consumed by the cattle. And the teeth would rot in the mouths of these animals."³³ Later, says Lickers, the cattle would die. Researchers have also documented the presence of PCBs and abnormalities in the nervous and skeletal systems and lungs of Mohawk men, women, and children.

The electrolytic process also produces dust, suspended particulates and sulphur dioxide (SO₂), which is present in the coke used to prepare the



Pouring molten aluminum

Photo: Aguirre/Switkes/Amazonia

LINKS:

Fluoride Action Network (Aluminum Industry):

www.fluoridealert.org/pollution/index.php/pollution/content/view/full/1170

Mohawks and fluoride:

whollywater.com/Fluoride/Mohawk.Nation.htm

Akewesasne's Toxic Turtles:

tuscaroras.com/graydeer/pages/Toxicturtle1.htm

Radio Free Asia ("Aluminum Smelting Villages Refuse to Eat Own Crops"):

www.rfa.org/english/news/science/2004/09/07/pollution

anodes. SO₂ is a major atmospheric pollutant contributing to the formation of acid rain and acid smog. This gas irritates the respiratory tract, and is also fairly damaging to plants, with concentrations around 0.03 ppm causing acute lesions on foliage.³⁴

One of the biggest environmental problems for the aluminum industry is what to do with spent smelting pot linings. The steel linings gradually absorb materials from the molten elec-

trolyte, and when ready to discard after their useful life of three to eight years, they are contaminated with fluorides and cyanide. Their volume is significant—as much as 20 tons of spent pot linings for every 1,000 tons of aluminum produced.

While the industry attempts to find ways to re-use pot linings, as is being done on an experimental basis in Australia, they are stored at plant sites as toxic waste.³⁵

RUSSIA'S TOXIC SMELTER LEGACY

The region of the former Soviet Union has been severely impacted by aluminum smelters using obsolete technology. In the northwestern region of Karelia, communities have been poisoned for decades by the Nadvoitsy aluminum smelter. Their teeth are corroding and discolored, and there are highly elevated incidences of miscarriages, still births, and congenital defects. The known carcinogen benzopyrene has been found in local water supplies. Russian authorities relocated populations from an area heavily polluted by fluoride gas, near the Soderberg-process Bratsk smelter in Irkutsk, where residents reported bone and lung diseases (the plant is now being modernized). Wind-blown emissions from the Tajik Aluminum Plant have caused cows in Uzbekistan to lose teeth, also affecting silkworm raising, vineyards, and fruit orchards. There has been a reported increase in the incidence of metabolic disorders, and diseases of the

endocrine system, blood stream, pulmonary organs and the musculoskeletal system. Birth defects and tumors are on the rise.

Community and activist groups in countries where highly-polluting Soderberg process smelters are being operated should demand that they be shut down, and that remedial action be undertaken, including epidemiological studies to address health and environmental impacts suffered during their operation.

LINKS:

National Wildlife article:

www.nwf.org/nationalwildlife/article.cfm?articleId=641&issueId=70

Tajik State of the Environment Report

www.grida.no/enrin/htmls/tadjik/soe2/eng/htm/air/state.htm

A WHALE OF A PROBLEM

Following a 17-year study, University of Montreal researchers found that beluga whales in the St. Lawrence River have the highest rate of cancer among non-humans in the world, 27 per cent among adults and 18 per cent among young whales, in particular, cancer of the digestive tract.

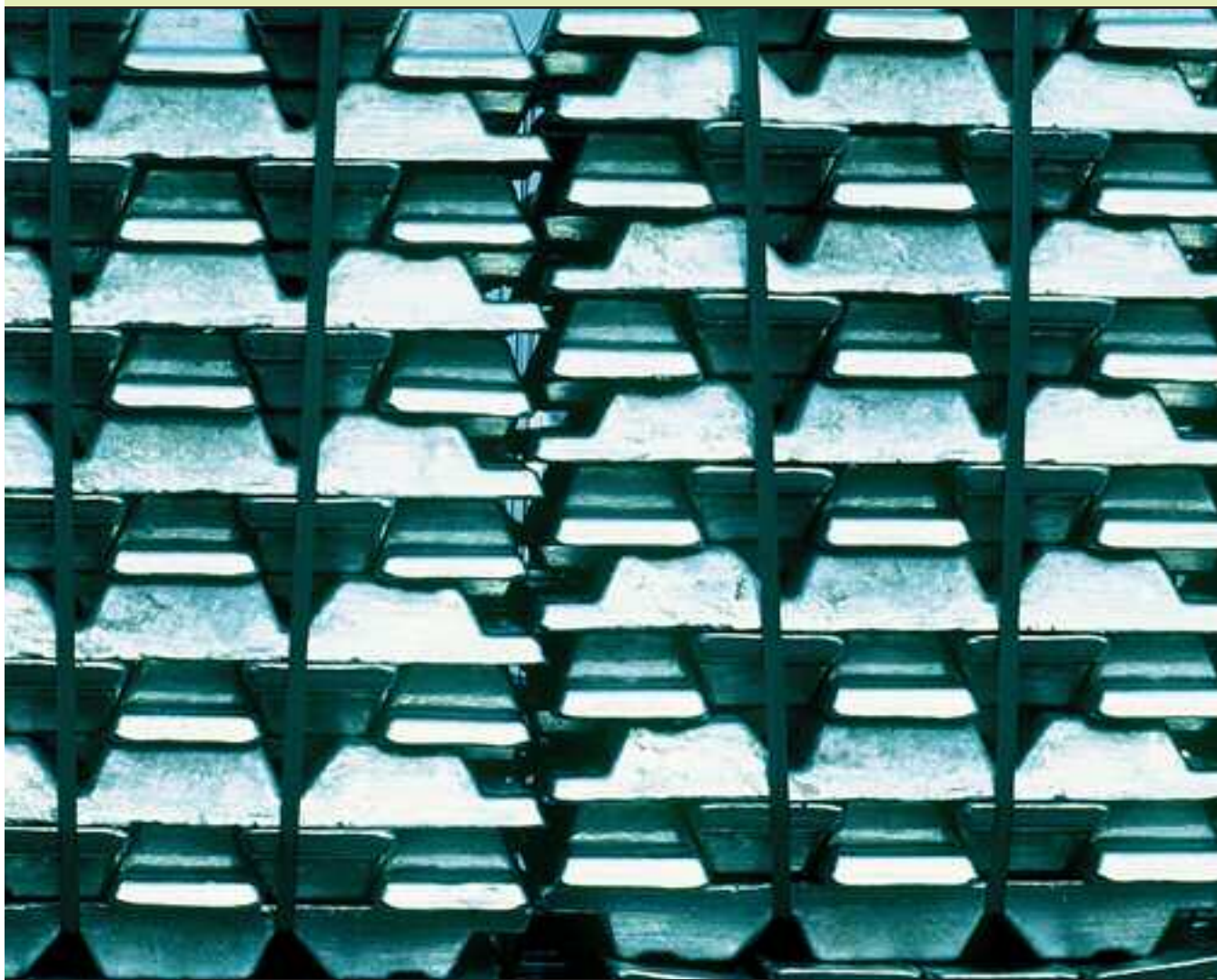
They blame toxic run-off from aluminum smelters on the Saguenay River, a tributary of the St. Lawrence. Human populations in the region have also shown an excess of lung, urinary, and digestive cancers, which researchers blame on PAHs (polycyclic aromatic hydrocarbons), PCBs, and heavy metal emissions from the smelters.⁴¹

Effects of aluminum operations on wildlife are a good indicator of their effects on human populations and the environment. Where such issues are raised, aluminum companies should be pressured to finance independent studies to determine cause and effect of these often far-reaching impacts. The negative side is that rigorous scientific studies often take years, which may delay rehabilitation efforts.

LINKS:

The Scientist magazine (free sign-on):

www.the-scientist.com/yr2000/oct/research_001002.html



IS THERE A CONNECTION BETWEEN ALUMINUM AND ALZHEIMER'S DISEASE?

Four and a half million Americans, including half of all Americans over the age of 85 have Alzheimer's, a degenerative disease of the central nervous system, characterized primarily by premature senile mental deterioration and dementia. There is no cure for Alzheimer's at this time.

Various studies have established a link between increased absorption of aluminum in the brain and Alzheimer's.⁴² Scientific studies have not proven, however, the connection between ingesting aluminum and contracting the disease. Some public health experts suggest playing it safe

by trying to control the pathways by which aluminum may be ingested into the body such as via drinking water,⁴³ use of aluminum cookware and aluminum foil, and use of antacids, buffered aspirins, and antiperspirants containing aluminum.⁴⁴

While science has not confirmed any link between ingestion of aluminum and Alzheimer's, this is an issue that is of great public concern and is worth keeping track of.

Even the possibility of a connection has led many to avoid using aluminum cookware, for example.



Ingots at Alcoa and Billiton's Alumar plant, São Luís, Brazil

Photo: Aguirre/Switkes/Amazonia

Aluminum:

World champion energy glutton

The aluminum industry is the world's largest industrial consumer of electrical energy, consuming about 1% of all the electrical energy generated globally, and about 7% of the total consumed by global industries.⁴⁵ Nearly all the electricity consumed in the aluminum production chain (and two-thirds of the total energy inputs) is in smelting primary aluminum.⁴⁶ The total amount of electrical energy consumed in primary aluminum production varies from 12-20 MWh per metric ton, with the global average estimated at between 15.2-15.7 MWh per ton.⁴⁷

About half of all electricity consumed by the aluminum industry comes from hydroelectricity, a percentage that is expected by industry sources to increase in the coming years. Another 36% comes from coal, 9% from natural gas, 5% from nuclear energy, and 0.5% from oil. Hydroelectricity dominates as the electrical energy source for aluminum smelting in Norway, Russia, Latin America, and North America. Coal is most widely used in Oceania and Africa.⁴⁸



Tucuruí Dam, Brazilian Amazon

Photo: Andreas Missbach

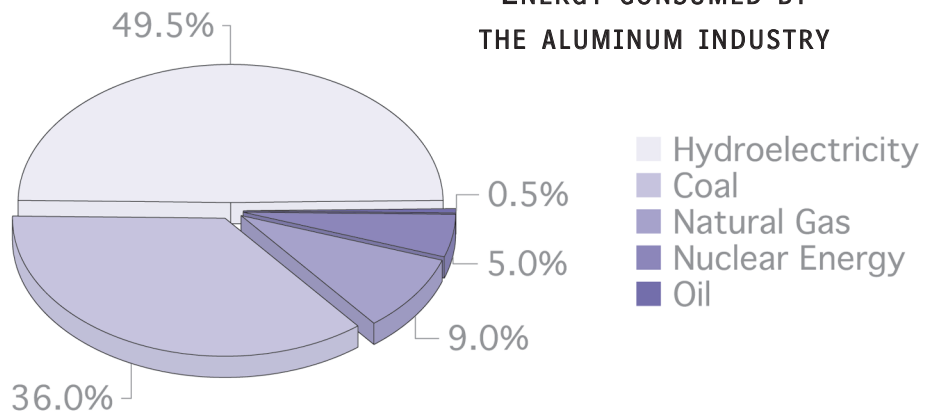
Over the past two decades many aluminum smelters in industrialized nations have been shut down in favor of new smelters in the so-called “developing” world, where energy and labor costs are lower, with energy being the single most important factor in cost analyses, accounting for about 25%–35% the total cost of primary aluminum production.⁴⁹ Aluminum industry sources say that companies paying more than \$35/MWh have found themselves unable to compete, and have been forced to close their plants or attempt to renegotiate energy costs.⁵⁰

Less important is access to raw materials like bauxite, which can be shipped overseas at relatively low cost. Aluminum production has migrated from North America, Europe, and Japan in favor of new production capacity in Asia and Africa.

Despite recent moves to privatize and deregulate energy industries in many

countries, governments still play an important role in determining energy prices offered to aluminum producers, and subsidies in the form of enormous quantities of cheap energy often make the difference in decisions on where to locate new smelters. These subsidies run counter to initiatives encouraging greater energy efficiency and lower energy use.

ENERGY CONSUMED BY THE ALUMINUM INDUSTRY



As an example, the coal industry receives direct grants from the governments of the United Kingdom⁵¹ and Germany.⁵² Electricity consumed by aluminum companies is subsidized by the government in Australia⁵³ and Brazil.⁵⁴ Multilateral development banks have offered loans at favorable rates to hydroelectric facilities linked to aluminum smelters in Argentina and Venezuela, among others.⁵⁵



The World Commission on Dams' case study of Tucuruí Dam in Brazil found that the Albrás/Alunorte and Alumar smelters received between \$193–411 million per year in energy subsidies from a state-owned utility.⁵⁶ The smelters recently employed the strategy of threatening to shut down and leave the country in order to obtain new, long-term contracts for subsidized electricity at far below the rates paid by other industries. More than 70% of the aluminum produced

by the plants is exported.

Many examples demonstrate that when aluminum smelters lose heavily subsidized electrical energy, the smelters lose their economic feasibility. Kaiser's Valco smelter had production curtailed after its contract with the government of Ghana expired. The contract had provided some of the world's cheapest energy (reportedly 11 cents per kWh, only 17% of energy generation costs).⁵⁷ In January, 2005, Alcoa signed a memorandum of understanding with the

government of Ghana to re-open the smelter, with energy rates undisclosed.

Providing subsidized energy to electric-intensive industries strongly affects national energy planning. Despite the fact that only 4.7% of Mozambique's population has access to electricity, BHP Billiton, Mitsubishi, and Industrial Development Corporation's (IDC's) Mozal smelter is doubling its capacity, and will devour four times the amount of electricity consumed for all other uses in Mozambique.⁵⁸

WORLD BANK REVIEWS ITS FINANCE FOR EXTRACTIVE INDUSTRIES

In response to criticism from NGOs and activists, the World Bank contracted an independent review of its financing of extractive industries, with the goal of providing recommendations to guide the World Bank Group's involvement in the oil, gas and mining sectors. The Extractive Industries Review (EIR) provided a strong critique of the bank's role in financing social and ecological disasters, but the bank has refused to stop supporting such projects.

In summary, the EIR recommended the adoption of transparent and participatory governance measures in countries prior to the implantation of extractive developments; comprehensive options assessments before projects go forward; directing project benefits to poorest communities, ethnic minorities, and women; guarantees of revenue sharing to local communities; improvements in quality of life for resettled populations; monitoring to ensure that companies observe the human rights of local populations; recognition of the right of indigenous peoples to prior,

informed consent to projects; banning extractive developments in areas of conflict; increased lending for renewable energy; banning riverine tailings and suspension of submarine tailings pending further studies; transparency in project agreements and documents; formalization of the moratorium on coal lending and a phase-out of oil and gas lending over the next five years.⁷⁴

Increasing scrutiny of investments by multilateral financial institutions in extractive industries is making it more difficult for the banks to justify their support for such projects. An international network working on mining issues can help local activists questioning the financing of mines and related refineries, smelters, and power plants.

LINKS:

World Bank Extractive Industries Review:

www.worldbank.org/ogmc/eirreports.htm

Civil society views on the report: www.eireview.info

ALUMINUM: HEATING UP THE EARTH'S CLIMATE

The principal greenhouse gases emitted by primary aluminum production are CO₂, methane (CH₄), and the perfluorocarbons CF₄ and C₂F₆.⁵⁹ The principal source of CO₂ emissions is the generation of electricity for the smelting process, principally from the burning of fossil fuels. Hydroelectric dams in tropical ecosystems release significant quantities of CO₂ and especially CH₄.⁶⁰

Australia's aluminum industry gets its electric power primarily from coal-fired power stations. These coal-burning plants emit 27 million tons of CO₂ annually. This is 6% of Australia's total greenhouse gas emissions, even though the aluminum industry represents only 1.3% of Australia's GDP from manufacturing.⁶¹ Aluminum and aluminum products are the country's second most important export—after coal. The industry has torpedoed government policy initiatives to establish mandatory renewable energy targets and a carbon emissions trading scheme. Australia has one of the world's highest per capita greenhouse gas emissions.

Australian aluminum production since 1990 has increased by 45% and is likely to continue to increase. While direct greenhouse gas emissions from the smelting process have gone down by 24% on 1990 levels (down 45% per ton), indirect emissions from the production of electricity for the smelters are up by 40% since 1990. Increased production means total emissions from aluminum smelters are up 25% from 1990.⁶²

The Australian aluminum industry produces five times as much greenhouse gas as agriculture, 11 times as much as mining and 22 times as much as other manufacturing activities for every dollar contributed to the national economy.⁶³ On a global level, the aluminum industry admits to generating an average of 11 tons of CO₂ equivalent for each ton of primary aluminum produced, principally from the burning of fossil fuels.⁶⁴

PFCs are potent greenhouse gases formed during alumina smelting. PFCs are some of the most long-lived atmospheric pollutants, remaining in the atmosphere for up to 50,000 years, and are considered 6,500-9,200 times more potent greenhouse gases than CO₂. Aluminum production accounted for 60% of global releases of PFCs into the atmosphere in 1995, although pollution controls have decreased the level of releases per ton of aluminum produced over the past two decades.⁶⁵

Global warming is an increasingly "hot" issue worldwide. With the Kyoto protocol now in effect, activists should question potential aluminum projects as to the quantities of greenhouse gases they will release. This can be a decisive argument in evaluating options for industrial development. More research is needed to quantify greenhouse gases from tropical reservoirs, since most new aluminum smelters are powered by hydroelectric dams.

LINKS:

Climate Action Network Australia: www.cana.net.au

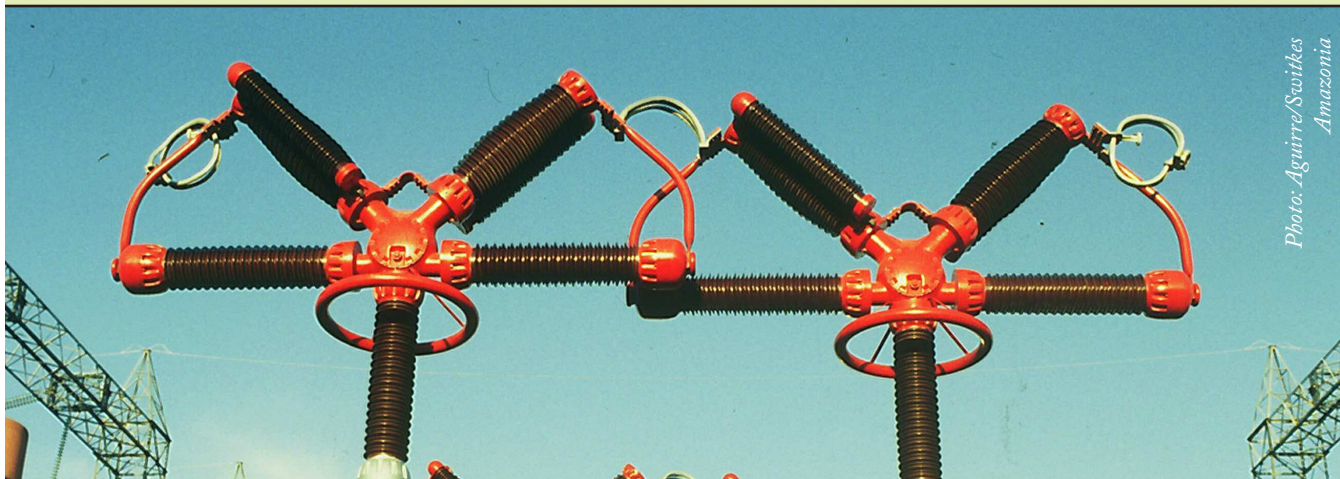


Photo: Aguirre/Swiss Amazonia

GLOBAL BANKERS BACK THE ALUMINUM INDUSTRY

Multilateral development banks and export credit agencies have furnished significant support for expansion of the aluminum industry. This support has taken the form of loans for bauxite mining, alumina and primary aluminum refining, and for electrical energy projects powering aluminum plants.

A case in point is the International Finance Corporation, the private sector arm of the World Bank, which provided \$120 million to Alusaf (South Africa) and Industrial Development Corp. (IDC - South Africa) for the first phase of the Mozal aluminum smelter, and \$25 million to BHP Billiton, Mitsubishi, IDC, and the government of Mozambique for the second phase. The project was also funded by Canadian, English, German, and Japanese export credit agencies. The IFC also funded two Venezuelan bauxite port projects (GMSV and ACBL) for a total of about \$9.5 million.⁶⁶ In 2004, together with the European Bank for Reconstruction and Development (EBRD), the IFC provided support for the Timan bauxite mine (Russia), part of an integrated bauxite/alumina/aluminum project owned by the SUAL group and the Komi Republic government.⁶⁷

The EBRD provided \$110 in loans for the Slovalco smelter in Slovakia, owned by Zavod Slovenskeho Narodneho Povstania (ZSNP). The EBRD financed Hydro Aluminium's entrance into the project as a minority partner.⁶⁸ In 2003, the bank cancelled plans to finance the Nematik smelter in the Czech Republic after several years of protests regarding toxic wastes and gas emissions.⁶⁹ Another controversial project reportedly slated for financing by the EBRD, the IFC, and the US Overseas Private Investment Corporation (OPIC) is the Sosnovy Bor aluminum smelter that would be powered by energy from obsolete and dangerous nuclear generating stations in Russia.⁷⁰

Another World Bank division, the Multilateral Investment Guarantee Agency (MIGA), provided \$80 million in loan guarantees in 2001 to the Guinea Investment Company Ltd. and a consortium of banks for a bauxite mine, alumina plant, electric and water utilities, and a railroad in Guinea.⁷¹

The Inter-American Development Bank (IDB) has also subsidized the aluminum industry, supporting the Caruachi (\$500 million)⁷² and now the Tocoma Dam, powering smelters in Venezuela's Guayana industrial zone. Many other hydroelectric dams in Latin America powering aluminum plants have received support from the IDB, the World Bank, and US Export-Import Bank.

The Japan Bank for International Cooperation has financed the Asahan Hydroelectric and Aluminum plant (North Sumatra, Indonesia) and Albrás/Alunorte (Brazil).⁷³

Campaigns against the financing of aluminum complexes by international financial institutions can be an effective way to halt these projects. The projects have a high level of risk, and raising critical issues with potential financiers early on in the project cycle may make these institutions more reluctant to get involved. Because hydroelectric dams or other power facilities connected with aluminum complexes are more likely to seek direct loans from development banks and export credit agencies than the aluminum facilities themselves, the financing for these facilities may be more vulnerable to pressure from local activists and international support groups.

LINKS:

Bank Information Center: www.bicusa.org

Equator Principles for environmental and social issues in private financing: www.equator-principles.com

Export Credit Agencies Watch: www.eca-watch.org/index.html

International Finance Corporation: www.ifc.org

Multilateral Investment Guarantee Agency: www.miga.org

Private Finance: www.banktrack.org

NEMAK project in Czech Republic described at www.bankwatch.org/issues/ebdrip/nematik/mainnematik.html

World Bank Guidelines on Aluminum Manufacturing: [ifcln1.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_alum_mfg_WB/\\$FILE/alum_PPAH.pdf](http://ifcln1.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_alum_mfg_WB/$FILE/alum_PPAH.pdf)

Molten Dams:

Hydroelectric dams built for the aluminum industry

I. Dams already built

Many dams have been constructed in large part to power the aluminum industry. Among the best known are:

SOUTH AMERICA

Tucuruí⁷⁵ (Tocantins River, Brazil)—3,960 MW, completed in 1984, 2,860 km² reservoir, estimated cost US\$8.77 billion). Currently being expanded to 8,000 MW. About half of the project's energy generation goes to the Alumar (São Luís-Alcoa, BHP Billiton, Alcan) & Albrás (Companhia Vale do Rio Doce, Japanese consortium Nippon Amazon Aluminum Company) plants. More than 24,000 people were displaced, and the dam has had serious impacts on the lives and livelihoods of tens of thousands of floodplain farmers and fishermen downstream. The Parakanã indigenous people were relocated, then relocated once more when engineering errors failed to predict the flooding of their new reserve. The Gavião indigenous people were also affected. Estimates are that the two primary aluminum smelters powered by Tucuruí have received between US\$193 million—\$411 million per year in subsidized energy.



Quilombola sets out to hunt and fish, Trombetas River region, Brazilian Amazon

Photo: Carlos Penteado

Guri and Macagua⁷⁶ (Caroní River, Venezuela)—Guri, built in 1986, 4,750 km² reservoir, 3,600 displaced, with 10,300 MW installed capacity, and Macagua with 2,712 MW fuel Alcasa (state Corporación Venezolana de Guyana—CVG with Alcoa) and Venalum (80% CVG, 20% Sumitomo, Showa, Kobe Steel, Mitsubishi, and Marubeni) plants. Reservoirs flooded land of Pemón indigenous people.

Brokopondo⁷⁷ (Suriname)—30 MW, 1965, 1,550 km² reservoir severely affected by proliferation of water hyacinth. 6,000 Maroons (descendents of escaped African slaves) displaced—Alcoa Suralco smelter.

Futuleufu⁷⁸ (Argentina)—448 MW, 1978, 92 km² reservoir, provides 90% of electricity for Aluar smelter (258,000 tons per year (tpy) capacity).

NORTH AMERICA

Grand Coulee⁷⁹ (Columbia River, US)—6,180 MW, 1942, 5,700 displaced, reservoir 333 km²—one-third of electricity generated goes to smelter owned by an Alcoa-Kaiser-Reynolds-Japanese consortium. Salmon threatened with extinction.

Kenney⁸⁰ (Nechako River, Canada)—896 MW, 1952, 920 km² flooded affecting 200 families including Cheslatta indigenous people. Has affected fish stocks and wildlife habitat. Kitimat smelter (272,000 tpy) operated by Alcan. Plans to increase dam capacity to 1416 MW.

James Bay Complex⁸¹ (La Grande, Eastman, Caniapiscaw rivers, Canada)—1996, 11 dams with total installed capacity of 15,743 MW flooded 15,900 km², 1,000 displaced. Has affected hunting grounds of Cree and Inuit indigenous people. Nearly 10,000 migrating caribou drowned when the Caniapiscaw river was flooded. A significant portion of energy fuels aluminum smelters operated by Alumax, Alcoa, Pechiney, Amax, VAW, Kobe Steel, Austria Metall, SGF, Marubeni, and Hoogovens at highly subsidized rates.

Various⁸² (Saguenay and Péribonka rivers, Canada)—Combined capacity of 2,687 MW operated by Alcan. Flooded 1,867 km² affecting indigenous peoples. Power Alcan's Grande Baie (186 tpy) and Laterrière (210 tpy) smelters.



Akosombo Dam, Volta River, Ghana
 Photo: World Bank

AFRICA

High Aswan⁸³ (Nile River, Egypt)—2,100 MW, 1970, 4000 km² flooded, 113,000 people displaced. Has decreased soil fertility downstream, forced intensive use of chemical fertilizers, and fouled Cairo's drinking water supply by increasing algae in the river. Led to increases in mosquito-borne illnesses. Had serious impacts on Nile estuary and related fisheries. Archaeological sites affected. Nag Hammadi smelter (cap. 245,000 tpy) operated by state company Egyptal is dependent on power from High Aswan.

Akosombo⁸⁴ (Volta River, Ghana)—1020 MW, 1965, created world's largest man-made lake (8,482 km²), 84,000 displaced—to fuel Valco plant (90% Kaiser Aluminum, 10% Reynolds—now Alcoa—cap. 200,000 tpy)—resulted in proliferation of waterborne diseases, including schistosomiasis, intestinal bilharzia, and malaria.

Song Loulou⁸⁵ (Sanaga River, Cameroon)—387 MW, 1981, 30% of its capacity fuels the Alucam smelter (87,000 tpy), now owned by Alcan.

ASIA

Sayano-Shushenskaya⁸⁶ (Enisei River, Russia)—6,721 MW, 1980, 621 km² reservoir, 9,700 displaced—Russia's largest hydro plant, 30% of its output goes to the Sayanagorsk aluminum smelter (404,000 tpy) and Sayanal foil mill, both owned by Rusal.

Krasnoyarskaya⁸⁷ (Enisei River, Russia)—500 MW, 1970, 2000 km², 56,100 displaced, powers Krasnoyarsk, world's second largest primary aluminum smelter (850,000 tpy).

Bratsk⁸⁸ (Angara River, Russia)—4,500 MW, 1965, 5470 km², 67,400 displaced, has flooded and destroyed wetlands affecting Lake Baikal. Powers the Bratsk smelter, world's largest (910,000 tpy, Trans World Group and others).

Irkutsk⁸⁹ (Angara River, Russia)—660 MW, 1960, 1,466 km², 18,000 displaced.

Nurek⁹⁰ (Vaksh River, Tajikistan)—2,700 MW, 1975, 98 km², 1800 displaced. At 300 meters, is the world's highest dam. Has contributed to the demise of the Aral Sea. Powers the Tursurzade smelter, whose capacity is being expanded to 517,000 tpy.

Sanmenxia⁹¹ (Yellow River, China)—410 MW, 1961, 410,000 displaced. The dam has lost most of its storage capacity to sedimentation. Sanmenxia is home to one of the world's largest integrated aluminum plants, with annual production capacity of more than 5 million tons alumina, 1.5 million tons electrolytic aluminum and nearly 500,000 tons of processed aluminum products. A project for 2.6 million tpy of alumina is now being built, and the region also has ample bauxite reserves.

Rihand⁹² (Rihand River, India)—300 MW, 1962, 466 km², 200,000 displaced for Hindalco plant at Remikoot, Uttar Pradesh (242,000 tpy), which uses 55% of Rihand's power. Dam has serious problems with sedimentation.

Mingechaur (Kura River, Azerbaijan)—360 MW, 1951, 635 km², 4,600 displaced.

Taanga and Siguragura Falls⁹³ (Asahan River, North Sumatra, Indonesia)—hydroelectric complex for P.T. Inalum smelter (225,000 tpy), began operation in 1986. \$3 billion investment by Japanese as part of project to relocate aluminum smelters from Japan. 75% of production owned by Sumitomo, Nissho Iwai, Nippon Light Metal Company, Marubeni, Mitsubishi, and Mitsui. Only a part of hundreds of fishing families affected by the dam received compensation. Batak-minority tribespeople downstream were also affected. Lake Toba has dropped 2.4 meters as a result of the hydro projects.

EUROPE

Various⁹⁴ (Norway)—aluminum smelters consume 15% of Norway's electricity, nearly all of which is produced by hydroelectric dams, beginning with Glomfjord Dam in 1920. Hydroelectric dams in Norway have affected agricultural communities and wilderness areas, flooding 10% of national parks and impacting Arctic and sub-Arctic plateaus. Migration of wild reindeer and moose obstructed.

OCEANIA

Lake Pedder⁹⁵ (Tamar River, Australia)—65 MW, 1972, 242 km². Comalco-operated Bell Bay smelter in Tasmania no longer needs the energy. Affects Tasmanian Wilderness World Heritage Area. Campaign to decommission dam and restore the lake.

Manapouri⁹⁶ (New Zealand)—170 MW, 1969, 142 km² has impacted lakes in Fiordland national park for Tiwai point smelter (335,000 tpy)—currently operated by Comalco/Rio Tinto (79%) and Sumitomo (21%).



*Protest at site of proposed Rio Blanco dams, part of Alumysa aluminum complex, Chilean Patagonia
Photo: Peter Hartmann*

II. Current struggles against dams for aluminum

SOUTH AMERICA

Argentina:

Principal groups: Pillan Mahuiza Mapuche Community, Ecopiuke, Rios Vivos Coalition, Patagonia Articulation

La Elena⁹⁷ (Carrenleufu River)—Patagonia region, 100 MW, 17 km², \$140 million. First of six dams planned (La Caridad—42 MW/ .75 km², Puesto Bustos—115 MW/ 20 km², Jaramillo—24 MW/ 23 km², Río Hielo—50 MW/ 18 km², Frontera—80 MW/ 4 km²) to permit expansion of the Aluar aluminum refinery. Would impact Mapuche indigenous communities and campesinos, and flood native forests.

Brazil:

Tocantins and Araguaia rivers—savanna and eastern Amazon—Alcoa, BHP Billiton, CVRD, Votorantim to fuel expansion of Alumar and Albrás plants—in all, at least 37 large and 9 smaller dams planned for basin.⁹⁸

Principal groups: Dam Affected Peoples' Movement (MAB), Pastoral Land Commission (CPT), Carajás Forum, Forum of the Eastern Amazon (FAOR), Indigenist Work Center, Indigenist Missionary Council, indigenous populations.

Serra Quebrada⁹⁹ (Tocantins River)—1328 MW, \$1.35 billion, 386 km² reservoir would flood most fertile lands of Apinajé indigenous reserve, and require expulsion of 14,000 people. Has not yet been offered for concession.

Estreito¹⁰⁰ (Tocantins River)—1109 MW, 590 km², would expel 6,000 people, and affect dolphins and other aquatic life. Currently delayed by legal challenges.

Santa Isabel¹⁰¹ (Araguaia River)—1080 MW, \$750 million, 240 km², would expel 2,841 people, and affect the Suruí-Aikewar indigenous people. In June, 2003, the consortium suspended its plans for the project after environmental officials ruled the project was environmentally unfeasible for its impacts on protected areas, and endangered species including river dolphins and turtles.

Xingu Hydroelectric Complex—6 dams, 20,000 km² flooded. Principal group: Movement for the Development of the Transamazon and Xingu—MDTX, Forum of the Eastern Amazon, Pastoral Land Commission.

Belo Monte¹⁰² (Xingu River)—5,500–11,182 MW, \$5–8 billion, 440 km², 16,000 people displaced. Would cut off water to the Big Bend of the Xingu, home to Paquicamba Juruna indigenous people. The project as currently designed will generate very little energy during low-water period, and speculation is that electric sector officials plan to proceed with the six-dam complex originally planned for the Xingu, flooding more than 20,000 km² of the rainforest and indigenous reserves. Most likely consumers are the expanded Alumar and Albrás smelters, and new mines and smelters.

Minas Gerais State, Upper Doce River Basin

Principal groups: MAB, CPT-MG, Global Justice

Candonga¹⁰³—140 MW, \$100 million, 2.7 km², 100 families displaced. CVRD/Novelis Construction has been marked by police violence against protests by dam-affected communities.¹⁰⁴



Lago Caro community would be forcibly removed for Alumysa smelter and dam project, Chile Photo: Peter Hartmann

Fumaça¹⁰⁵ 10 MW, 2.2 km², 200 families displaced. Also **Furquim/ Prazeres**¹⁰⁶ total capacity 18 MW, \$21 million, Novelis (USA)—“small” hydroelectric dams planned in populated rural areas will affect hundreds of small farmers to power plant for aluminum rolled products. Novelis is a new company which spun off from Alcan.

Southern Brazil—Principal groups: MAB, Atlantic Coast Forest Network, APREMAVI, Santa Catarina Federation of Ecological Groups-FEEC, Friends of the Earth Brazil.

Barra Grande¹⁰⁷ (Pelotas River)—690 MW, \$500 million, 81 km². Project of aluminum companies Alcoa and Companhia Brasileira de Alumínio, and construction conglomerate Camargo Correa. They omitted mentioning in environmental studies that more than 2,000 hectares of virgin endangered araucaria pine forests, and 4,000 hectares of other types of forests would be flooded. Project awarded an operating license by federal environmental authorities in 2004. Reservoir filling suspended following blockades of clearing crews by affected people, but the project secured another operating license and reservoir filling resumed.

Southeastern Brazil—Principal groups: MAB, MOAB (Movement of Dam-Threatened People of the Ribeira Valley), SOS Mata Atlantica, Socio-Environmental Institute.

Tijuco Alto¹⁰⁸ (Ribeira do Iguape River)—150 MW, 100 km², would dam São Paulo state’s last undammed river, flood Atlantic Coast rainforests and lands of the quilombolas. In 2003, project was denied an environmental license by federal authorities. In March, 2005, the CBA aluminum company announced it had modified the project design for Tijuco Alto, and would re-apply for environmental licensing approval.

Chile:

Principal groups: Aysén Life Reserve, Patagonia Campaign, Fiscalía del Medio Ambiente (FIMA), Greenpeace Chile

Alumysa Project¹⁰⁹—US\$2.7 billion project includes three dams (1000 MW total capacity), port, and smelter with capacity of 440,000 tpy. In August, 2003, Canadian-based Noranda announced it had withdrawn its request for environmental licensing after Chilean environmental authorities raised extensive issues concerning problems in the EIA. Chile has invited Noranda to select an alternative site for its smelter, raising questions as to whether the hydroelectric part of the project will continue in the new plan.

AFRICA

Cameroon:

Lom Pangar (Lom River)—51 MW, \$115 million, 610 km², number of villages affected unknown. AES-Sonel project would regulate Sanaga river to increase power generation from downstream dams. Energy would principally go for expansion of Alcan’s Alucam smelter. Would flood protected Deng-Deng forest.

EUROPE

Iceland:

Principal groups: Iceland Nature Conservation Association, Friends of the Earth International, Worldwide Fund for Nature, Bankwatch.

Karahnjukur¹¹⁰ (Joekulsa a Bru, Joekulsa and Fljoetsdal rivers)—630 MW, \$1.1 billion. Alcoa stepped in in 2002 to replace Norsk Hydro, and electricity will fuel their 322,000 tpy Reydaral smelter. The dam’s Halslon reservoir will flood 57 km² of highland vegetation, and the extensive network of engineering works will directly affect 2,900 km², or three percent of Iceland’s land area. It will partly flood one of Iceland’s largest and most spectacular canyons, the Dimmugljufur.

Serbia and Montenegro:

Principal groups: Most, IUCN, European Nature Heritage Fund.

Buk Bijela¹¹¹ (Tara River)—450 MW, UNESCO World Biosphere reserve, to power Podgorica aluminum plant.

ASIA

Malaysia:

Principal groups: Sahabat Alam Malaysia, Friends of the Earth, World Rainforest Movement.

Bakun¹¹² (Balui River)—2,400 MW, 694 km², will displace 10,000 indigenous people from five ethnic groups and 15 longhouse communities, and flood rainforests and farmland. There is a proposal to construct an aluminum smelter (500,000 tpy, \$7 billion) in Semilanjau, Sarawak, which would guarantee the dam’s feasibility and purchase of 37.5% of Bakun’s capacity.

LINKS:

Molten Rivers—the Aluminum and Hydro Connection:

www.irn.org/programs/aluminium/pdf/aluminumreport2003.pdf

WWF: Rivers at Risk—Dams and the future of freshwater ecosystems:

www.panda.org/downloads/freshwater/riversatriskriversympo_sumpapercollier.doc

MALAYSIA'S BAKUN DAM UNFEASIBLE WITHOUT ALUMINUM SMELTER

The 2,400 MW Bakun Dam in Sarawak, Malaysia, which has required the relocation of 10,000 indigenous people, is now seen to be dependent on whether or not an aluminum company decides to build a smelter in the province. The Gulf International Investment Group Capital company is now indecisive as to whether to move ahead with the Smelter Asia project after a Dubai-based partner pulled out of the plan. However, BHP Billiton and Rio Tinto are said to be interested in the \$2.5 billion smelter project, as some Chinese companies are also said to be.¹¹⁶

Relocation for Bakun Dam has been underway for some time. The inhabitants are being settled on only three hectares of land, less than the 7.5 hectares they were originally to be offered. Human rights workers say that resettlement housing is of extremely poor quality.¹¹⁷

Malaysia has not designed a comprehensive energy plan, and while new dams are being constructed, natural gas is being exported, and conservation and alternative energy sources are being ignored. Bakun is an instructive lesson on how a dam, originally presented as essential for meeting the nation's energy needs, now has its feasibility dependent on electro-intensive industries to consume the power it would provide. It is a case of “the cart pulling the horse,” in the direction of environmental and social devastation.

LINKS:

Coalition of Concerned NGOs on Bakun:

www.xlibris.de/magickriver/bakun.htm

Rivers Watch East and Southeast Asia on Bakun:

www.rwesa.org/statement/statement20020824.html



Villagers displaced to make way for Bakun Dam, Malaysia

Photo: Borneo Project

DAMMING THE AMAZON FOR ALUMINUM

The largest dam ever built in a tropical rainforest, Brazil's Tucuruí Dam, was constructed principally to fuel the Albrás/Alunorte and Alumar aluminum smelters. Now, the smelters are planning to expand their capacity, and Alcoa has indicated its interest in developing a new bauxite mine/alumina refinery complex in the Amazon. This will place added pressure on the Brazilian government to promote plans for new hydroelectric dams in the Amazon, where two-thirds of Brazil's hydroelectric generating potential is located.

Aluminum companies consume 5.5¹¹³-8%¹¹⁴ of all electrical energy in Brazil. Alcoa has said it would be interested in investing as much as \$1 billion as part of a consortium being formed to construct Belo Monte Dam, the first of a series which would be built on the Xingu River.¹¹⁵ Belo Monte would displace at least 16,000 people, and would dry up the river below the dam, affecting 500 indigenous

people. Five other dams planned for the Xingu would flood thousands of square kilometers of rainforests and indigenous reserves.

Brazilian activists, in collaboration with technical experts and organized labor, have raised important issues regarding the implications of a national industrial development policy that provides incentives for aluminum production for export. Efforts have been made to discuss the impacts of the aluminum industry at regional meetings in the Amazon, and to place this discussion within the national debate on the need for new hydropower projects in the rainforest and energy alternatives for Brazil.

LINKS:

Article on Amazon dam plans: www.socioambiental.org

Programa Brasil Sustentável e Democrático (in Portuguese): www.brasilsustentavel.org.br



*The Igarau community successfully resisted expulsion for an Alcoa waste pond at the company's Alumar plant, Brazil
Photo: Aguirre/Switkes/Amazonia*

GLACIAL ALUMINUM

New dam and smelter complexes planned for Iceland and Chile threaten some of the most pristine ecosystems on the planet. Alcoa is building the Karahnjukar Hydropower Project, an ambitious scheme of large dams, reservoirs, and tunnels which will have massive impacts on Iceland's Central Highlands, the second-largest remaining wilderness area in Europe, and perhaps its most dramatic. Karahnjukar will consist of nine dams and will block and divert several glacial rivers. Alcoa will use the electricity to fuel a smelter it plans to produce 322,000 tons of aluminum per year. The area is a critical breeding area for the Pink-footed goose, Purple Sandpiper, and Rednecked Phalarope. Environmentalists warn of potential problems with siltation and of the dangers of the siting of the dam in a volcanic area. The project is in construction, but labor stoppages targeting the Italian company Impregilo—who unions say is violating Icelandic law by importing low-wage workers—have left it behind schedule. Alcoa also has been ordered by a court in Iceland to undertake a new Environmental Impact Assessment for the project.¹¹⁸

The Canadian company Noranda is planning a 440,000 tpy smelter in Chilean Patagonia, which will cost \$2.75 billion. To power the Alumysa project, Noranda proposes constructing six hydroelectric dams, with a total installed capacity of 1,000 MW. The complex, which also includes a

deep-water port and transmission lines, would affect an area which has been promoted by environmentalists and ecotourism companies as a “reserve for life,” in order to protect glacier-fed rivers, native forests, coastal waters, and endangered species. The Alumysa project is currently on hold, following challenges by Chilean environmental authorities.¹¹⁹

In the Iceland case, national and international environmental pressure was insufficient to stop the aluminum complex, although activists are still working against the project at all levels—government, environmental agencies, international financial institutions, etc. In the case of Alumysa, a well-coordinated national and international campaign, including Canadian activists, created significant public-relations and regulatory obstacles for Noranda. The effectiveness of environmental campaigns depend upon factors including the level of funding available for activist campaigns, the ability to get articles published in national and international media, “celebrity” participation in campaigns, and the potential to bring pressure on aluminum companies in their country of origin.

LINKS:

Natturuvaktin: www.natturuvaktin.com/english.htm

Killing Iceland: www.killingiceland.org

We CAN recycle

What responsibility do consumers have, given that they are the “beneficiaries” of the aluminum production chain? One obvious responsibility they have is to maximize their recycling of aluminum. Recycling is a crucial way to reduce impacts from aluminum production, since through recycling, 95% of the energy needed to produce primary aluminum is saved, and the pollution and other impacts generated by primary aluminum smelters is avoided.¹²⁰ Most aluminum products can be recycled, and secondary aluminum retains most of the characteristics of primary aluminum, making it feasible for most kinds of re-use.

Much of the debate on recycling has focused on aluminum cans, which along with aluminum foil are the best-known consumer uses of aluminum. It comes as no sur-



prise that Americans are the largest consumers of aluminum cans, consuming, per capita, 350 drinks in aluminum cans per year (the runner-up in beverage can purchasing is Sweden, with 103 cans purchased per year). To make matters worse, only 44% of aluminum cans purchased in the US in 2003 were recycled, the lowest rate of recycling in 25 years!¹²¹

The Container Recycling Institute (CRI) estimates that replacing the record 55 billion cans wasted last year with new cans made from virgin materials squandered the equivalent of over 20 million barrels of crude oil, and generated more than 3.5 million tons of greenhouse gases and other emissions. The amount of energy saved by recycling is astounding. Replacing one wasted can requires 0.5 kWh of electricity, enough to light a 100-watt light

bulb for five hours. And, for every six-pack of beer or soft drink in cans that is not recycled, the energy equivalent of a can full of gasoline is wasted.

CRI found that, since the aluminum industry began keeping records in 1972, Americans threw away more than one trillion cans without recycling them. To give an idea of the magnitude of this waste, these cans, if laid end-to-end, would stretch for 76 million miles, equivalent to 158 roundtrips to the moon. Such a quantity of scrap aluminum would have a current value of \$21 billion. If Americans were to recycle at a higher rate, the environmental and social impacts of operating hydroelectric dams and coal-fired power stations, bauxite mines and primary aluminum smelters in pristine ecosystems, and the displacement of indigenous communities and local

populations could be lessened.

Germany, which has led the way in promoting aluminum recycling in Europe has had some very positive and also more difficult experiences with recycling. Germany's 1991 law making it mandatory for stores selling packaged goods to present an option for recycling these packages, such as aluminum cans, has had a positive impact. However, the 2002 law levying a deposit on products sold in tin or aluminum cans has been criticized for being too complicated, and has triggered a wave of non-compliance. Switzerland, which recycles 91% of its aluminum cans, and Sweden, with a recycling rate of 86% are the European leaders, but the continent's average is only 40% recycled.

Brazil was among the world's leaders in

ALUMINUM CONSUMPTION ON THE RISE

The principal use for aluminum on a global basis is in the transportation industry, which is also the fastest-growing segment of aluminum consumption worldwide. Transportation uses constitute 30% of aluminum use in the western world, including its use for commercial and military aircraft, railroad cars, trucks, trailers, buses, etc.¹²² Automobile and light truck applications alone account for nearly one-fifth of all US aluminum consumption in 2000, with passenger cars containing an average of 257 pounds of aluminum. Transportation accounts for only 14% of China's aluminum use.

The next most important segment of aluminum use is in construction. This sector accounts for 18% of western consumption (13.1% in the US).

Packaging, including cans, foil and other uses comprises 17% of the western market (20.4% of aluminum consumption in the US). Other important uses included machinery and equipment (9%), electrical uses (8%), and consumer durables (6%). The principal force driving China's aluminum consumption is building and construction, accounting for 30% of its aluminum use.¹²³

LINK:

Container Recycling Institute:
www.container-recycling.org

recycling in 2003, with nearly 90% of aluminum cans recycled. In Brazil's case, the principal factor in the country's outstanding recycling success was its widespread poverty, a strong incentive to taking advantage of the added income opportunity presented by recycling.

Changing the patterns of consumption of aluminum can play a pivotal role in the formulation of strategies to avoid the most severe impacts of the aluminum production chain. A term which has been coined is "mineral efficiency." As a society, we must take responsibility to reduce our con-

sumption of metals, to make fullest use of their ability to be recycled and reused, and by doing this reduce the massive inputs of energy and water currently used to process minerals, as crucial steps toward sustainable societies. Laws should be passed to ensure that producers are responsible for taking back and recycling containers and other products they sell. When we have no option but to purchase products that come in aluminum packaging, insist on adequate policies to facilitate aluminum recycling, avoiding the additional impacts of manufacturing new, primary aluminum.

BOTTLE BILLS: SMALL FINANCIAL INCENTIVES PROVIDE AN ENORMOUS BOOST TO RECYCLING

Eleven US states currently charge a small deposit on aluminum cans at point of purchase. Research by CRI shows that recycling rates are far higher when even a small deposit is charged—in states where there is a 5 cent deposit, recycling rates reached 85%, nearly double the national average, and in Michigan, the only state where there is a 10 cent deposit, these rates reached 95%.¹²⁴

There are also other factors that help account for the decline in recycling rates in the US in recent decades. According to CRI, "a major reason for the recycling decline is the insufficient availability of recycling options at the point of consumption." As Americans commute greater distances to work, people consume more food and beverages on the go, and less at home, where they would be more likely to recycle.

By making your neighbors aware of the enormous impacts of the aluminum production chain, you can help increase recycling and reuse of aluminum, as well as raise consumer consciousness regarding the consequences on a global scale of unbridled consumerism. Working locally to promote bottle bill legislation is a practical way of providing incentives toward the recycling of aluminum cans.

LINK:

Container Recycling Institute Bottle Bill Toolkit:
www.toolkit.container-recycling.org

PAYING FOR ALUMINUM'S COSTS OVER A LIFETIME

Recognizing the severe impacts resulting from increased production and consumption of aluminum is only a first step. What is more difficult is to build a case for the superiority of alternative materials to aluminum. The state-of-the-art technique for weighing aluminum's social and environmental costs and benefits vs. those of other materials is called life cycle analysis. In it, one measures the sum of all impacts of the production of aluminum, including energy, loss of forests, and costs resulting from pollution generated during the process, against the benefits of using aluminum—for example, the energy it saves as a material used in vehicles due to its light weight compared to steel.

In a 1999 study, the Materials Systems Laboratory at the Massachusetts Institute of Technology (MIT) analyzed the emissions of CO₂ and other substances from producing the aluminum used in vehicles, and the CO₂ savings resulting from lighter aluminum vehicles burning less fuel. They did not consider other factors, such as social and environmental impacts of hydroelectric dams which generate electricity for primary aluminum smelters. Looking at the net results for converting a fleet of steel-structure cars to aluminum, they found that net drops in CO₂ emissions would be realized only after 15-17 years of vehicle use, which is more than the expected life of the car, and that if modern ultra-light steel were utilized, the aluminum cars would prove more climate friendly only after 32-38 years of driving. The MIT scientists concluded that aluminum body designs do not offer gains in life-cycle CO₂ production.¹²⁵

There are substitutes for aluminum use in the airplane industry as well. Boeing's new 7E7 aircraft moves away from aluminum, using graphite toughened with epoxy resin as a composite, with wings made of titanium and

graphite.¹²⁶ Copper can replace aluminum in electrical applications; magnesium, titanium, and steel can substitute for aluminum in structural and ground transportation uses. Composites, wood, and steel can substitute for aluminum in construction, and glass, plastic, paper, and steel can substitute for aluminum in packaging. Here, too, there are a complex set of considerations in determining the superiority of materials, but the social and environmental impacts of producing primary aluminum make it desirable to identify alternatives to its use.

Earlier studies by the Danish Environmental Protection Agency had compared lifecycle emissions from aluminum use in serving trays, frequently used for pre-prepared food, as compared with PET (plastic) trays, and they found PET to be more environmentally friendly. While single use containers do not appear to offer an attractive alternative, reusable glass or PET bottles are clearly good alternatives to aluminum cans, particularly if recycling options are inadequate.¹²⁷ Unfortunately, the infrastructure for recycling glass in the US is inadequate, and more and more glass is ending up in landfills.

Such studies are likely to be the benchmark for more sophisticated analyses of the impacts of aluminum vs. other materials for many years into the future. The aluminum industry has attempted to refute these studies with its own research. What is universally agreed is that significant benefits to the environment take place when aluminum is recycled or reused, and that aluminum enters the arena at a great environmental disadvantage when compared with other materials, due to the enormous energy requirements for primary aluminum smelting.

Alcoa: Aluminum foil, mag wheels, and widespread environmental destruction

In order to develop strategies to control the impacts of the aluminum industry on a global scale, it's worth taking a closer look at the world's largest aluminum company, Alcoa, and how it operates. Alcoa is one of the oldest metals companies in the world, and in fact, the electrolytic process to reduce aluminum oxide to aluminum was co-invented by Alcoa's founder, Charles Martin Hall in 1886, radically reducing the cost of producing aluminum. Hall and partners formed the Pittsburgh Reduction Company and by 1888 were producing aluminum on a commercial scale. Before long, Hall and company were selling manufactured aluminum products such as cooking utensils, electrical wiring, motor parts, and others.



Region affected by Alcoa's Karahnjúkar project, Iceland

Photo: Arni Finnsson

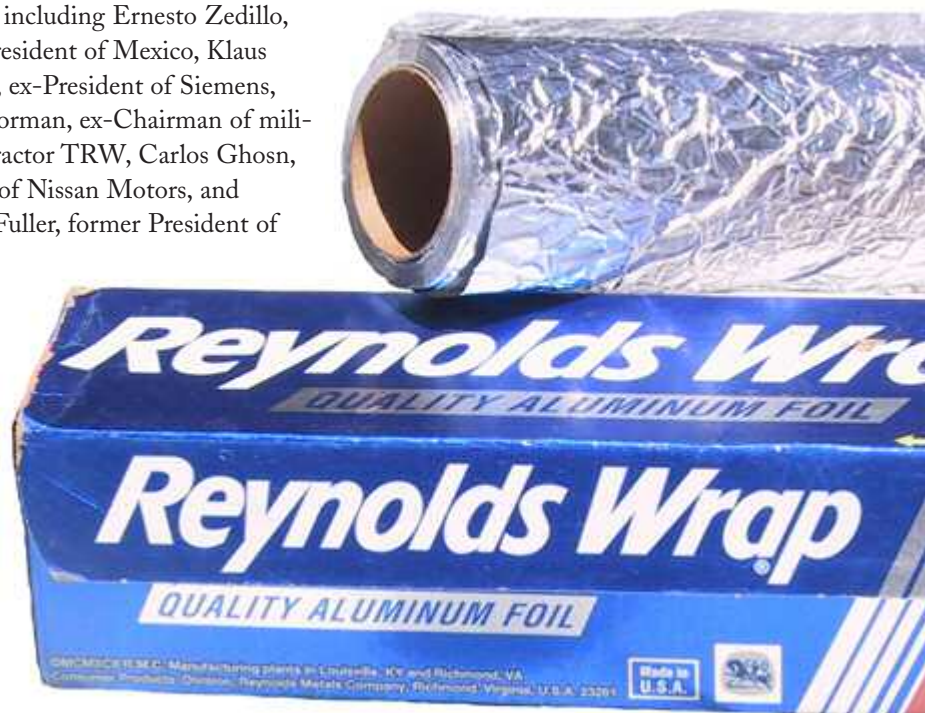


Virgin araucaria pine forests flooded by Alcoa's Barra Grande Dam, Brazil
Photo: Adriano Becker

By the first decade of the twentieth century, the company owned bauxite mines in Arkansas, an aluminum refinery in Illinois, and three primary aluminum smelters in New York and Canada, and had changed its name to the Aluminum Company of America (later changed to Alcoa in the 1960's). The company grew impressively during World War II, when it received financing from the US government. Following the war, the government-financed plants were sold to other aluminum companies to avoid anti-trust suits.

Alcoa has 120,000 employees worldwide. Its income in 2003 was \$21.5 billion, a year in which Alcoa enjoyed profits of \$938 million. About half of Alcoa's revenues come from sales of fabricated products, principally for the transportation and construction industries. The other half is split between

aluminum and alumina sales and packaging and consumer items. Alcoa's Board of Directors reflects sectors considered strategically important for the company, including Ernesto Zedillo, former President of Mexico, Klaus Kleinfeld, ex-President of Siemens, Joseph Gorman, ex-Chairman of military contractor TRW, Carlos Ghosn, ex-CEO of Nissan Motors, and Kathryn Fuller, former President of





Aluminum mag wheels

Photo: DGB Bildungswerk

World Wildlife Fund US. Chairman Alain Belda rose to his position via his experience as President of Alcoa's Brazilian affiliate.

Alcoa is the world's principal producer of bauxite (with mines in Australia, Guinea, Suriname, Jamaica, Brazil, and Guyana), alumina (nearly one-quarter of global production with nine refineries in the US, Australia, Spain, Brazil, Jamaica, and Germany), and primary aluminum (13% of world production, with 27 smelters in the US, Canada, Australia, Brazil, Spain, Italy, and Norway), as well as fabricated aluminum. The company provides aluminum for commercial transport, the aerospace industry, civil construction,

aluminum packaging, and automobiles, also producing machinery for fabrication of aluminum packaging.

Alcoa has ambitious plans for expanding its activities. The company is currently increasing the capacity of its alumina refineries in Suriname (250,000 tpy) and Jamaica (250,000 tpy), and is planning even greater expansion in Australia (2 million tpy at the Wagerup plant and 600,000 tpy at Pinjarra), Brazil (2 million tpy at its São Luís plant), Guinea (1.4 million tpy), and Jamaica (an additional 1.4 million tpy expansion in capacity is being analyzed for feasibility). Whether or not Alcoa goes ahead with these projects will depend on whether

global demand for alumina will continue to rise.

Alcoa is currently building a primary aluminum smelter in Iceland (322,000 tpy), is expanding its Alumar smelter in Brazil (by 63,000 tpy), and is analyzing new smelter projects in Bahrain (1,100,000 tpy) and Trinidad (250,000 tpy). Alcoa has also aggressively expanded operations in China, and has bought 8% of Chinalco, with whom it will jointly operate the Pingguo alumina and primary aluminum plant in southern China.

Alcoa is also working to guarantee access to cheap energy by planning investments in new hydroelectric dams in Brazil, including Belo Monte Dam on the Xingu¹²⁸ and Serra Quebrada Dam on the Tocantins River. Its plans for Santa Isabel Dam on the Araguaia River were dropped after environmental licensing authorities determined the project to be environmentally unfeasible.¹²⁹ Another project it plans to develop with BHP Billiton, Tractebel, CVRD and others, Estreito Dam, has faced difficulties in acquiring an environmental license, due to omissions and inconsistencies in environmental studies submitted by the consortium.¹³⁰ Alcoa's Barra Grande Dam in southern Brazil, although nearing completion, received an operating license, despite the fact that a fraudulent environmental impact study failed to mention that 6,000 hectares of endangered forests would be flooded by the dam.¹³¹

Alcoa has recently run into problems with organized labor at its smelter in Becancour, Quebec, Canada, over the issues of job security, outsourcing, and pensions. In 2004, a strike lasting four months forced the company to reduce production at the mill, one of the world's largest, by two-thirds.¹³² Workers at four Alcoa plants in the US are also threatening to strike over outsourcing of jobs. Union representatives

LINKS:

Alcoa: www.alcoa.com

at Alcoa's Alumar smelter in Brazil complained the company was blocking unionization and failing to report injuries at the plant.¹³³

Alcoa also operates 13 “maquila” assembly plants just over the Texas border in Mexico where 15,600 workers tolerate poor pay (\$70-\$83/week) and working conditions to put together wire harnesses for export to US car makers. Alcoa has refused to negotiate with workers, threatening instead to move its

operations to other countries.¹³⁴

Yet, Alcoa was chosen “one of America’s most admired companies” by *Fortune* magazine in 2004, and is proud of its “commitment to sustainability.”¹³⁵ It’s ironic how terms developed by environmentalists lose their meaning when hijacked by one of the world’s dirtiest companies.



Aluminum coils

Photo: DGB Bildungswerk

ALCOA RUNS AFOUL OF US LAWS

Alcoa has faced legal action as a result of pollution from its plants. In 2003, Alcoa was ordered by the EPA to cut sulphur dioxide and nitrogen oxide emissions by up to 95% and pay \$4 million in compensation at its Rockdale, Texas plant, which burns lignite coal from an on-site mine for the company's aluminum smelter.¹³⁶ Spewing more than 75,000 tons of pollutants into the atmosphere each year in a plume which reaches for hundreds of miles, Alcoa's Rockdale plant is the nation's largest non-utility emitter of SO₂ and NO.¹³⁷ Like many of Alcoa's older operations, Rockdale was exempted from the 1971 Clean Air Act requirements because it predated the law. Alcoa has since agreed to shut down three of its four dirty coal-burning power plants fueling the Rockdale smelter, saying it hopes to lease the plant sites to other companies that would replace them with cleaner facilities. Skeptics say that Alcoa is just trying to buy time, and that it is unlikely another power plant operator with financing will be found. 1,100 local people and plant workers have sued Alcoa for diseases caused by asbestos exposure from the Rockdale plant.¹³⁸

In 1991, Alcoa agreed to pay \$7.5 million in civil and criminal penalties for dumping PCBs and other pollutants, including spent pot liners at its Massena plant.¹³⁹ The \$3.75 million criminal penalty was the largest in US history for a hazardous waste violation. Alcoa also paid \$2.4 million and came to an agreement with the EPA to invest

\$6.4 million in air pollution and waste reduction because of poisoning the Ohio River.¹⁴⁰

In December, 2004, Alcoa was ordered to pay \$11.4 million to cleanup mercury contamination in Lavaca Bay, Texas, and soil contamination near the site of its Point Comfort plant, which produced chlorine and sodium hydroxide from 1948-1994.¹⁴¹ Contamination had reached the level where oyster raising, fishing, and crabbing were prohibited. According to Don Pitts, a scientist with the Texas Department of Parks and Wildlife, "There was direct impact to fish and birds in the area. In the case of fish, the mercury altered their behavior so that they couldn't evade predators like they used to." Larger shore birds, such as great blue herons, suffered damage to their reproductive systems.¹⁴² Alcoa also agreed to transfer 729 acres to the US Fish and Wildlife Service to increase the Aransas Wildlife Refuge. Alcoa will dredge mercury-contaminated sediment, operate a ground water recovery system at the former plant and monitor mercury levels in sediments and fish until the levels are acceptable.

LINKS:

Neighbors for Neighbors (Texas):

www.neighborsforneighbors.com

Preliminary Public Health Assessment Alcoa (Point Comfort)

—Texas Department of Health:

www.atsdr.cdc.gov/HAC/PHA/alcoa/alc_toc.html



*Alcoa's coal-burning plant, Rockdale, Texas
Photo: Neighbors for Neighbors*



*Alcoa's Rockdale, Texas strip mine
Photo: Neighbors for Neighbors*

FOILING THE ALUMINUM INDUSTRY

How then can we pressure Alcoa, or another major aluminum company if they are carrying out activities which threaten your community or an endangered ecosystem? One way activists have found works to have your message heard is to organize a campaign of faxes or letters to company officials, publicizing the campaign in the mass media. To the company, the sudden barrage of expressions of public outrage are a clear indicator that they are ripe for even broader public criticism. The company's immediate reaction will be to counter the information with press releases and postings on their website.

It's important to research the company you're targeting as carefully as possible, so that you can better understand how they work, as well as identifying potential points of vulnerability. There are many good resources on the web,¹⁴³ ranging from depositories of official documents filed by the company itself, to sites where NGOs and community representatives denounce the company's actions in a specific project.

Another tactic widely employed is to purchase a few shares of company stock, and organize a protest at the annual shareholders' meeting to publicize problems caused by the company's actions.¹⁴⁴ This is also an effective way to reach institutional investors who may have socially-conscious investment guidelines, such as public pension funds and church groups.¹⁴⁵ The Corner House has published several very useful documents with information on lobbying companies and financial institutions. The Friends of the Earth International document cited below is also a highly recommended resource.

Another way to pressure a company is to organize a boycott of the company's products. If this is well-organized, and the word gets out to a large number of consumers, the company may feel that, in the long run, their products will lose prestige among consumers. The Corner House document "Campaigner's guide to financial markets" has excellent examples of the power and limitations of consumer boycotts.¹⁴⁶ It cites a survey that found that 4 out of 10 people worldwide had boycotted a company's prod-

ucts for ethical reasons during 1999.¹⁴⁷ Co-op America also has published a useful guide to organizing consumer boycotts.¹⁴⁸

In Alcoa's case, for example, the company may be vulnerable to boycotts, because it manufactures products which are marketed directly to consumers, and which are very lucrative. Notable is Alcoa's Reynolds Wrap Aluminum Foils (Reynolds Wrap accounts for 58% of the US aluminum foil business), Reynolds plastic wrap, oven bags, hot bags, wrappers, foil bags, foil sheets, baking cups, Cutrite wax paper, parchment paper, freezer paper, and Reynolds Pot-Lux Cookware, the most important products in Alcoa's \$3.2 billion consumer products division (in the UK, Alcoa sells aluminum foils under the brand name of Baco Foil). Alcoa also sells Dura-Bright aluminum wheels, and aluminum siding, trim, and curtain walls under the trade names of Cedar Discovery, Mastic, Reynobond, and Reynolux.¹⁴⁹

Corporate campaigns take a lot of work, and involve mobilizing large numbers of consumers and investors. But, in today's globalized world of increased private capital flows, the only handle activists and communities may be able to get on an aluminum company planning a destructive project is through actions targeting the company on its home ground. By developing well-documented arguments, preferably with the direct involvement of representatives of affected communities, activists can demonstrate to the company that if it insists on moving ahead with the project, it will pay a cost in terms of diminished prestige, and that it is likely to suffer project delays and resulting financial losses if it insists on moving ahead. This type of argument can also have an impact with private or public financial institutions considering financing the project.

LINKS

The Corner House:

www.thecornerhouse.org.uk

Friends of the Earth International:

www.foe.org/international/shareholder

Conclusion

The aluminum production chain results in significant impacts which have degraded critical ecosystems and destroyed communities. Direct impacts of producing aluminum include air and water pollution. Indirect impacts from power projects fueling aluminum smelters, include environmental destruction and social upheaval caused by the damming of wild rivers and the contribution to global warming caused by burning fossil fuels.

The global aluminum industry has shown itself to be unwilling to address the serious impacts of aluminum production worldwide. The consumption of aluminum products, currently on the rise, must be curtailed as a reflection of increasing consumer concern over social and environmental responsibility. The recycling of aluminum cans and other products is an important way to prevent much of the impact caused by primary aluminum smelting, and should be encouraged through official policies, such as bottle bills.



*Trombetas Region, Brazil
Photo: Carlos Pentead*

Glossary

alumina: aluminum oxide refined from bauxite ore; feed-stock for the smelting of aluminum metal.

anode: carbon blocks which serve as positive electrodes in the smelting process. The two most common types of anodes are Soderberg and pre-bake anodes.

bauxite: aluminum ore, found principally in tropical and sub-tropical areas.

Bayer process: procedure used to refine bauxite ore into alumina.

calcinations: the conversion of metals into their oxides as a result of heating to a high temperature.

caustic soda: an alkali used as a reactant in alumina refining—it is very corrosive to the eyes, skin, and respiratory tract.

ingot: primary aluminum cast from smelted molten aluminum in an oblong shape which makes it convenient for shipping.

life-cycle analysis: the “cradle-to-grave” accounting of the net benefits and impacts of industrial and other processes, taking into account factors such as energy and pollution.

pot lining: large rectangular steel box lined with carbon made by baking a mixture of metallurgical coke and pitch. This lining serves as the cathode (or negative electrode) in the smelting of primary aluminum.

primary aluminum: aluminum ingots produced from bauxite, or other aluminum ores via a smelting process.

red mud: bauxite residue from refining to alumina via the Bayer process.

secondary aluminum: aluminum metal resulting from recycling or recovered from aluminum scrap.

smelting: the conversion of alumina to primary aluminum using an electrolytic process.

Other Key Documents

Aluminum Can'ts, Austin Chronicle, January 11, 2002
www.austinchronicle.com/issues/dispatch/2002-01-11/pols_feature4.html

Appeal from Kashipur, Orissa, December 30, 2003
www.sabrang.com/otconcern/orissa.pdf

Barclay's and the Karahnjukar Project, FOE/IRN, 2004
www.foe.co.uk/resource/briefings/barclays_karahnjukar.pdf

Behind the Shining, SEEN, 2001
www.saanet.org/kashipur/docs/seenalum.htm

Coal Hard Cash, Austin Chronicle, September 3, 1999
www.austinchronicle.com/issues/dispatch/1999-09-03/pols_feature.html

Dirty Metals, Mineral Policy Center, 2004
www.nodirtygold.org/dirty_metals_report.cfm

Extractive Industries Review: Introduction, Bankwatch, 2003
www.bankwatch.org/issues/wb-imf/eir/meir.html

Global Mining Campaign www.globalminingcampaign.org

The Icelandic Rift: Industry versus natural splendor in a "progressive" nation, Orion www.oriononline.org/pages/om/04-2om/Swan.html

Molten Rivers—the Aluminum and Hydro Connection, IRN, 2003 www.irn.org/programs/aluminium/pdf/aluminumreport2003.pdf

Multinational Company Union Networks Bulletin, Brazil, 2003 www.observatoriosocial.org.br/download/Aluminio.pdf

Neighbors vs. Neighbors, Austin Chronicle, July 27, 2001
www.austinchronicle.com/issues/dispatch/2001-07-27/pols_feature.html

Noranda: From Canada to Patagonia, A Life of Crime, 2003
www.sociedadcivil.cl/ftp/Noranda.pdf

Perfluorocarbon (PFC) generation during primary aluminum production, Marks, Roberts, Bakshi, Dolin,
www.epa.gov/highgwp/aluminum-pfc/pdf/pfc_generation.pdf

Power Driven, Guardian on Iceland project, November 29, 2003
www.guardian.co.uk/weekend/story/0,,1094541,00.html

Take Profit out of Pollution, American Lung Association of Texas, February 24, 2002
www.neighborsforneighbors.com/MediaPages/AAS/Take%20Profit%20Out%20Of%20Pollution/TakeProfitOut.html

Technology and Economics of Reducing PFC Emissions from Aluminium Production, Marks, Atkinson, Chase, Rand, 2002
www.epa.gov/highgwp/aluminum-pfc/pdf/AlTechEcon.pdf

Toxicological Profile for fluorine, hydrogen fluoride, and fluorides, Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service, September 2003
www.atsdr.cdc.gov/toxprofiles/tp11.html

Trashed Cans: The Global Environmental Impacts of Aluminum Can Wasting in America, Container Recycling Institute, June 2002 www.container-recycling.org/publications/trashedcans/TCExecSum.pdf

Will Alcoa Clear the Air?, Austin Chronicle, October 8, 2004
www.austinchronicle.com/issues/dispatch/2004-10-08/pols_feature12.html

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Endnotes

1. For explanation of aluminum production process, see for example Altenpohl, D.G. *Aluminum: Technology, Applications, and Environment*, Chapter 2 at www.tms.org/pubs/Books/4062.chapter2.pdf on 3-01-05. Brief description also at USEPA Office of Compliance Sector Notebook Project *Profile of the Non-Ferrous Metals Industry*, 1995 at www.epa.gov/Compliance/resources/publications/assistance/sectors/notebooks/nfmetlsnpt1.pdf on 3-01-05. Somewhat more technical explanation in Electrochemistry Encyclopedia (article by T.R. Beck). *Electrolytic Production of Aluminum*, 2001 at electrochem.cwru.edu/ed/encycl/art-a01-al-prod.htm on 3-01-05
2. Alcan facts 2004 at [www.alcan.com/web/publishing.nsf/AttachmentsByTitle/Investors-OtherPublications/\\$file/2004_Alcan_Facts_E.pdf](http://www.alcan.com/web/publishing.nsf/AttachmentsByTitle/Investors-OtherPublications/$file/2004_Alcan_Facts_E.pdf) on 2-28-05; www.rusal.com/about/us on 2-28-05
3. Aluminum Association, *Primary aluminum production* at www.aluminum.org on 3-03-05
4. International Aluminum Institute at www.world-aluminium.org/iai/stats/formServer.asp?form=11 on 2-28-05
5. International Aluminum Institute at www.world-aluminium.org/iai/stats/formServer.asp?form=1 on 2-28-05
6. Natural Resources Canada (by W. Wagner) *Aluminum*, 2001 at www.nrcan.gc.ca/mms/pdf/nfo/nfo01/alume.pdf on 3-01-05
7. UNCTAD, *Recent and planned changes in production capacity for bauxite, alumina, and aluminium*, 2000 r0.unctad.org/infocomm/comm_docs/docs/official/poitcdcom27.en.pdf#search='unctad%20aluminium%20production%20capacity' on 2-28-05
8. Metalprices.com at metalprices03.metalprices.com on 6-13-05
9. See Alcan *China's Aluminum Industry: Setting the Record Straight* at [www.alcan.com/web/publishing.nsf/AttachmentsByTitle/Investors-OtherPublications/\\$file/Broch_Chine_AN_v8a.pdf](http://www.alcan.com/web/publishing.nsf/AttachmentsByTitle/Investors-OtherPublications/$file/Broch_Chine_AN_v8a.pdf) on 3-01-05
10. Anderson, J. *The End of the China Love Affair*, May 2005 at www.feer.com/articles1/2005/0505/free/p020.html on 6-13-05
11. Richards, A. *Aluminum Outlook to 2006* at www.commodities-now.com/members/content/issues/oct-2004-lme-week-supplement/article-4.php (membership) on 3-01-05
12. Liang Zhongxiu, *China's Aluminum Industry and Aluminum Market in Rapid Growth* www.metalbulletin.com/speakerpapers/alum/presentations/ChalcoPaper.pdf#search='chalco%20aluminium%20china' on 2-28-05
13. US Geological Survey, *Mineral Commodity Summaries*, January 2005 at minerals.usgs.gov/minerals/pubs/commodity/bauxite/bauximcs05.pdf on 6-13-05
14. Western Australian Forest Alliance, *Alcoa Clearing Jarrah Forest* at www.wafa.org.au/articles/alcoa on 6-13-05
15. Estado de São Paulo, *Trombetas: the world's largest bauxite mine*, at www.waterconserve.info/articles/read.asp?linkid=23649 on 2-28-05
16. Estado de São Paulo, *Mineradora acusada de poluir floresta e rio no Pará*, Mar 28, 2002 at www.estadao.com.br/ciencia/noticias/2002/mar/28/99.htm on 3-02-05
17. India Resource Center, *Groups protest violence against anti-mining activists*, Feb 1, 2005 at www.indiaresource.org/news/2005/1004.html on 2-28-05
18. Samata, *The People's struggle against Utkal alumina plant in Kasipur, Orissa*, 2002 at www.globalminingcampaign.org/theminingnews/assets/pdf/utkal.pdf on 3-1-05
19. Independent Media report, *Sixteen tribals, mostly women, critically injured* at www.saanet.org/kashipur/articles/actionagainsttribals.htm on 6-13-05
20. Mining Watch Canada. *ALCAN juggling with the futures of marginalized peoples in India*, Dec 2003 at www.miningwatch.ca/publications/Utkal_Action_backgnd.html on 6-13-05
21. Fernandez, B, *Contamination of Water Resources by the Bauxite/Alumina Operations in Jamaica* www.aguaboliwia.org/situacionaguaX/IIIEncAguas/contenido/trabajos_verde/R-111.htm on 2-28-05

22. Los Angeles Times (by Carol J. Williams), *Dust Up Swirls around Key Jamaica Industry*, Oct 14, 2004 at www.minesandcommunities.org/Action/press461.htm on 2-28-05
23. Gonnella, *Alcoa Refinery Emissions Cause Health Fears*, Aug 31, 2002 at www.mineweb.net/columns/down_under/73109.htm on 2-28-05
24. ABC News, *Refinery Emissions Possibly Caused Sensitivity*, Oct 28, 2004 at www.abc.net.au/wa/news/200410/s1230155.htm on 2-28-05
25. AMWU OH&S News. *Victory for Alcoa's Injured Workers & the Wagerup Community*, Jan 2003 at www.amwu.asn.au/images/amwu_ohs_6.pdf on 3-01-05
26. ABC News, *Mining Company Fined for Air Pollution*, Dec 23, 2004 at www.abc.net.au/news/newsitems/200412/s1271336.htm on 3-01-05
27. The West Australian (by Michael Southworth). *Alcoa loses self-policing right over dust tests*, July 1, 2003
28. ABC News, *Alcoa records 8th refinery spill*, Nov 6, 2004 at www.abc.net.au/news/newsitems/200411/s1236141.htm on 6-13-05
29. See National Institutes of Health site, for example www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2793238&dopt=Abstract on 3-01-05
30. Earth Island Journal (by Gar Smith), *Why Fluoride is an Environmental Issue*, at www.earthisland.org/eijournal/fluoride/fluoride_editorial.html on 3-01-05
31. Rozhkov A.S., Mikhailov T.A. *The Effect of Fluorine-Containing Emissions on Conifers*. Berlin: Springer-Verlag, 1993, cited at www.fluoridealert.org/fconifers.htm on 3-01-05 and *Animal and Plant Diversity and Ecology in Siberia* www.bionet.nsc.ru/misc/ecopro/eng/2_9.html on 3-01-05
32. Maylin, K.L. *Industrial fluoride pollution. Chronic fluoride poisoning in Cornwall Island cattle*. www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=467082 on 3-01-05
33. Indian and Northern Affairs Canada at www.ainc.inac.gc.ca/ch/rcap/sg/si20_e.html on 3-01-05
34. *Canadian Handbook on Health Impact Assessment* at www.hc-sc.gc.ca/hecs-sesc/ehas/publications/canadian_handbook/volume2/appendix1_manufacturing.htm on 3-02-05
35. Materials World, Sept 2002 *Aluminum smelting—reprocessing of spent pot linings* at www.azom.com/details.asp?ArticleID=1686 on 3-03-05
36. US EPA Office of Compliance Sector Notebook Project. *Profile of the Nonferrous Metals Industry*, 1995, p. 16 at www.epa.gov/Compliance/resources/publications/assistance/sectors/notebooks/nfmetlsnpt1.pdf on 3-02-05
37. Numerous abstracts on NIH website, for example Czerwinski, Nowak, Dabrowska, Skolarczyk, Kita, Ksiezzyk in Arch Environ Health. 1988 Sep-Oct;43(5):340-3, *Bone and joint pathology in fluoride-exposed workers* at www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=3178291&itol=iconabstr on 3-01-05
38. Occupational Safety and Health Administration, US Dept. of Labor at www.osha.gov/SLTC/healthguidelines/hydrogenfluoride/recognition.html on 3-01-05
39. International Archives of Occupational and Environmental Health (article by Fritschi, Sim, Forbes, Abramson, Benke, Musk, and de Klerk) *Respiratory symptoms and lung-function changes with exposure to five substances in aluminium smelters*, 76:2, pp. 103-110, Feb 2003 at springerlink.metapress.com/app/home/contribution.asp?wasp=1he17qwhuj5yy1fm8eeq&referrer=backto&backto=issue,2,11;journal,16,80;linkingpublicationresults,1:101165,1; on 3-01-05
40. "The Age," by Dan Silkstone (6/30/04), *Some Cancers 'more likely' in Alcoa workers*, at www.theage.com.au/articles/-2004/06/29/1088487966054.html?from=storylhs&oneclick=true on 3-01-05
41. Environmental Health Perspectives, by Martineau, D., Lemberger, K., Dallaire, A., Labelle, P., Lipscomb, T., Michel, P., and Mikaelian, I. *Cancer in Wildlife, a Case Study: Beluga from the St. Lawrence Estuary, Québec, Canada*, Mar 2002 at www.medvet.umontreal.ca/pathologie_microbiologie/beluga/ehp_mars_02_a.htm on 3-01-05
42. See, for example, scientific studies on the site of the International Aluminum Network of European Co-operation in the field of Scientific and Technical Research at www.bio.unipd.it/~zatta/alumin.htm on 3-02-05

43. Health Canada, at www.hc-sc.gc.ca/hecs/sesc/water/pdf/aluminum.pdf on 3-02-05
44. Null, G. *Brain Boosters* at www.garynull.com/Documents/Aging/brain_boosters.htm on 3-02-05
45. Choate, W., and Green, J. *US Energy Requirements for Aluminum Production: Historical Perspective, Theoretical Limits and New Opportunities*, US DOE, 2003 at www.secat.net/docs/resources/US_Energy_Requirements_for_Aluminum_Production.pdf on 3-02-05
46. Bergsdal, Stromman, and Hertwich, *The Aluminum Industry: Environment, Technology, and Production*, p. 12. Norwegian University of Science and Technology: Trondheim, 2004 at www.indecol.ntnu.no/indecolwebnew/publications/rep/orts/rapport04/rapport8_04web.pdf on 3-02-05
47. *ibid.* p. 12
48. International Aluminum Institute, *Energy Sources of Electrical Power, 2003* at www.world-aluminium.org/iai/stats/formServer.asp?form=7 on 3-02-05
49. Estimates from sites of US-based Aluminum Association, Inc. at www.aluminum.org and the International Aluminum Institute at www.world-aluminium.org
50. See, for example *Minutes of the Northwest Power Planning Council's Demand Forecasting Advisory Committee*, p. 3. Portland: 2002 at www.nwcouncil.org/energy/powerplan/dfac/2002_1031/minutes.pdf
51. US DOE *Country Analysis Briefs: United Kingdom* at www.eia.doe.gov/emeu/cabs/uk.html on 3-02-05
52. Brown, L. *Blueprint for a better planet* in *Mother Earth News*, Feb/Mar 2004 at www.motherearthnews.com/arc/6839 on 3-02-05
53. Evans, Geoff. *Aluminium—Australia's Climate Criminal* (unpublished Paper for International Roundtable Meeting on Aluminium, São Luis, Brazil), p. 3, Oct 2003
54. Pinto, L. in *Jornal Pessoal, A Novela do Contrato de Energia da Albrás*, Belém, Apr 19, 2004
55. See following section: Global bankers back the aluminum industry
56. World Commission on Dams Case Study, *Tucuruí Hydropower Complex, Brazil*, p. ix, 2000 at www.dams.org/docs/kbase/studies/csbrmain.pdf on 3-02-05
57. AllAfrica.com by Reed Kramer, *US firm opens talks to end dispute with Ghana's government*, May 27, 2003. at allafrica.com/stories/200305271005.html on 3-02-05
58. Intermediate Technology Consultants Ltd. *The Mphanda Nkuwa Dam project: Is it the best option for Mozambique's energy needs?* 2004 at www.sarpn.org.za/documents/d0000929/index.php on 3-02-05
59. Harnisch, Wing, Jacobi and Prinn, *Primary Aluminum Production: Climate Policy, Emissions and Costs* at web.mit.edu/globalchange/www/MITJPSPGC_Rpt44.pdf on 3-01-05
60. Excerpt from "Silenced Rivers" (by Patrick McCully), *Dirty reservoirs: Greenhouse gas-emitting dams* at www.irn.org/programs/greenhouse/index.php?id=intro_sr2001.html on 3-02-05
61. Evans, Geoff *Aluminium—Australia's Climate Criminal* (Paper for International Roundtable Meeting on Aluminium, São Luis, Brazil), p. 3, Oct 2003
62. *ibid.* p. 3
63. *ibid.* p. 3
64. Marks, J. *The aluminum sector story* (powerpoint presentation, June 12, 2003 in Bonn) at www.ghgprotocol.org/docs/PresentationsSBSTABonnJune2003/SBTA_IAI_JerryMarks-Presentation.ppt#1
65. Harnisch, Wing, Jacoby, and Prinn. *Primary Aluminum production: Climate policy, emissions, and costs*, p. 16 at dspace.mit.edu/bitstream/1721.1/3603/1/MITJPSPGC_Rpt44.pdf on 3-02-05
66. IFC website at ifcln001.worldbank.org/IFCExt/spiwebsite1.nsf/2bc34f011b50ff6e85256a550073ff1c/0d19e96f7eb0480185256b26007cee61?OpenDocument
67. IFC *Summary of Project Information* at ifcln001.worldbank.org/IFCExt/spiwebsite1.nsf/2bc34f011b50ff6e85256a550073ff1c/5cbe8809d10cba1b85256e67006a954b?OpenDocument on 3-02-05
68. EBRD (press release). *EBRD and Slovakian aluminium smelter sign loan agreements*, July 12, 1994 on EBRD site www.ebrd.com on 3-02-05
69. CEE Bankwatch network (press release). *EBRD Cancels NEMAK Aluminium project in Czech Republic*, May 4, 2003 at www.bankwatch.org/press/2003/press19.html on 3-02-05
70. Coalition Clean Baltic. *Letter to Peter Woike, President of IFC*, May 17, 2003 at www.ccb.se/statement/PeterWoicke_CCB_IFC.doc on 3-02-05

71. Multilateral Investment Guarantee Agency at www.miga.org/screens/projects/guarant/regions/ssa/Belgolaise.htm on 3-02-05
72. IDB. *Proyecto de la central hidroeléctrica Caruachi* at www.iadb.org/exr/doc98/apr/ve788s.htm on 3-03-05
73. JBIC *Annual Report*, 1997 at www.jbic.go.jp/english/base/achieve/annual/exim/97annualreport/A28/1997jexim-e.pdf
74. Environmental Defense. *Extractive Industries Review Recommendations to the World Bank*, 4/16/04 at www.environmentaldefense.org/article.cfm?contentid=3667 on 3-02-05
75. World Commission on Dams, *Tucuruí Dam case study*. www.dams.org/kbase/studies/br on 3-17-05
76. Central Hidroeléctrica Guri at www.geocities.com/ievzla/guri.html on 3-17-05; McCully, op. cit. pp. 254, 336-337
77. Cambior. Rosebel gold project at www.cambior.com/acrobat/english/operations/environmental%20Impact%20Assessment/executive_sum.pdf on 3-17-05; McCully, op. cit. pp. 334-335
78. US Geological Survey, 1998. *Primary Aluminum Plants Worldwide—Pt. 1 (detail)*, p. 38 at www.minerals.usgs.gov/minerals/pubs/commodity/aluminum/alplants1.pdf on 3-15-05; Stancich, E. *Cuando los ríos se modifican* at www.grain.org/biodiversidad/?id=168; Frente Mapuche and Campesino en Chubut, 2004 at lists.peacelink.it/latina/msg05613.html on 3-18-05
79. McCully, *ibid.*, pp. 254, 334-335
80. Alcan power project. www.wgint.com/docs/at/alcan.pdf on 3-15-05; Indian and Northern Affairs Canada www.ainc-inac.gc.ca/ch/rcap/sg/sg40_e.html on 3-15-05,
81. McCully, op. cit., pp. 322-323
82. USGS, op. cit. pp. 32, 34
83. *ibid.*, pp. 254, 324-325
84. Solutions site case study. *Remediation of the environmental impacts of the Akosombo and Kpong Damss* at www.solutions-site.org/cat4_sol114.htm on 3-15-05; GNA. *VRA to increase production to 1020 megawatts*, 3-06-05
85. Cameroun tribune. *Electricité : la solution d'urgence du gouvernement*, 6-10-03 at camlions.iwebadmin.de/camguide/fr/news.php3?nid=2543 on 3-15-05
86. Broker Credit Research Study. *Sayano-Shushenskaya HPS*, 2003 at www.bcs.ru/eng/show_res.asp?id=1770 on 3-15-05; McCully, op. cit., pp. 332-333
87. Malik, L.K., Koronkevich, N.I., Zaitseva, I.S. and Barabanova, E.A. 2000. *Development of Dams in the Russian Federation and NIS Countries*, p. 22 at www.dams.org/docs/kbase/studies/csrmain.pdf on 3-16-05
88. *ibid.*, p. 21; Slavic Research Center, Hokkaido: 1999. *Economic Development and the Environment on the Sakhalin Offshore Oil and Gas Fields II* at src-h.slav.hokudai.ac.jp/sakhalin/eng/71/kitagawa2.html on 3-15-05; USGS, op. cit. p. 82
89. *ibid.*, p. 21
90. Untitled at www.fifoost.org/tadschikistan/taji.pdf on 3-15-05; US DOE. Energy Overview of Tajikistan at www.fe.doe.gov/international/Russia_and_Central_Asia/tajikover.html on 3-15-05; USGS, op. cit. p. 99
91. Shang Wei, 1998. *A Lamentation for the Yellow River* at www.probeinternational.org/pi/index.cfm?DSP=content&ContentID=9428 on 3-16-05; *Invest in Henan* at www.fdi-hn.gov.cn/english/news/2004/2/18/1077089153687.shtml on 3-16-05
92. Amnesty International, 2000. *Defending Human Rights in India* at web.amnesty.org/library/Index/ENGASA200082000?open&of=ENG-352 on 3-16-05; USGS, op. cit. p. 115
93. Ghee and Valencia, eds., 1990. *Conflict over Natural Resources in South-east Asia and the Pacific*, Ch.8 at www.unu.edu/unupress/unupbooks/80a04e/80A04E08.htm on 3-18-05; Jakarta Post, Mar 25, 2002 (by Apriadi Gunawan. *Environmental body slams Lake Toba regreening policy* at www.ecologyasia.com/news-archives/2002/mar-02/thejakartapost.com_20020325.F02.htm on 3-18-05; USGS, op. cit. p. 120
94. Hydro website at www.hydro.com
95. Pedder 2000 Inc. website www.lakepedder.com
96. Mark, A.F., 2001. Integrating conservation with hydroelectric development of Lakes Manapouri and Te Anau, New Zealand: an exercise in complexity, at journal-ci.csse.monash.edu.au/ci/vol08/mark01/mark01.pdf on 3-18-05
97. Provincia del Chubut, 2004. *Plan Energético Nacional 2004-2008/ Aprovechamiento Hidroeléctrico Cuenca Río Carrenleufu*, pp. 10-74; Periódico Mapuche Azkintue, Feb/Mar 2005 (by Daniel Cayuqueo). *En Defensa del Carrenleufu* at www.nodo50.org/azkintuwe/febrero10_10.htm on 3-20-05

98. Agência Nacional de Águas (ANA), 2003. *Minuta dos Termos de Referência: Elaboração do Plano Estratégico de Recursos Hídricos da Bacia Hidrográfica dos rios Tocantins e Araguaia*
99. Themag, Billiton, Alcoa, 2000. *Estudo de Impacto Ambiental UHE Serra Quebrada*; Almeida and Régis, 2003. *Águas sem Barragens* at www.ebooksbrasil.com/adobeebook/cartilhabarragens.pdf on 3-20-05
100. La Cámara Nacional de Empresas de Consultoría (CNEC), 2002. *Estudo de Impacto Ambiental UHE Estreito*; Regis and Switkes, Sep 1, 2004. *Anatomia de um Licenciamento* at www.adital.com.br/site/noticia.asp?lang=PT&cod=13651 on 3-20-05
101. Desenvix, 2001. *Estudo de Impacto Ambiental AHE Santa Isabel*; Ciência e Cultura, Oct/Dec 2003 (by Rafael Evangelista). *Consórcio desiste da usina, mas patrimônio continua ameaçado* at cienciaecultura.bvs.br/scielo.php?pid=S000967252003000400005&script=sci_arttext&tlng=pt on 3-20-05
102. Eletronorte at www.eln.gov.br
103. MAB and CPT, Feb 19, 2005. *Violencia da CVRD (Companhia Vale do Rio Doce e Novelis do Brasil (Ex-Alcan) contra agricultores atingidos por Barragem*, e-mail communication
104. Justiça Global, MAB, CPT-MG, NACAB, Rio de Janeiro, Ponte Nova: 2004. *Atingidos e Barrados. As violações dos direitos humanos na hidrelétrica de Candonga* at www.global.org.br/english/arquivos/candongareportportuguese.pdf on 3-20-05
105. Zhouri, 2003 (powerpoint presentation). *Hydroelectric dams and sustainability* at www.boell.de/downloads/global/ee_Brasilien_Zhouri.pdf on 3-21-05
106. Novelis web site at www.novelis.com.br/brazil/novelis/corporate/sitebrasil.nsf/wInstitucional?openform&sitelcanbrasil&institucional&hidreletricas on 3-20-05
107. Diário Catarinense, 2-13-05 (by João Cavallazzi). *FATMA questiona usina billionária* at www.prsc.mpf.gov.br/noticias/?arq=Clipping/2005/130205_usina_barragrande.htm 3-20-05; Apremavi web site. *Barra Grande dossier* at www.apremavi.com.br/dossie/pbarragrande.htm on 3-20-05.
108. Estado de São Paulo, 10/02/03 (by Liana John). *As Águas do Ribeira continuam livres!* at www.estadao.com.br/ciencia/colunas/ecos/2003/out/02/60.htm on 3-21-05; Brasil Mineral, 2-3-05. *Projeto Tijuco Alto, da CBA, passa por reformulação* at www.brasilmineral.com.br/BM/default.asp?COD=1631&busca=&numero=198 on 3-21-05
109. CONAMA, no date. *Proyecto Alumysa Desistió en Evaluación de Estudio de Impacto Ambiental* at www.conama.cl/portal/1255/article-28505.html on 3-21-05
110. Iceland Nature Conservation Association web site www.inca.is
111. IUCN, (press release) 1/28/05. *Dam project might threaten world heritage site in Serbia and Montenegro* at www.iucn.org/themes/wcpa/newsbulletins/news/pressreleases/serbia-and-montenegro-dam-project.pdf on 3-21-05; BBC radio, 10/14/04. *Dam threatens Montenegro river* at news.bbc.co.uk/1/hi/world/europe/3743698.stm on 3-21-05
112. Rousseau, 1994. *The Bakun Project* at www.irn.org/programs/bakun/index.php?id=review.html on 3-21-05
113. Revista Escola de Minas (article by João Bosco Silva). *A indústria de alumínio e a crise de energia* at www.scielo.br/scielo.php?script=sci_arttext&pid=S0370-44672001000200003 on 3-02-05
114. Switkes, G. *A Conexão hidrelétrica e alumínio* at www.irn.org/programs/aluminium/pdf/aluminumreport2003_port.pdf on 3-02-05
115. Pinto, L. (Adital) *Minérios. Pará é do mundo*. June 7, 2004 at www.adital.com.br/site/noticia.asp?lang=PT&cod=12511 on 3-02-05
116. United Press International. *Rio Tinto may invest in Malaysia smelter*, Feb 15, 2005 at www.sti.net/home/news/clari/news/wed/bo/Umalaysia-smelter.Rvez_FFF.html on 3-02-05
117. see IRN Bakun campaign at www.irn.org/programs/bakun/ on 3-02-05
118. see site of Iceland Nature Conservation Association www.inca.is
119. see site of Aysén Life Reserve www.noalumysa.cl
120. Gitlitz, J. *Trashed cans: The global environmental impacts of aluminum can wasting in America (Exec Summary)* at www.container-recycling.org/publications/trashedcans/TCExecSum.pdf on 3-03-05
121. Container Recycling Center (press release), May 24, 2004. *One trillion beverage cans trashed in America from 1972-2003* at www.container-recycling.org/aluminum/index.htm on 3-02-05
122. Evans, R. powerpoint presentation June 2004, p. 11.

- Primary aluminum: The China Syndrome* at [www.alcan.com/web/publishing.nsf/AttachmentsByTitle/Investors-Presentations/\\$file/UBS_Presentation.pdf](http://www.alcan.com/web/publishing.nsf/AttachmentsByTitle/Investors-Presentations/$file/UBS_Presentation.pdf) on 3-03-05
123. *ibid.*, p. 11.
 124. Gitlitz, J., Oct 2003, *The role of the consumer in reducing primary aluminum demand* (paper for International Strategic Roundtable on Aluminum Industry)
 125. Environmental News Network, May 26, 1999 at www.physics.ohio-state.edu/~kagan/phy367/P367_articles/Trans_ElectricCars/aluminum_3406.asp on 3-03-05
 126. Azom.com, June 13, 2003. *New Boeing 7E7 to be made largely of composites* at www.azom.com/news.asp?newsID=674 on 3-03-05
 127. Ekvall, Person and Ryberg, Widheden. *Lifecycle assessment of packaging systems for beer and softdrinks*. Ministry of Environment and Energy: Denmark, 1998 at www.mst.dk/udgiv/Publications/1998/87-7909-014-1/pdf/87-7909-014-1.PDF on 3-03-05
 128. see previous section “Damming the Amazon for aluminum”
 129. Bermann, C. *Indústrias Eletrointensivas e Autoprodução: propostas para uma política energética de resgate do interesse público* at www.ilumina.org.br/zpublisher/materias/Estudos_Especiais.asp?id=15872 on 3-02-05
 130. Adital (by Mayron Régis and Glenn Switkes) *Anatomia de um licenciamento*, Jan 9, 2004 at www.adital.com.br/site/noticia.asp?lang=PT&cod=13651 on 3-03-05
 131. Adital (by Eduardo Zen) *Entidades denunciam fraude em estudo ambiental de hidrelétrica*, Sep 30, 2004 at www.adital.com.br/site/noticia.asp?lang=PT&cod=13947
 132. Bloomberg, Nov 22, 2004. *Alcoa, union agree on contract that would end strike* at www.awu.net.au/national/campaigns/awualumina/news_1101588223_15868.html on 3-03-05
 133. José Maria, president Sindmetal, São Luís. personal communication
 134. New York Times (by Sam Dillon), Feb 14, 2001. *Profits Raise Pressures on US-Owned Factories in Mexican Border Zone* at www.globalexchange.org/countries/mexico/news/nyt021401.html on 3-02-05
 135. Alcoa sustainability reports at www.alcoa.com/global/en/about_alcoa/commitment_to_sustain/sustain_report_list.asp on 3-03-05
 136. US EPA. *Alcoa Inc. Clean Air Act Settlement*, April 9, 2003 at www.epa.gov/compliance/resources/cases/civil/caa/alcoa.html on 3-02-05
 137. US EPA, *Alcoa Inc. Clean Air Act Civil Judicial Settlement Fact Sheet* at www.epa.gov/compliance/resources/cases/civil/caa/alcoafs.pdf on 3-02-05
 138. Austin American-Statesman (by Patrick Beach), Aug 31, 2003 *The bitter price of a better life* at www.statesman.com/specialreports/content/specialreports/alcoa/0831alcoa.html on 3-03-05
 139. Logtech. *Alcoa's Environmental Management System*, p. 7 at www.logtech.unc.edu/Alcoa_web_II.doc on 3-02-05
 140. US EPA *Enforcement Action Summary Fiscal Year 2000* at www.epa.gov/region5/orc/enfactions/enfactions_2000/law-mm.htm on 3-02-05
 141. Texas Parks and Wildlife Dept., Dec 21, 2004 *Lavaca Bay settlement provides restoration, cleanup* at www.fishingworld.com/News/Read.php?ArtID=000013607 on 3-02-05
 142. Houston Chronicle (by Anne Marie Kilday), Dec 11, 2004. *Alcoa will pay to clean Lavaca Bay*
 143. Hildyard and Mansley, 2001. *Campaigner's guide to financial markets* at www.thecornerhouse.org.uk/pdf/document/camguide.pdf on 3-03-05
 144. The Cornerhouse, 2002. *Financial market lobbying: A new political space for activists* at www.thecornerhouse.org.uk/pdf/briefing/25finmkt.pdf on 3-03-05
 145. Friends of the Earth International. *Confronting Companies Using Shareholder Power: A Handbook on Socially-Oriented Shareholder Activism* at www.foe.org/international/shareholder
 146. Hildyard and Mansley, *op.cit.*, p. 72
 147. *ibid.*, p. 22
 148. Murtagh, Lukehart. *Co-op America's boycott organizer's guide* at www.boycotts.org/pdf/Boycott_Organizers_Guide.pdf on 3-03-05
 149. see Alcoa web site www.alcoa.com