

Consumer Awareness and Corporate Environmental Policy in the Aluminum Industry

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A thesis submitted to the University of Colorado at Boulder in partial fulfillment of the requirements to receive Honors designation in Environmental Studies

December 2012

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Abstract

Consumer demand for products is increasing all around the world and putting pressures on the environment through the extraction and production of these products. In particular, the demand for aluminum is increasing. The large scope of aluminum products and the environmental impacts of aluminum production give rise for the need to investigate the impacts of consumption. This research aimed to question if consumer awareness of environmental issues reflected in corporate environmental policy in the aluminum industry. Two main methods were used in order to investigate this relationship: an evaluation of the internal perspective from aluminum industry representatives and an evaluation of the relationship between two indicators. Media was used as an indicator for consumer awareness and corporate environmental spending was used as an indicator for environmental policy. The internal perspective was that consumers do in fact pass demand for environment quality along a complex supply chain. While there was a relatively strong relationship between media coverage and corporate environmental spending, the data from this research showed that changes in corporate spending generally lead to the changes in media coverage. These findings raise new questions about the relationship between producers, media, and consumers.

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Introduction

Growing demand for consumer goods and infrastructure around the globe has put an ever-increasing demand on our natural systems. In particular, the demand for aluminum resources is increasing. It is consumers who are demanding the products and services that require 3.4 million metric tons of aluminum to be mined, shipped, processed, shipped, smelted, shipped, rolled-out, shipped, manufactured and then consumed and sometimes recycled.

While aluminum can be found in a myriad of products, many of which are keys to a more sustainable future, such as aluminum frames for lighter vehicles and transmission wire to distribute renewable energy, the production of primary aluminum comes with significant environmental impacts. However, over the last thirty years, the companies that manufacture these products have made huge investments into the environmental quality of these products and materials, although there are still significant environmental impacts of these processes, including huge energy requirements and mining and processing byproducts.

This research aims to ask the question of what motivates companies invest in environmental quality, and more specifically, are the values of the end consumers a driving factor of these investments. There is the saying ‘vote with your dollar’, but do consumers, in fact, have a voice in their purchasing patterns, especially in complex, multi-layered supply chains such as aluminum? In order to explore this question, it was approached from two sides: the internal perspective of industry employees and from tracking an indicator for environmental awareness against companies’ investments in decreasing environmental impacts.

Background

In stores and shopping malls all around the world, consumers increasingly encounter ‘eco-friendly’ products. But what is an ‘eco-friendly product’? Why are these products on the shelves of our stores? And what makes consumers go out of their way, sometimes spending much more for an advertised environmental benefit? Conventional economics tells us that the market provides what the consumer demands; logic would lead us to believe that consumers have been demanding more environmentally friendly products (Muellbauer, 1975; Blend, 1999; Thompson, 1998; O’Brien, 1971).

In order to test this theory, it may be important to investigate how the consumer affects a specific industry. Because of the global importance, end-use infiltration, and environmental impacts of aluminum and the aluminum industry, it is important to understand how consumer awareness affects environmental practices in this industry. Specifically, this research considers how this relationship is playing out in the globally important ecosystem of the Amazon in Brazil and in the U.S., a large producer and consumer.

Conscious Consumption- What is Consumer Awareness?

What is consumer awareness? First, an investigation of ‘eco-friendly’ or conscious consumerism is important to understand the consumer practices that are considered to demonstrate more consumer awareness. There are an ever-increasing number of products and brands on the market that advertise a social or environmental benefit. While these products are trying to sell a physical product, they are also inadvertently selling a value and an idea: the added environmental value and the idea that the consumer can affect the upstream production of their consumption.

The opponents of ‘green consumerism’ make arguments that lead to a solidification of the issues that arise from unchecked capitalism but do not solve real environmental issues. Others say that it relieves people from their taking significant action on environmental issues, because of the perceived environmental benefit (Sparks, 1992). Still others argue that an unintended byproduct of the “individualization of responsibility” is the disengagement in public, political environmental actions that have long been the pressure for legislative change, which many argue is the only tool that is truly effective in mitigating environmental harms caused by consumerism (Maniates, 2002). In Maniates’ paper on green consumer choices, he argues that problems of overconsumption are embedded in our institutional systems, and the focus on the individual and “uncoordinated individual responses” is undermining our motivations to act collectively.

“In our struggle to bridge the gap between our morals and our practices, we stay busy—but busy doing that with which we’re most familiar and comfortable: consuming our way (we hope) to a better America and a better world. When confronted by environmental ills—ills many confess to caring deeply about—Americans seem capable of understanding themselves only as consumers who must buy “environmentally sound” products (and then recycle them), rather than as citizens who might come together and develop political muscle sufficient to alter institutional arrangements that drive a pervasive consumerism.” (Maniates)

There has also been discussion of the actual benefit or difference of environmental friendly products. And of course, there is much discussion on the fact that many advertising schemes use green washing simply as a way to sell more products, without any value-added environmental benefit (Ramus, 2005).

Some argue that while there is significant debate, green consumption needs to be a part of the arsenal of tactics to confront the environmental problems that we face today (Muldoon). Others still argue that it is creating a shift in consciousness in the corporate world towards a

minimization of waste and efficiency of all systems, which will be more profitable and in turn more and more businesses will follow these business models more willingly (Hawken, 1999). Largely due to this economic incentive, others argue the power that consumers have with their purchasing practices and that it only takes a relatively small number of people to cause rippling change in the market (Nava, 1991). Consumerism and capitalism is designed to be driven by consumer demand. But there are significant institutional barriers for consumers to believe that their dollar makes an impact on the global society (Moisander, 2007).

World Aluminum Consumption

Metals are important to human development and present in nearly every advancement in human progress. With more and more development worldwide, the use of nearly all metal resources has been on the rise (Gradel, 2011). While the use and consumption of metal products can be described as improving lives all around the world, there should be some evaluation of the processes that allows societies around the world to reap the benefits of using such metals.

One metal that has had a particular importance on human development is aluminum; it has been called the most important metal in today's global economy (Browar). In use today, there is approximately 516 million metric tons of aluminum (Martchek, 2005), in everything from our cars, planes, and trains, to building structures, to electrical cables, to our soda cans, and our electronics (UNEP, 2011). Aluminum use is seen as a major contributor to development in developing countries (Industry, 2002). Figure 1 below shows the rise in use in various applications over time.

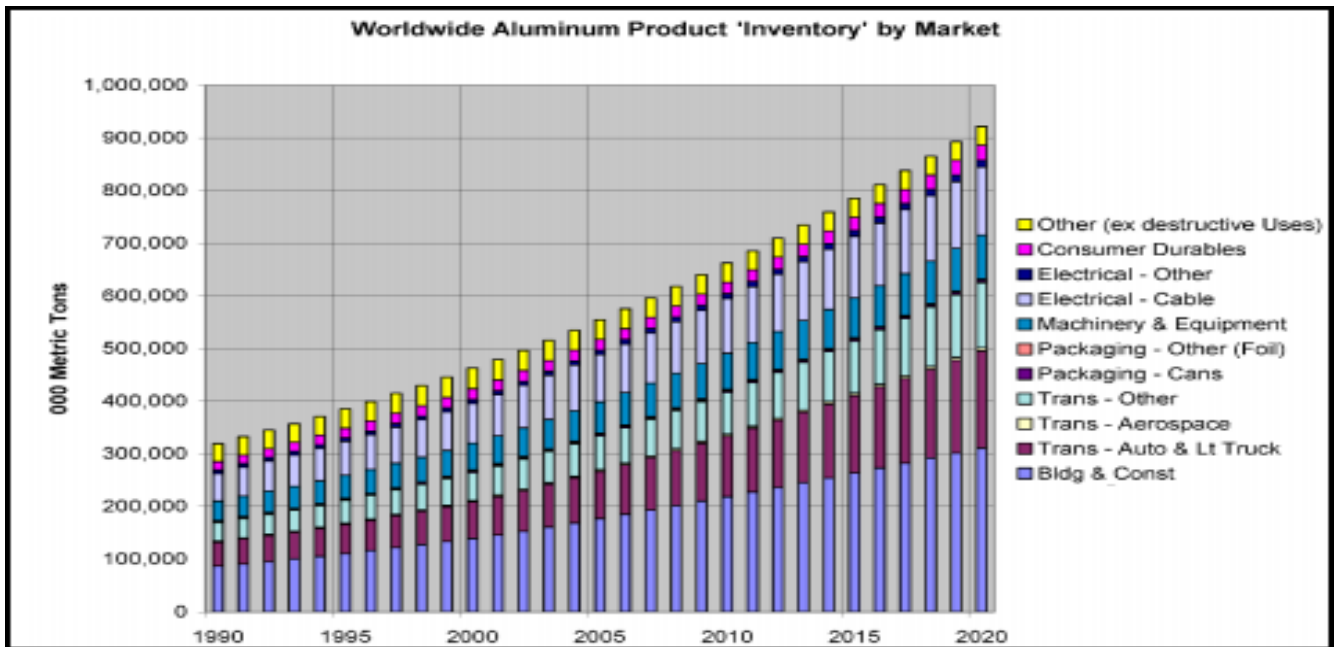


Figure 1. (Martcheck, 2006)

Aluminum is a versatile metal because of its many beneficial properties; it is strong, lightweight, non-corrosive, conductive, malleable, abundant, etc. (Mondolfo). Along with these properties, aluminum is nearly infinitely recyclable. Aluminum has been labeled a part of a more sustainable future (Improving, 2012). Because it is a lightweight material, it is being used in transportation to significantly increase efficiency. Also, aluminum is used in electrical transmission lines, which are the key in distributing the more disperse, renewable energy technologies (Mai, 2012). It is also a key material in concentrated solar power (CSP) reflectors (Mok, 2011) Aluminum is also being considered as a possible energy storage material, also important piece in a sustainable energy mix (Shkolnikoy, 2011).

Because of all these applications, according to a joint U.S. Geological Service (USGS) and U.S. Department of the Interior report, the global demand for aluminum is expected to increase by a factor of at least 2.5 by 2025 (Mencize, 2010). While aluminum has become all-but essential in our modern world, this rise in the extraction and production that the aluminum supply chain involves should be evaluated because of its global scale. According the research

done by Kenneth Martchek, an Alcoa researcher, and updated by OECD, there is 7.2 million tons of aluminum that is not recycled or does not re-enter the production cycle every year (Menzine, 2010). In other words 10.46% of the primary aluminum ingots supplied to the global market each year along with the externalities associated with it could be avoided, but would not reduce the need for increased aluminum production with increased demand.

The USGS is currently reviewing the accuracy of these numbers. Most of the numbers from the primary studies on global flows of aluminum, including Marchek and the USGS study comes from the IAI- International Aluminum Institute, although the USGS found incompatible numbers. There is some discrepancy in the definitions of what is considered to be 'recycled scrap'. From my understanding, the IAI considers aluminum that is recycled at aluminum processing plants (USGS, 2011; written communication, 2012).

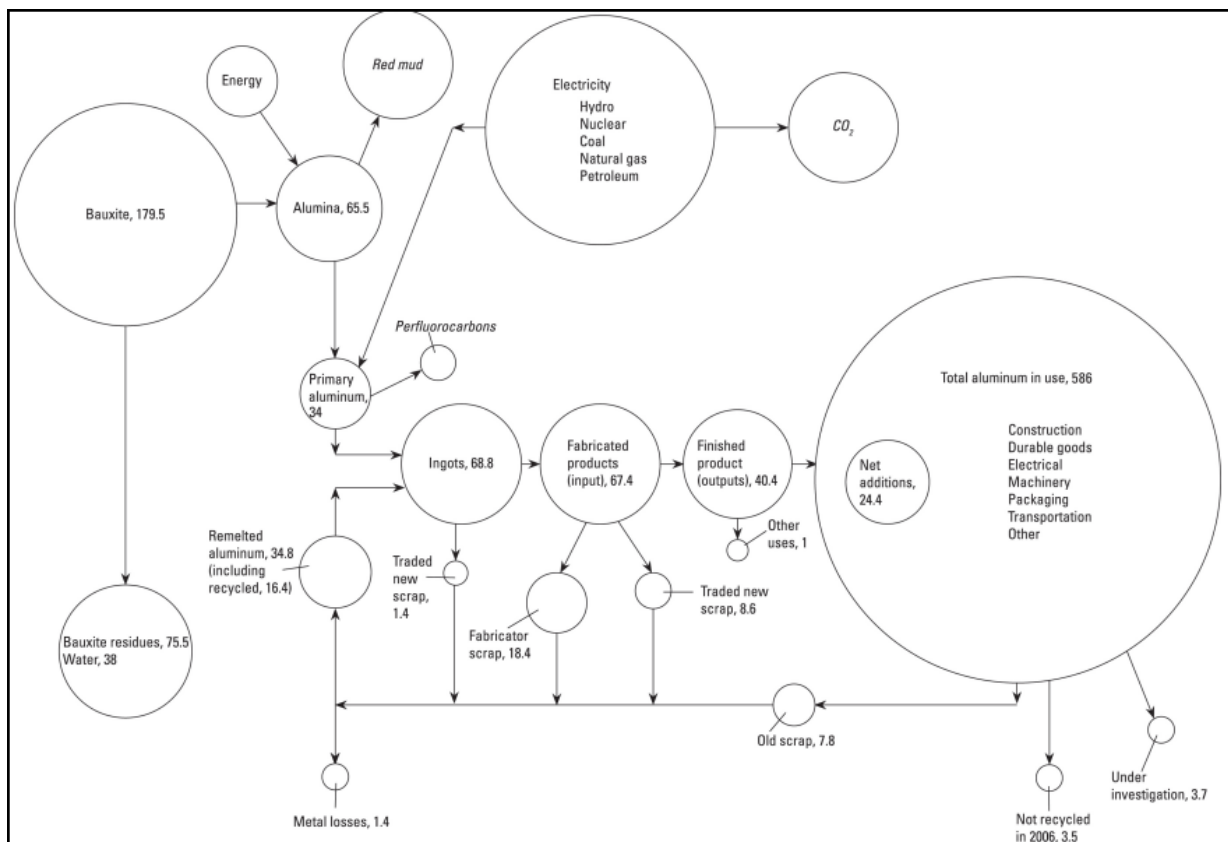


Figure 2. The figure above, taken from the OECD study illustrates the global resource chain of aluminum production.

Stages of Aluminum Production and Environmental Impacts

Aluminum products are a vital part of our modern society, but in order to understand fully how aluminum production impacts the environment, it is prudent to understand each stage of the production of aluminum, the environmental impacts and industry trends that are associated with each. Each stage of production has different impacts, which affect the way industry interacts with the environmental impacts and environmental awareness. The general stages of primary aluminum production are displayed in Table 1.

Table 1. Steps in the Aluminum Production Cycle

Step in Production Cycle	Major Inputs	Major Environmental Impacts
1) Bauxite mining	Fuel Land	Deforestation
2) Refining bauxite into alumina	Bauxite Caustic Soda Energy	Red Mud
3) Electrolysis or smelting of alumina into aluminum	Energy Petroleum Coke Anodes	GHG emissions due to energy production and Fluoride emissions
4) Casting, Rolling, Extruding aluminum into products	Ingots Energy	
5) Re-smelting (recycling)	Post-Consumer and Industrial Recycled Aluminum	Saves 95% of energy and GHG emissions

Mining Bauxite

Aluminum is an incredibly abundant in the earth's crust; it is about 8% of the content (Davis). But because aluminum is relatively reactive, unlike other metals, aluminum is almost never found as pure aluminum, but rather is always bonded to other elements. The most common source of aluminum is bauxite. About 85% of the world's bauxite extraction is used for aluminum production (USGS, 2012).

Bauxite is a heterogeneous rock formation that forms mainly in tropical and subtropical regions after the soil has been leached of soluble minerals, which requires a wet climate history (King, 2011). This is a result of intense or long term weathering processes (Ayorinde, 2011). Because of this, the climatically wet regions of the tropics

World Bauxite Reserves:

75- 55 billion tons (USGS, 2012)

$(75 \cdot 10^9)$ tons/ 220,000 tons/year= 340,000 years

$(55 \cdot 10^9)$ tons/ 220,000 tons/year= 250.000 years

have the highest reserves, as shown in **Error! Reference source not found.** The USGS data explains where those reserves are in the world: 32% in Africa, 23% in Oceania, 21% in South

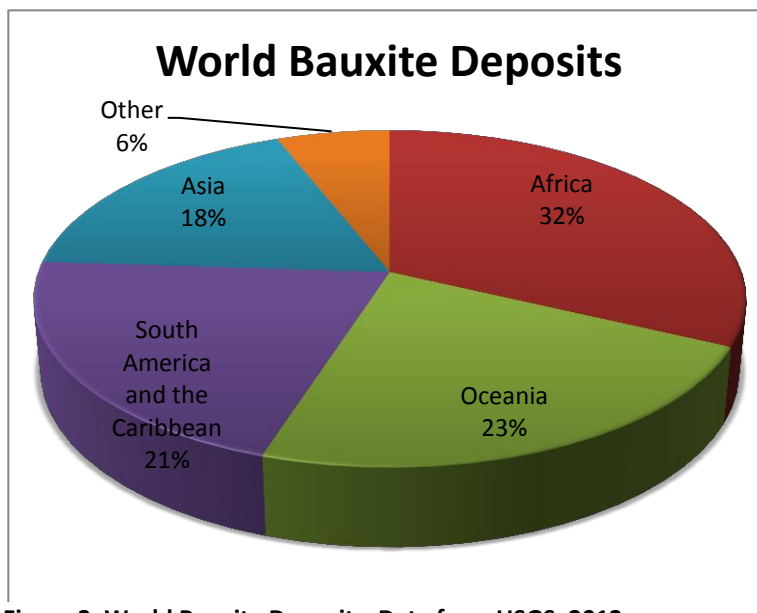


Figure 3. World Bauxite Deposits, Data from USGS, 2012

America and the Caribbean, and 18% in Asia (USGS, 2012). The world resources of bauxite are estimated to be anywhere between 55 to 75 billion tons, which at current usage would last between 340 and 250 thousand years.

Because bauxite is

usually found in a relatively shallow layer, bauxite mines are generally open-pit or strip mines.

Alcoa characterized the steps in the mining process in the following stages:

- “Exploration Drilling
- Mine Planning
- Clearing
- Top Soil and Overburden Removal
- Secondary Overburden Removal (SOBR)
- Mining, Crushing and Conveying” (Alcoa Australia)

Each mine is different, but another example is from the sequence of processes from Mineracao Rio do Norte (MRN), which describes the process as in these steps: “Land clearing, stripping, crushing, railway transport, loading and unloading of ore, washing and tailing handling, laboratory quality control, drying, bauxite storage, and ship loading” (Operational, 2012). Below is MRN’s generalized visualization of the process:

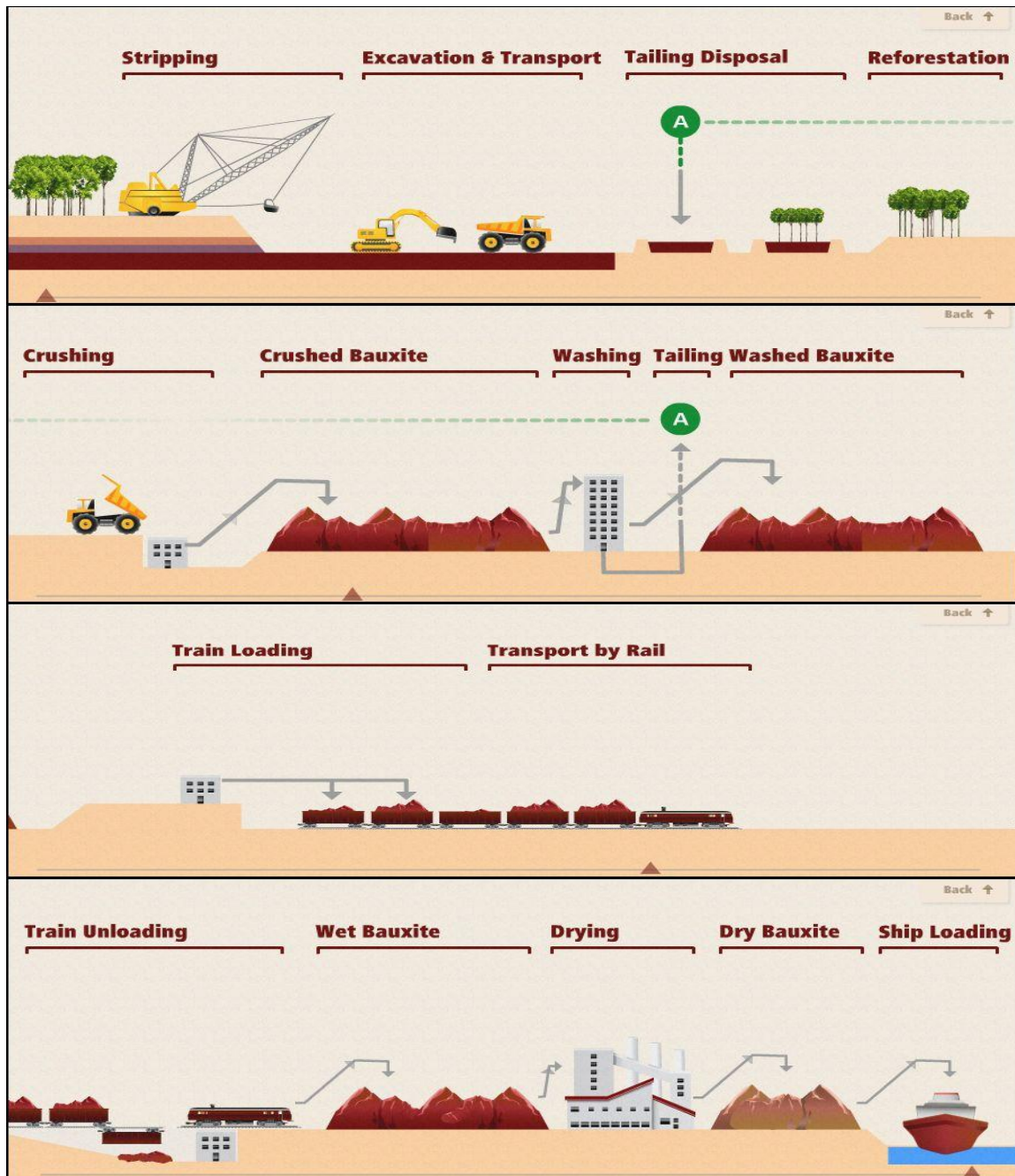


Figure 4. MRN Bauxite Mining Depiction, (Operational, 2012)

The first major step in mining is clearing and removing overburden, which is defined as anything above the bauxite layer that they have to move. The bauxite layer can be anywhere from a few centimeters below the surface to tens of meters below (Alcoa Australia; Land, 2012; Bhat, 2002). Because mining generally takes place in tropical regions, a majority entails clear-cutting tropical forests. Then the topsoil is removed and stored, if reforestation or rehabilitation requires it. Then the secondary overburden layer is removed and stockpiled. The removal of overburden generally takes place with excavators and other typical mining heavy machinery. In the case of any hard, rock layers explosives and other methods can be employed (Alcoa Australia).

The bauxite is then extracted using excavators and front-end loaders and taken to crushers. The bauxite is then crushed into smaller pieces to make it easier for transport (Bauxite Processing, 2011). Then the bauxite is washed to remove clay and impurities. According to the USGS Global Flow of Aluminum, from Figure 1. (Martcheck, 2006 above, this bauxite residue or tailings are about 30% of the total mass of the removed bauxite. This accounts for 75 million metric tons globally. If the bauxite is being shipped long distances, especially to colder regions where freezing is a possibility, the wet bauxite is then dried and then loaded into ships.

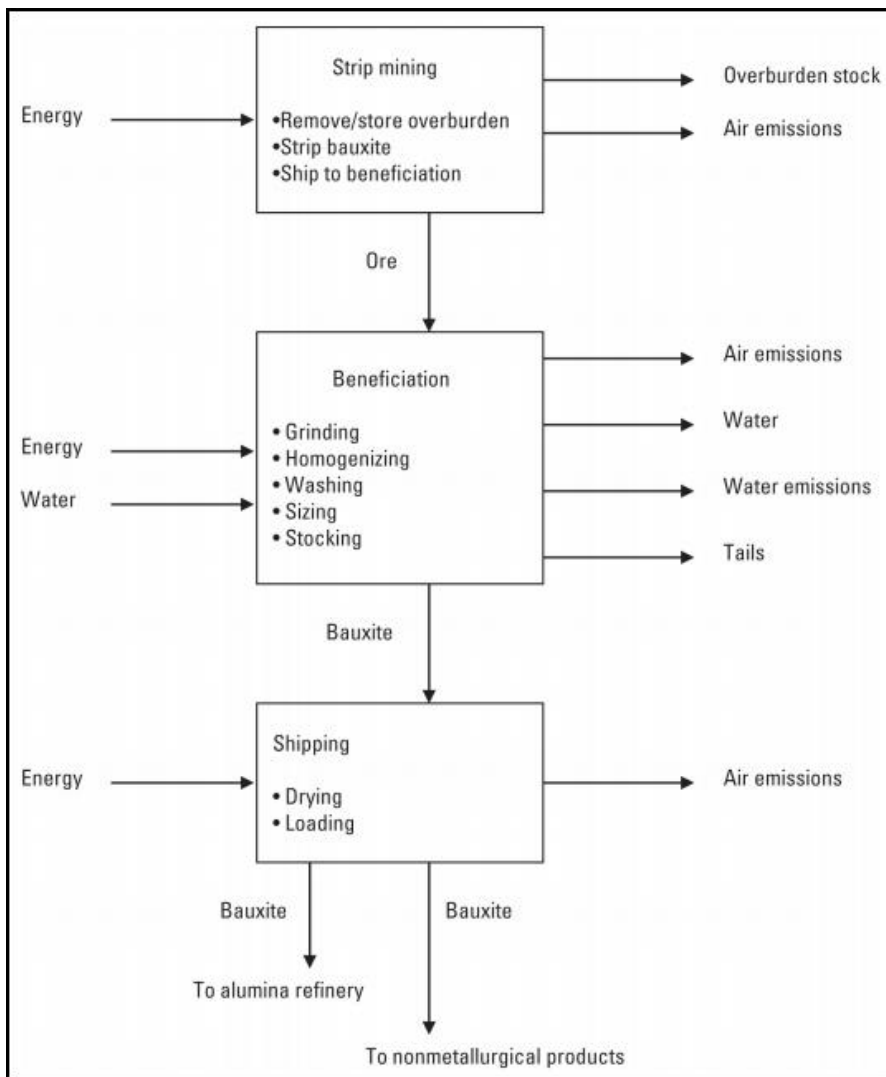


Figure 5. Bauxite Mining Inputs and Outputs (Menzine, 2010)

The by-products of this washing process create the tailings, which generally noted as the most environmentally harmful product of the mining process, along with the deforestation and loss of biodiversity associated with it. Other major impacts include water use and fuel and energy use. In particular, MRN began the first trials into how to manage bauxite

tailing that result in reforested areas. MRN has been investing in research into how to dry tailing reservoirs and then reforest them (Operational, 2012).

There has been significant research into how to best go about restoring biodiversity after the bauxite is extracted (Karthikeyan, 2012; Schafer, 2006; The Bauxite). Not only is this research and investment aiding in rehabilitation, but it also has been contributing to research on biodiversity and native species. In some cases, such as MRN, this can be used as a local development tool, because these companies purchase seeds and seedlings from local communities (MRN, 2012). In fact, around 70% of completed bauxite mines have now been rehabilitated to native forests (Industry, 2002).

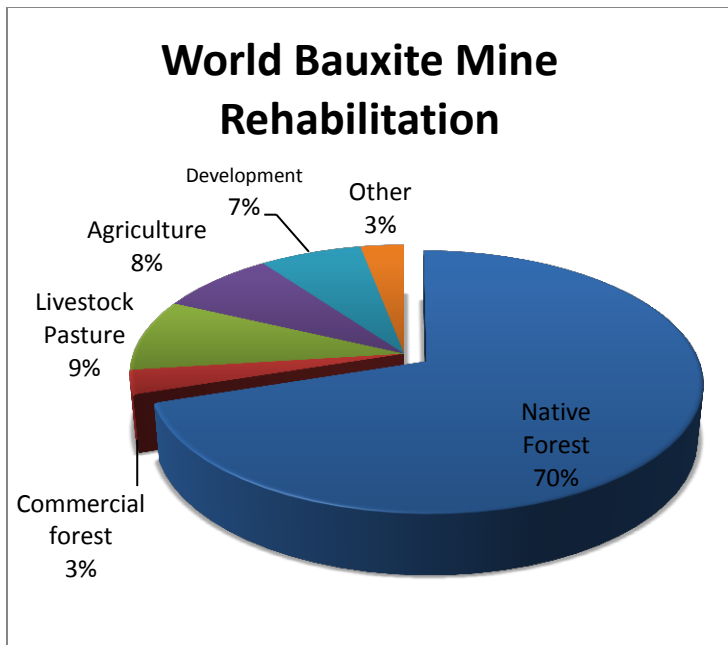
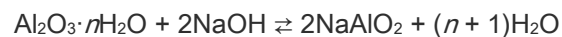


Figure 6. World Rehabilitation After Bauxite Mining (Industry, 2002)

Refining into Alumina

The next part of the process in producing aluminum is turning raw bauxite into alumina through the Bayer process. This process was patented by Karl Joseph Bayer in 1888 and although there have been improvements made upon the process, the fundamentals remain the same (Habashi, 1995). The fundamental chemical formula in this process is:



The steps in the Bayer process are as follows, as explained by the USGS:

- **“Digestion”**- Bauxite is ground and slurried into a caustic soda (NaOH), which is then pumped into large pressure tanks called digesters. The sodium hydroxide reacts with the alumina minerals to form soluble sodium aluminate (NaAlOH).
- **Clarification**- The solution from the digestion step is depressurized and processed through cyclones to remove coarse sand. The remaining fluid is processed in thickeners where flocculants are added to agglomerate solids, which are removed by cloth filters. These residues (red mud) are washed, combined, and discarded, and the clarified solution (containing the NaAlOH) is passed to the next step.
- **Precipitation**- the solution from the clarification step is seeded with alumina seed (very small) crystals to aid precipitation of larger agglomerated alumina crystals.

The product-sized crystals are separated from the small crystals (recycled as seed) and are washed to remove entrained caustic residue. The agglomerates are moved to the next step.

- **Calcination**- The agglomerates of NaAlOH are placed in rotary kilns or stationary fluidized-bed calciners at temperatures that can exceed 960°C ($1,750^\circ\text{F}$), which drives off the chemically combined water, leaving a residue of commercial-grade alumina” (Menzie, 2006

Below in Figure 7 is a map of the distribution of alumina refineries around the world as of 2011, from which on can notice the spatial distribution.

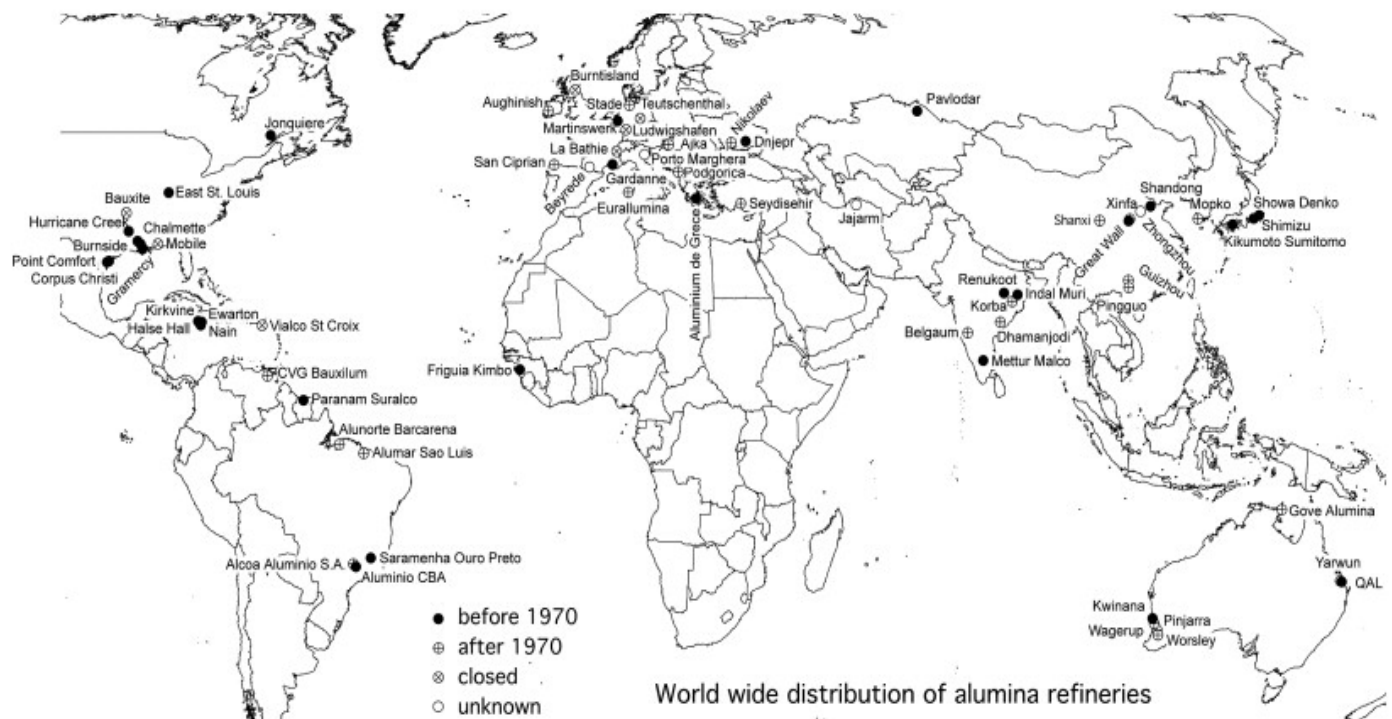


Figure 7. World Alumina Refineries (Power, 2011)

Through this chemical process, the largest by-product is what is known as ‘red mud’. About 70 million tones of red mud are produced annually (Lui, 2007; Power, 2011). Red mud is generally characterized as having a high alkalinity and contains high concentrations of heavy metals (Brunori, 2005). Currently, the main method for handling the vast quantity of red mud produced is to dispose of it at sea or to pump it into ‘lagoons’ for permanent storage. While the disposal at sea is the least costly, it disturbs marine ecosystems and is strongly discouraged by

international organizations, such as the United Nations Industrial Development Organization and its practice has been largely phased out (Power, 2011).

The most common practice today is called 'lagooning' which basically consists of storing the effluent in large reservoirs. This method is more costly than marine disposal because of the permanent maintenance required. The major attendance required is the prevention of leakage into groundwater and failure of the containment systems (Power, 2011). The tragic failure of a red mud containment system in Hungary in 2010 leaked almost a million tones of red mud, which killed nine nearby residents and injured over 100 (Enserink, 2010). Not only does it pose risks in containment, but it also takes a significant amount of land use.

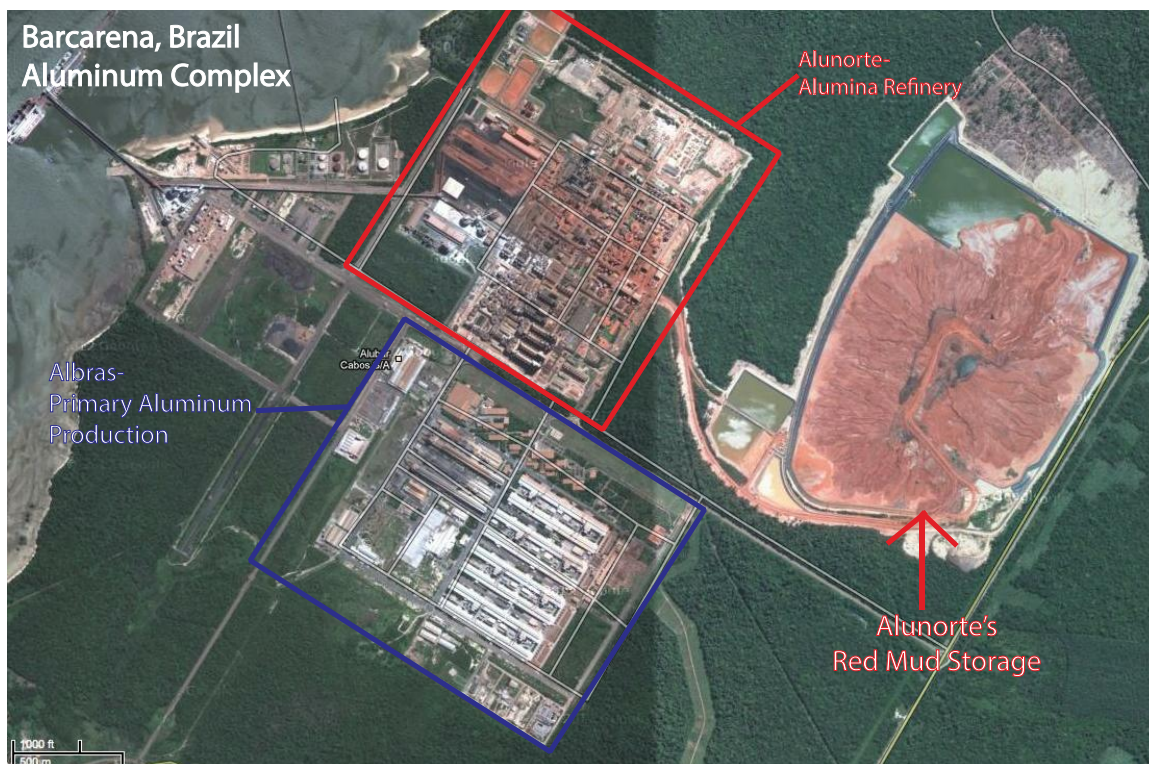


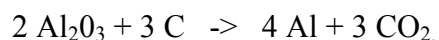
Figure 8. Aluminum Complex showing 'red mud' tailings, adopted from Google Earth

Up until recently, red mud had been seen as a by-product, a liability and a cost to the process, but that has been changing with new processes being developed to reduce toxicity and recycle and reuse the effluent (Brunori, 2005; Power, 2011; Tuazon, 2008). Alunorte, shown

above, is undergoing a pilot program in order to attempt to reuse their red mud as a material for bricks, which is being researched at alumina refineries all around the world.

Refining into Primary Aluminum

In order to produce aluminum from alumina, there is an electrolysis reduction process, known as the Hall-Heroult process. This process was actually developed independently by an American Charles Hall and a Frenchman Paul Heroult in 1886. The basic chemical formula is:



but the process involves various additional inputs and outputs.

In this process, aluminum oxide, from the alumina, which has a melting temperature of over 2,000 degrees Celsius, is mixed into a cryolite bath, which is a combination of the alumina and aluminum fluoride, which cuts the melting temperature almost in half (Ophardt, 2008).

This mixture is inserted into an electrolysis cell, which consists of a cathode (negatively charged) and a carbon anode (positively charged). This is a reduction process, therefore; the aluminum ion is then reduced, which means that it gains electrons from the anions. This process is fueled through the electric current running through electrolytic cell.

The electrons that the aluminum gains come from the oxygen anions reacting with the carbon anode, which produces carbon dioxide. Because of this, the carbon anode is continuously depleted in the electrolysis process, so they have to be replaced about once every 24-48 hours on average (Principles).

The main environmental impacts of primary aluminum smelting are the GHG emissions from energy use and perfluorocarbons (PFCs) and the waste generated from the spent anodes.

Energy use is especially important because of the large amounts of energy required for aluminum smelting and the environmental impacts that go along with energy production. Producing just one ton of aluminum requires nearly 15,000 kWh of electricity (Menzie, 2010). In 2002, the aluminum industry accounted for 3% of the energy consumption of all industrial emissions in the US (Quantifying, 2008). In 2007, aluminum smelting accounted for 3.5% of global electricity consumption (IEA, 2009). That equates to 0.4 gigatons of CO₂eq, which is nearly 1% of global GHG emissions (Energy, 2009).

There are two key factors that contribute to the emissions from energy use in primary aluminum production: smelter technology, and sources of energy (Energy, 2009). There have been significant investments into efficiency in the process, largely due to the fact that energy costs account for roughly 25% of the cost of producing primary aluminum (Industry, 2002).

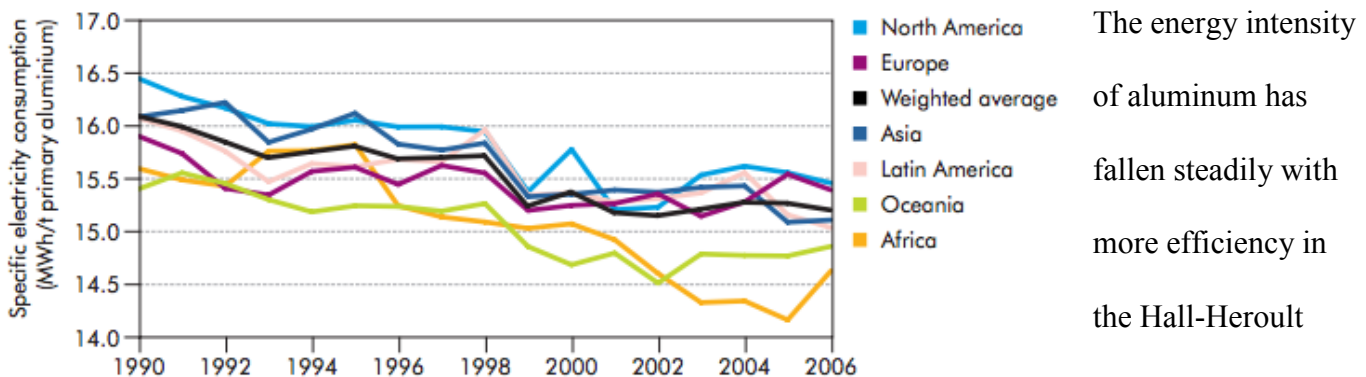


Figure 9. Energy Consumption of Primary Aluminum by Region (IEA, 2007)

process, although there is current research into alternative reduction processes (Aluminum: Industry, 2003).

There is still significant potential to improve upon the efficiency of the Hall-Heroult process. The Department of Energy's Energy Efficiency and Renewable Energy Office did a study considering evaluation of the theoretical minimum energy requirement, which is the chemical energy required for the chemical transformations, and compared that to what energy is used in practice today (DOE, 2007). They found significant potential for energy reduction,

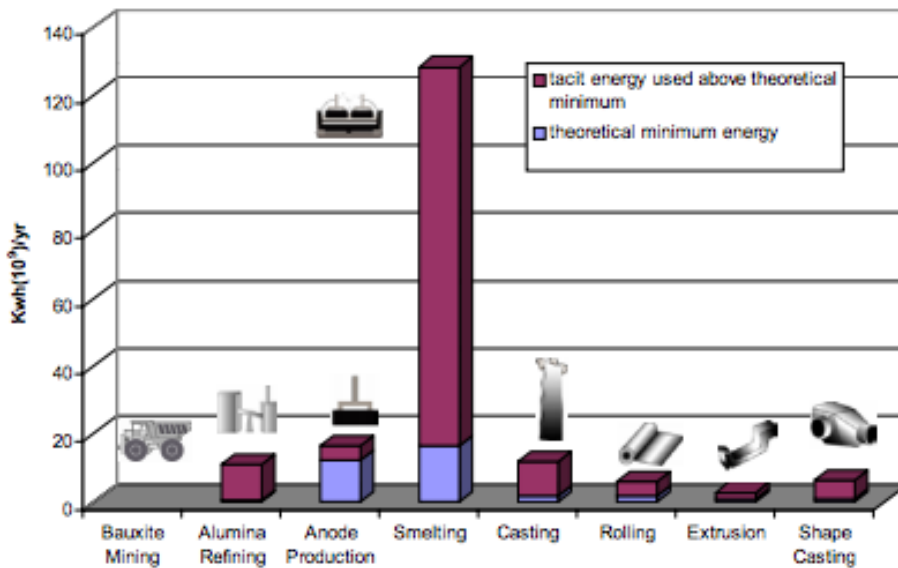


Figure 10. Energy Consumption and Theoretical Minimum of US Aluminum Operations (DOE, 2007)

especially in the smelting or electrolysis process. The most efficient primary production plants in 2007 required about 13 kWh/kg of aluminum, whereas the theoretical minimum was found to be 5.99 kWh/kg, which

would mean a 46% reduction in

energy requirements, as described in Figure 10 below (DOE, 2007).

The source of energy certainly contributes to emissions as well. In fact, while the global production of hydroelectric power accounts for about 16% of total electricity (International, 2011), primary aluminum production uses roughly 50% hydroelectric power (DOE, 2007).

Generally speaking, hydroelectric power offers a cheap and reliable supply of electricity and with the

globalization of trade, it is easy to build the plants where the lowest-cost energy is and ship the raw materials.

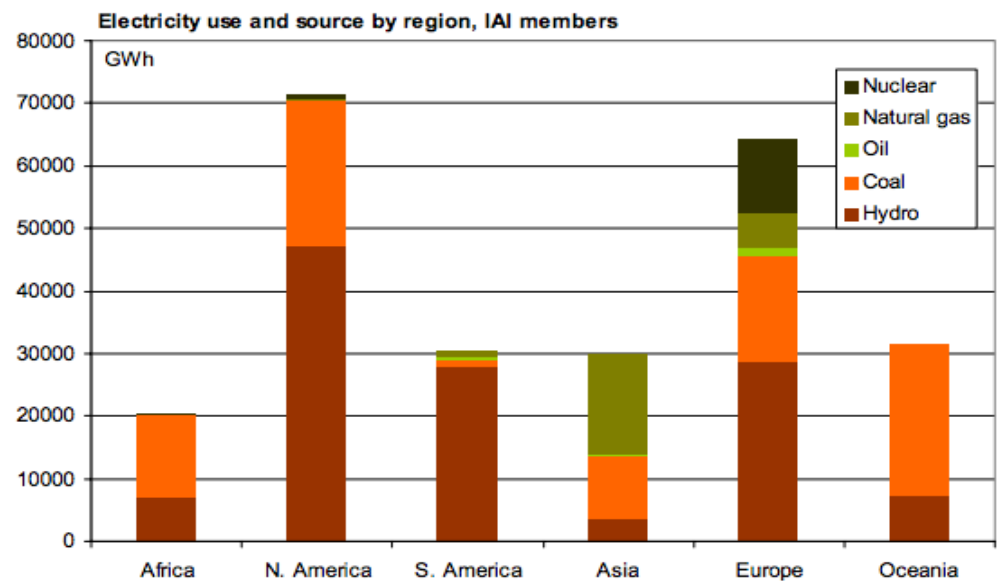


Figure 11 Primary Production Electricity Use and Source, (Luo, 2007)

Another major environmental impact is the perfluorocarbons emissions that result from the electrolysis process due to the fluoride in the cryolite. A majority of the PFCs are emitted from the electrolysis cell is from periods called anode effects (Zhu, 2000). These are times in which the alumina in the cell reaches a low level, which causes current to decrease and voltage to spike, which leads to formation of PFCs instead of CO₂ (DOE, 2007). For every one ton of primary aluminum production, there is about 4.5 kg of fluorine emissions (Menzie, 2010).

Perfluorocarbons are between 6,500 and 9,200 times more effective as a GHG than CO₂ (EPA, 1999). In 1997, the emissions for perfluorocarbons were 50 million tones, about 45% of total CO₂eq. Because of emission controls, perfluorocarbon emissions have decreased about 60% to 34 million tones, which accounts for 39% of CO₂eq emissions for primary aluminum production (Industry, 2002). This is done through several techniques; including mechanized, constant alumina feed, monitoring cell temperatures, and capture and recycling of the excess emissions (EPA, 1999). Overall, the industry has reduced the number of anode effects from 3-4 per day in 1948 to about 1.5 per month (DOE, 2007). Another possible reduction in PFCs is through the use of inert anodes, which are largely still in research and development stage, but could provide significant reductions in CFCs (Tabereaux, 1994).

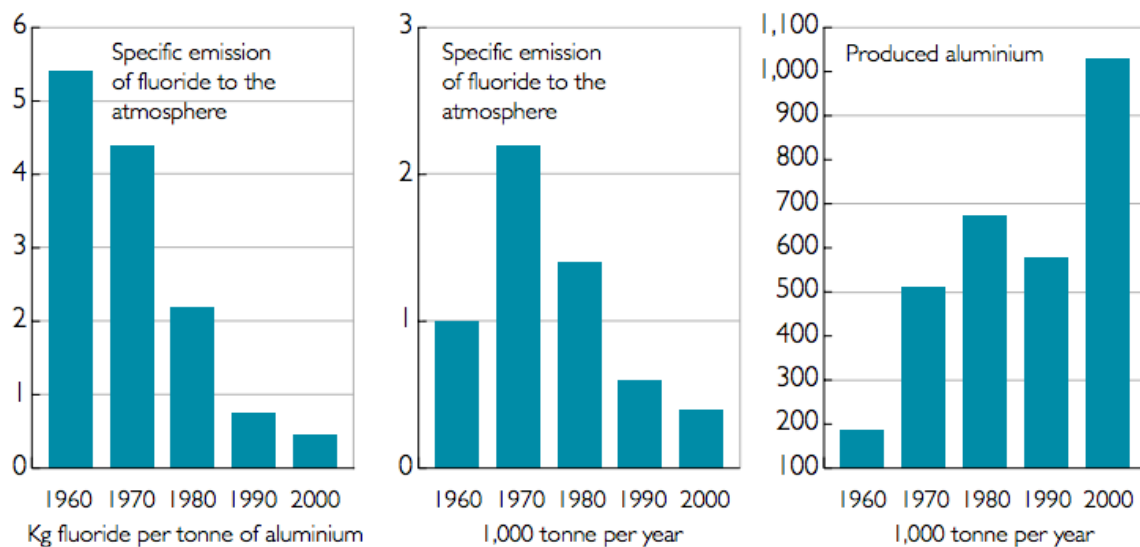


Figure 12 Fluoride Emissions of Primary Production (Industry, 2002)

Secondary Aluminum Production- Recycling

Secondary aluminum, or recycled aluminum is re-smelted in order to be put back into the production cycle. It is easy to make the case for recycling aluminum because of the significant environmental and economic benefits. One ton of recycled aluminum requires only 5% of the energy required to produce primary aluminum (DOE, 2003). In 2003 in the US alone, recycling saved 167×10^9 kWh (DOE, 2007).

There are two classifications of recycled aluminum: “new” scrap and “old” scrap. New scrap is the aluminum by-product of processing and manufacturing, whereas old scrap is post-consumer recycled aluminum (EPA, 1995). Compared to the primary production, the process is relatively simple. There are two main steps: cleaning and sorting, and smelting (Aluminum, 1998). The type of cleaning used depends upon the type and purity of the scrap. There are three main techniques in cleaning process including mechanical cleaning, which is a physical process of separating aluminum from containments; pyrometallurgical cleaning, which involves heating to separate contaminants with different melting points; and hydrometallurgical cleaning, in which water is used to clean and leaches out contaminants (EPA, 1995).

The smelting process for secondary aluminum requires the melting of the aluminum, but it is not an electrolysis process, which is why there is significant energy savings (In-Depth, 2008). There is no need to break chemical bonds, which is why produced aluminum is said to have embodied energy. The aluminum is heated to a temperature of 960 degrees Celsius and then the aluminum is smelted in order to recast it into ingots or rolled sheets for future processing.

There are several considerations in terms of recycling aluminum, including the time to recover the products from the market place. While 30% of the US recycled aluminum is used beverage containers (UBCs) (In-Depth, 2008), which have a quick turn-around, other aluminum products, especially such as building materials and electrical cables, have a long life-time in the market and are not recycled quickly (DOE, 2007).

There has been improvement in recycling rates of aluminum globally (International, 2011). There is significant investment from the aluminum industry into increasing recycling rates because of the embodied energy and cost savings. In fact, the production of secondary aluminum has tripled between 1980 and 2006 (Energy, 2009). There is significant potential for improvement in the way the secondary aluminum production takes place, especially in terms of the designs of aluminum products to make them even easier to recycle (Das, 2011). There is investment in this sector, especially from Alcoa, who is now Cradle to Cradle certified and has announced an investment of \$2 million to increase US aluminum recycling rates up to 75% (MBDC, 2012; Alcoa Investing, 2012).

Aluminum Industry



Figure 13. Location of Aluminum Smelters, (Industry, 2002)

The aluminum industry is a diverse industry in terms of location, with representation on every continent except for Antarctica. The industry is relatively centralized, with 21 companies representing over 60% of global production (Industry, 2002). The largest of these companies are Rusal, a Russian producer; Rio Tinto Group, a merge of an Australian and Canadian company; Alcoa, an American company; Chalco, a Chinese company; Norsk Hydro, a Norwegian company; Dubal, a United Arab Emirates company; China Power Investments, a Chinese company; BHP Billiton, a British company; Shandong Xinfu Aluminum, a Chinese company; and Alba, a Bahrain company (Troszkiewicz, 2012).

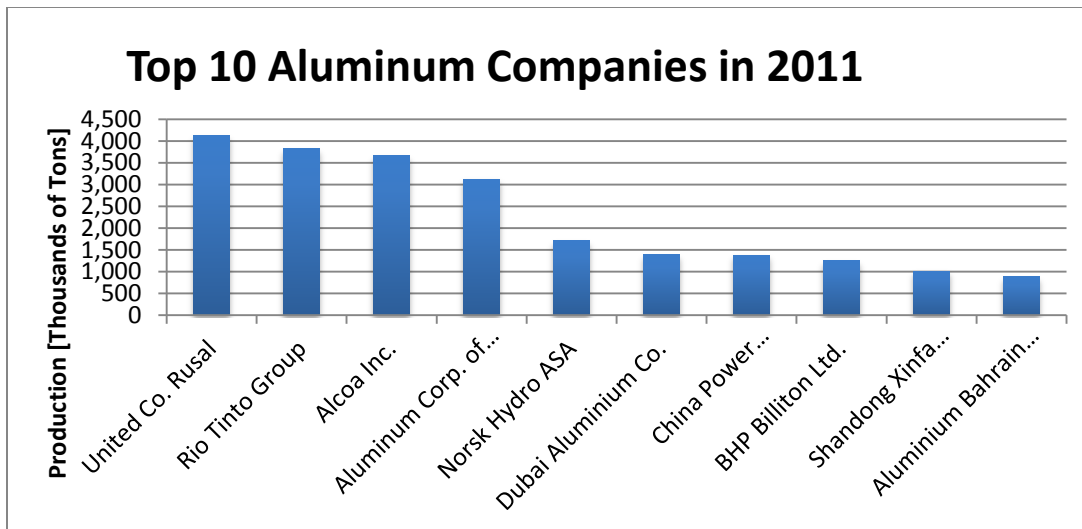


Figure 14. Ten Largest Aluminum Companies, Data from Troszkiewicz, 2012

Most of these companies have investments in several of the production cycles. Others like BHP are strictly a mining company. Still others have operations only in primary aluminum production, such as Dubai Aluminum. Many of these companies also have significant energy production to fuel the primary aluminum smelting.

The economic downturn hit the aluminum industry hard. It caused a crash in the cost of aluminum on the world market. The price of a ton of aluminum fell from \$3071 in August of 2008 to \$1330 in February 2009 (World, 2012). This was a challenge to the industry, although, since then, the price has risen back up to over \$2000 (World, 2012).

Aluminum Industry in the Amazon Region

The Amazon Region plays an interesting role in global aluminum industry because of the vast resources that it contains; including the world's third largest reserves of Bauxite and is the world's second largest producer of bauxite (Factbox, 2007). Two large mines have opened in the Amazon region since 2007, Alcoa's mine at Juruti in 2010 and Hydro's mine at Paragominas, and there are still plans to further exploration and expansion into this region

because of the rich reserves (Bauxite, 2012). Roughly 50% of the world's primary aluminum production utilizes hydroelectric power (US DOE, 2007).

Along with the immense reserves of bauxite, there is also some of the world's highest potential for hydroelectric power (Corley, 2010; International, 2000). Because of the access to high amounts of electricity, Brazil has the capacity to do something as energy intensive as refining aluminum. For example, in 2011 the largest Brazilian mining company, Vale, became an investor in Belo Monte, which will be the world's third largest hydroelectric dam once completed; although Vale is primarily a mining company, it is heavily invested in Belo Monte, as well as nine other hydroelectric dams in Brazil alone because of the necessary link between mining and production and energy consumption (Rapoza, 2011). Alcoa is also invested in several existing and planned hydroelectric dams in Brazil (Alcoa annual report, 2010).

Vale, as well as other industrial companies, especially in the aluminum industry, has an interest in energy production because they consume large quantities of it. The world's third largest aluminum refining plant, Albras, uses 2.5 times the amount of energy that the nearby city of Belem, a city of just over two million; this one plant uses 1.5% of the total consumption of energy of all of Brazil (Albras, 2012). The power from Albras comes directly from nearby Tucuruí, the world's fourth largest hydroelectric dam; in fact there are four sets of power lines leaving Tucuruí and one set goes directly to Albras, utilizing three of the twenty-three 350 megawatt turbines (Geração, 2012).

The case of aluminum is interesting in Brazil because the use of hydroelectric power nearly eliminates the negative output of greenhouse-gas emissions; globally, the aluminum industry is responsible for roughly 1% of global GHG emissions, 60% of which typically comes from electricity production (Global, 2009). The Amazon Region of Brazil has all of the

ingredients to have a thriving aluminum industry, so it is no surprise that the industry in Brazil is one of the largest in the world and has been growing (ALBAL, 2011).

Aluminum Industry in the US

The US has a robust aluminum industry, which processes over 9.6 million tons and generates around \$40 billion in products (DOE, 2007). There is no longer any bauxite mining in the US, although the US does import around 11,000,000 tons of bauxite and 2,230,000 tons of aluminum (Bray, 2012). There are over 400 plants that operate in 41 states and employ nearly 150,000 people (DOE, 2007).

Although the US still has a strong industry, the heat wave and subsequent low snowpack in the Northwest of 2001 caused spiking electricity costs 43% of the primary aluminum facilities in the US to shut down (DOE, 2007). In one year, the US primary production of aluminum went from 3.6 million tons to 2.6 million tons (Buckingham, 2010). Since then, there has been a few smelters coming back online, but it is estimated that the US smelters operated at 64% capacity in 2011 (USGS Aluminum, 2012).

“In 2011, **5 companies** operated **10 primary aluminum smelters**; 5 smelters were closed the entire year. One smelter that was closed in 2009 was reopened during the first quarter of 2011. Five potlines that were closed in late 2008 and early 2009 at four other smelters were also restarted in early 2011. Based on published market prices, the value of primary metal production was \$5.27 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 34% of domestic consumption; the remainder was used in packaging, 27%; building, 12%; electrical, 8%; machinery, 8%; consumer durables, 7%; and other, 4%.” (USGS Aluminum, 2012)

The companies that operate the primary aluminum smelters are Alcoa, which operates six smelters across the U.S., Century Aluminum, Rio Tinto Alcan, Noranda Aluminum, and Ormet (United, 2011; Pawlek, 2011).

Objective of Research

If these large systems are driven by consumer demands, to what extent do their values affect the system that they are driving? Consumers are asked to choose products responsibly and sometimes spend more to support ‘greener’ practices, but do those choices make real differences in business practices?

Are consumers’ voices heard up the production chain? And to what extent? Through what channels? What causes companies to adopt environmentally friendly practices? In particular, what motivates companies to use capital (investment in infrastructure, research, clean-up methods) when they are not obligated to do so? Does it come from the consumer, even when the consumer is several layers removed in the production cycle?

Over-arching Research Statement

Is consumer awareness on environmental issues reflected in corporate environmental policies in the aluminum industry in the Amazon region and the U.S.?

Specific Research Questions

- 1) What is the internal perspective of the relationship between consumer environmental awareness and corporate environmental policy in the aluminum industry in the Amazon region?
- 2) How has consumer awareness of environmental issues changed over time?
 - a. How do you measure consumer awareness of the environmental impacts of the aluminum industry?

- 3) How has corporate environmental spending changed over time?
- 4) Does consumer awareness and corporate environmental spending seem to be related, by these indicators?

Methods and Procedures

Definition of Terms

1) Consumer Awareness

In this research, the goal is to measure the consumer awareness of bauxite and the aluminum industry, and the environmental impacts that they cause. Consumer awareness is the level of information or the amount of consideration that consumers pay to issues.

2) Corporate Environmental Policies

For the purpose of this research, the company's internal definition of environmental spending will be used. While this may vary from company to company, this research is only interested in the trends, therefore different definitions of environmental spending and what is included in said spending is *less important*.

Internal Perspective

What is the internal perspective of the relationship between consumer environmental consciousness and corporate environmental spending?

The information procured was the perception of employees involved in environmental policy decision making on consumers effects. What influences effect environmental decision making the most? Are these related to consumer awareness? In order to gather that information, voluntary and anonymous interviews were conducted with employees directly responsible for the environmental policies of the aluminum industry's companies and/or projects in the Amazon region and in the US.

The methods used to solicit interviews varied from the companies in Brazil and the companies in the U.S. The interviews in Brazil were all solicited from the five large producers

in the state of Para. The interviews in the US were solicited based mainly on two criteria: whether they were one of the top ten largest companies, and also having some operations in the U.S., and any company operating a primary aluminum production plant. There was significant overlap between those distinctions. Two local Colorado companies were also contacted in order to capture some sample of the small scale producers. Overall, the success rate of securing interviews in Brazil was 4 out of 5; while in the U.S. the success rate was 3 out of 8.

Because it is generally against corporate policy for employees to be a part of research of this manner, all companies and interviewees are reported on anonymously. There may be a bias towards companies with commitment to environmental management that leads to their employee's willingness to participate. Because of the sensitivity to corporate policies, the interviews were not recorded, but they were transcribed.

The interviews were conducted in a semi-structured manner. The following basic interview questions in the chart below:

Interview Questions for Company Employees	
English Version	Portuguese Version
1) How many years have you worked for (Company Name)?	1) Ha quantos anos você trabalha por (Empresa)?
2) What role have you had in forming the environmental policies of (Company Name)?	2) Que papel você teve na formação das políticas ambientais de (Empresa)?
3) How has (Company)'s commitment to environmental protection changed over time?	3) Como o compromisso para a proteção ambiental mudou ao longo do tempo na (Empresa)?
4) In your opinion, what are the main five reasons that (Company Name) invests in environmental programs?	4) Na sua opinião, quais são as cinco principais razões que (Empresa) investe em programas ambientais?
5) What do you think the role of the end consumer is on the environmental policy of (Company Name)?	5) O que você acha do papel do consumidor final sobre a politica ambiental da (Empresa)?
	6) (This question was not asked in Brazil)

Table 2. Interview Questions

The questions were designed to make the interviewee feel comfortable answering questions and draw out comparable information. The first two questions were asked in order to get a better understanding of the interviewee in order to draw from and place value on their personal experience. The main question that was used to compare interview responses was the fourth question, in which the interviewees listed what they considered the main reasons or motivations for their company's investments in environmental programs. The fifth question was used to probe into those motivations and steer conversation in order to gain a deeper understanding of meaning in regarding this research.

Although the above interview questions were the foundation of the interviews, there were nearly always follow-up questions and explanations requested. Each interviewee had a unique perspective from unique companies and/or projects that warranted specific insight. Those types of considerations were generally gathered prior to the interview request through available company documents and press remarks.

Finding an Indicator for Consumer Consciousness

How do you measure consumer awareness of the environmental impacts of the aluminum industry?

In order to find an indicator of consumer consciousness, there was much research and conceptual consideration of the causes of consumer consciousness required. This indicator needed to be an accurate representation of the trends in consumer consciousness and the relative level of consumer consciousness over time. On the other hand, the indicator did not necessarily need to be caused by consumer awareness or a cause of consumer awareness, but merely correlated with it.

There were also certain elements that were needed in an indicator in order to be able to be applicable and comparable to corporate environmental policy; such as a consistently chronicled, with consistent methods. In order to fulfill this, a conceptual map was first created in order to examine the range of possible influences and influencers. Through that conceptual map, media coverage rose as an appropriate filter of public opinion and external influences. To investigate that, a review of literature that considered media as a proxy for public opinion, which can be representative of consumer awareness, was reviewed.

Because of the conceptual nature of this topic, there needed to be a thorough exploration of potential misrepresentations and possible basis in the chosen indicator. While it would be ideal to have a perfect indicator, such an indicator may not exist, but it should be said that this research looks to observe overall trends and does not claim to perfectly measure consumer awareness.

Tracking Consumer Awareness over Time

How has consumer awareness of environmental issues in regards to the aluminum industry changed over time?

Media coverage was chosen as an indicator of consumer awareness, for reasons discussed below in the Results Section. In order to show the change in consumer awareness over time, the level of media coverage about this issue from year to year was used. In order to show the level of media coverage, the frequency of stories relating to this topic was used. The frequency was gathered for every year from 1980 until 2010, which corresponds roughly with the time in which the aluminum industry has been in operation in the Amazon region.

This information was obtained through the use of LexisNexis' News Database. Because of the disperse and international nature of consumers of aluminum products, the "Major World News Publications" was used. LexisNexis' definition of "Major World News Publications is as follows:

"The Major World Publications group file, MWP, contains full-text news sources from around the world which are held in high esteem for their content reliability. This includes the world's major newspapers, magazines and trade publications which are relied upon for the accuracy and integrity of their reporting."

Although newspapers are not the only outlet for media and information, only newspapers were used in this research. There is a wealth of information available to consumers today through the internet. These sources are becoming increasingly important in the dissemination of information and the forming of values and beliefs. Unfortunately there is currently no way to adequately sample past information of online sources, therefore this data will be ignored.

In order to better understand the connections between consumers' consciousness and corporate environmental policy, there was the need for a thorough investigation into what countries and regions are being represented by this database, and a reflection of whether this compares to the consumers of aluminum products. Over this time period, this database consisted of 158 newspapers.

In order to get a reference for general awareness of environmental issues related to bauxite and aluminum, the following search terms were employed:

- 1) 'environment' AND SUBJECT(Bauxite Mining) OR SUBJECT(Aluminum Industry)

This search generated a total of 3980 stories over the thirty year time period. There are certain factors that simply did not fit into the scope of this study, such as the nature of stories, whether they are positive or negative. Also, the nature of the newspapers considered as “Major World News Publications” was not investigated and considered for type of audience. Also, non-English newspapers were not considered in this study. This creates a bias towards English speaking countries and leaves out large consuming populations, such as China from the results. In order to see how biased the data was, each year the frequency was filtered by region.

There are many factors that make tracking consumer awareness through media coverage confusing and unclear. There are outside factors, such as corporate public relations spending that could factor in to the amount of media coverage and be entirely unrelated to consumer awareness. Because of this, there will be no consideration of specific companies or projects, only consideration of the industry as a whole, in order to diffuse the effect of individual companies on the media.

Further Analysis of Media Coverage

It is clear that the ‘Major World Publications’ search from Lexis Nexis is not an accurate representation of the media from the highest consumers’ countries, so another approach was used in order to represent consumers more accurately and to inspect the stories for content. The method used was to analyze the content of a selection of the articles in the previous searches for a period of time. This was employed in order to assess the type of articles and the level of their coverage of issues relating to environment issues or qualities of aluminum. In order to be representative of consumer awareness, the four countries with the highest consumption rates in the world. That data was found through the USGS’s data on aluminum consumption.

Then, for each country selected, there was a review of literature in order to choose a newspaper or newspapers that are generally chosen to study, in order to be representative of each country's media coverage. Generally, at least two prominent literature sources were used to select the newspapers for each country. Any English version papers or English translated papers were given preference if previous studies articulated that they were representative. This was done to minimize translation errors. In the cases where no English papers were available, a simple translator was used in order to glean general meanings and sentiments.

In some cases these newspapers that the literature suggests as representative to study for the high consuming countries were not included in the original search's "major world news publications" as defined by lexis nexus. In some instances, there was not a good record of articles through Lexis Nexus, and thus the database Factiva was used. With either database, the search that was used was to search for both the word "aluminum" and the word "environment" for the prescribed data range and newspaper.

Coding was employed to quantify levels of coverage for articles in different subject areas. The articles were scanned for various variables relating to either aluminum production or aluminum products, which included:

- Efficiency
- Energy Reduction
- Reduction in Pollution/ Byproducts
- Recycling
- Environmental Degradation
- Pollution
- Man-Made Disasters/ Accidents
- Natural Disasters

In each article, each time the above themes were mentioned in regards to either aluminum production or aluminum products it was noted. For example, if there was a mention about energy use in producing aluminum, that was considered even if the article was focused on another topic. If an article focused on different aspects of aluminum production, such as the chemical effluents from processing alumina or the various benefits of recycling aluminum, each time a theme was mentioned, it was accounted for. If an article discussed the energy input needed for primary aluminum and mentions that recycled aluminum saves energy, that was accounted for three times: one for energy input as environmental degradation, recycled aluminum as recycling, and saving energy as energy reduction.

There was also a weighting system used in regards to what type of prevalence the theme had in the article, so each article was divided into headline, first paragraph and body. Each mention in a headline was weighted by a factor of five; each mention in the first paragraph was weighted by two; while each mention in the body was weighted by a factor of one. When environmental impacts of aluminum were mentioned in the headline, it counted as five, whereas if it was mentioned in the body of the article it counted as one. This was done in order to attempt to quantify the relevance of the mention of aluminum.

These themes were chosen to attempt to cover the full range of environmental considerations as it relates to aluminum production and products. This was deduced from an understanding of the environmental impacts of each of the stages of aluminum production and from a sense of what the companies themselves discuss in regards to environmental protection in their annual reports and press releases. The themes were defined as broad categories, in order to capture a wide range of stories. Environmental degradation was the broadest category;

that was defined as any mention of an environmental impact of aluminum, such as red mud or GHG from energy production.

This data was then aggregated for each country for each year. Then, those yearly coverage amounts were multiplied by the percentage of the total population corresponds to each country. This was done because the purpose of tracking media coverage was to track the consumer awareness and in order to attempt to make this data representative of actual consumer markets, it seemed prudent to weight each country's coverage by their share of the market.

This yearly data for the selected years was then compared to the frequency data from the 'major world publications', in order to see if there were any major discrepancies in the two methods. This was done by a simple visual graph, because the finding the trends in coverage was the motivation. Also, a simple regression was implied in order to quantifiably see how well the data tracked each other.

Environmental Corporate Spending over Time

How has corporate environmental spending changed over time?

This information was gathered through the company's annual reports all found on their respective websites. The data that was collected was collected based on availability. The companies/projects that were considered from the Amazon regions are as follows:

- | | |
|--------------------------------------|---------------------------|
| 1) Mineração Rio do Norte (MRN) | Bauxite Mine |
| 2) Alunotre | Alumina Refinery |
| 3) Albras | Primary Aluminum Smelting |
| 4) Alcoa (Mina de Juruti) | Bauxite Mine |
| 5) Norsk Hydro (Mina de Paragominas) | Bauxite Mine |

Data was also collected for a few of the large corporations that operate in the U.S., including:

- 1) Alcoa
- 2) Hydro
- 3) Century Aluminum
- 4) Rio Tinto, Alcan
- 5) Noranda

Unfortunately, not all the annual reports for all years of operation for each respective company were available to the general public, so all data that was available was collected. In this case, the operations that were a part of a larger company, including Alcoa's Mina de Juruti and Hydro's Mina de Paragominas, the data was not available for the specific operations, but it was available for their entire company. From all of these companies and operations, there were four companies that had a significant history of reporting on environmental spending that were used.

These data were collected from the companies' annual reports. As stated above, the spending numbers were taken from what they defined as environmental investments or environmental programs, which varied from company to company. Regardless of differences in company definitions, this data was taken to show trends in spending, and was less motivated by outright amounts, so the distinctions in definitions are less important.

Nonetheless, there may be problems in using these data without scrutiny. The data are arguably skewed because of the bias of the available data. There is no real mandate that they need to report this information, and companies do have a preference to appear as the do-gooder in most instances and may be not want to report unfavorable information. For certain companies or operations, this information was not published information, and thus not obtained and considered. Also, general accounting changes may have large changes in the way the

information is reported over the years. This, once again, creates a bias towards the companies which are taking environmental quality seriously as a part of their business model.

Relating Environmental Awareness to Corporate Environmental Spending

Does consumer awareness and corporate environmental spending seem to be related, by these indicators?

In order to determine if these indicators were related, first observational methods were employed. The frequency of stories was compared to the environmental spending graphically and any visible trends were noted. The data were also displayed over time. The objective of this step was not to show a causal relationship, only whether a relationship existed. Because of the differences in scales for each company, they were compared separately in order to understand trends from each company.

The data from the media coverage was compared to the individual companies spending in two ways: visually and graphically for noticeable trends and by a simple regression. The graphical analysis is more for a visual interpretation of the data, while the regression was used to put a value on the strength of the trend. Because aluminum is traded on the global market, with global consumers, each company's spending was compared to the total media coverage. This may present some biases because certain companies work mainly in specific markets, while others do in fact have more of a global reach. Although it is not in the scope of this research, it may be prudent to break down each company by the media coverage in the markets in which their aluminum ends up.

A regression line and coefficient of determination or r^2 value was found for each company. An r^2 value explains how much the variation in the dependent variable (environmental spending) is explained by the independent variable (media coverage). This is to

say, if media coverage increases, does that seem to lead to an increase in environmental spending. In theory, a coefficient of determination can be used to predict how much you can predict the dependent variable from changing the independent variable.

Results

Internal Perspective on Corporate Environmental Policy

The insights gleaned from the interviews conducted with personnel involved in environmental management shed new light on the perceived impact of consumers on environmental policies. What was gleaned from these interviews was that motivations for investment in environmental quality management are largely fueled by the norms of the industry, which are ever changing, complex, and largely fueled by international pressures with a ‘race to the top’ type of influence.

The following table is the responses to the fourth interview question, which was meant to give a snapshot of internal perception of the motives for investment in environmental quality. As discussed above in the methods section, this question was designed to give comparable results from each interviewee. The wording is meant to be as representative as possible, using the interviewees’ own wording whenever possible.

Main Reasons for Environmental Investment- Brazil Interviews			
<ul style="list-style-type: none"> ○ Legal Requirements ○ NGOs ○ Suppliers ○ Clients ○ Financers ○ Media/Journalists ○ Social Movements 	<ul style="list-style-type: none"> ○ Owners/Stakeholders ○ International Norms ○ Coordination/Learning with other companies ○ Social Movements (specifically after Kyoto) ○ Competition in international Markets ○ “The Client is King” ○ Internal Interests 	<ul style="list-style-type: none"> ○ Internal Interests ○ Integrated Policy Management ○ Legal Requirements ○ Certifications/Licenses ○ Stakeholders 	<ul style="list-style-type: none"> ○ Integrated Management Systems ○ Competitiveness ○ Longevity of business ○ Legal Requirements ○ Owners/Stakeholders ○ International Pressures ○ Partner/Clients

Table 3. Reasons for Environmental Investment- Brazil

The following is a reorganization of the above chart, with the repeated or similar reason grouped together:

- | | |
|---|---|
| 1) International Norms (4) | b) Federal |
| a) International Norms | 5) Competitiveness (2) |
| b) International Pressures | a) Competition in international Markets |
| c) Social Movements (2) | b) Competitiveness |
| i) Social Movements (specifically after Kyoto and Earth Summit) | 6) Integrated Management (2) |
| 2) Owners/Stakeholders (4) | a) Integrated Management Systems |
| a) Owners/Stakeholder (3) | b) Integrated Policy Management |
| b) Financers | 7) Internal Interests (2) |
| 3) Clients (3) | 8) Certifications/Licenses |
| a) Client is King | 9) Coordination/Learning with other companies |
| b) Clients | 10) Longevity of business |
| c) Clients/Partners | 11) Media/Journalists |
| 4) Legal Requirements (3) | 12) NGOs |
| a) State and Local | 13) Suppliers |

Main Reasons for Environmental Investment- US Interviews		
<ul style="list-style-type: none"> ○ Reputation ○ Recycling is valuable ○ Clients ○ Cost Competitive- cost reductions ○ Regulation ○ Progressive Management 	<ul style="list-style-type: none"> ○ Cost Savings ○ Return of Investment ○ Buyers/Clients ○ Certifications- Proving quality to buyers 	<ul style="list-style-type: none"> ○ Long term cost savings ○ Clients want to deal with responsible companies ○ Internal Interests- progressive management & employee pride ○ Investors ○ NGOs

Table 4. Main Reasons for Environmental Investment- US

- | | |
|-------------------------------|-------------------------------|
| 1) Costs/Economics (4) | a) Progressive Management (2) |
| a) (Long term) Cost Savings | b) Employee Pride |
| b) Return on Investment | 4) Reputation (2) |
| 2) Clients (3) | 5) Regulation (1) |
| a) Buyers want to do business | 6) Investors (1) |
| with responsible companies | 7) Certification (1) |
| 3) Internal Interests (3) | 8) NGOs (1) |

Combined Perspectives

There were several elements that ran through almost every perspective, including the pressures from clients:

- | | |
|--------------------------------------|---------------------------|
| 1) Clients (6) | 5) Legal Requirements (4) |
| 2) Investors/Stakeholders/Owners (5) | 6) Cost Savings (4) |
| 3) Internal Interests (5) | 7) Competition (2) |
| 4) International Norms (4) | |

Further Discussions of Apparent Trends

From the above initial responses and additional questioning, the following overall themes from the respondents were most prevalent. First the seven responses from above that had more than one occurrence are discussed, at length or briefly depending on the degree to which the theme adds to the research objective.

1) Clients

Nearly all of the respondents discussed the concept that none of the parties along the supply chain want poor environmental practices attached to their products, whether it is refined aluminum for airplanes or bauxite straight from a mine.

A slogan that arose out of a quality program in the late eighties was ‘the client is king’. It is their perspective that their clients, or the companies down the supply chain that purchase their products, reserves the right to accept or deny their product if they are not satisfied, for any reason.

The same topic that was discussed by four respondents was that the clients along the supply chain have been demanding more environmental quality; such as higher certifications. If there is any type of scandal in regards to their environmental practices, they run the risk of not having a market for their products.

Three respondents gave nearly the same answer in reasoning that the clients, the purchasers of the products, are the ones that pass along the end consumer’s demand for environmental quality all along the supply chain. Three examples are discussed by respondents below:

- The parties who buy airplanes do not buy directly from any of these companies discussed, but they are demanding more and more quality and environmental standards in their products, thus creating the need for the companies operating in Para, Brazil to have higher standards.
- When a consumer purchases a hamburger wrapped in aluminum foil, they are not thinking about the fact that they are purchasing aluminum, but because of the availability of information and accountability today, none of the stakeholders along the supply chain want to be liable for purchasing unnecessarily environmentally damaging products; therefore the respondents’ respective companies wish to avoid environmental damage when available.

- The more customers value and pay for things like recycled content, the more the market will shift towards it. Some industry members and institutions are rather accustomed to operating in a certain way, but if costumers demand a more environmentally friendly product, then producers will shift habits, which they have been increasingly.

2) *Owners/Stakeholders/Investors*

Throughout these interviews, as expected, there was discussion of the wishes and general norms and consciousness of the respective owner and/or stakeholder of the company/project. As discussed above, the respondents discussed the different influences of the differing environmental consciousness of the stakeholders, especially in the case of changing stakeholders. It was mentioned that investors are increasingly interested in environmental quality, not only because of the decreased risk, but because it is increasingly becoming a requirement for investment portfolios.

3) *Internal Interests*

There were a few versions of the reasoning for internal interests causing environmental policy: either because it was in the beliefs in which the company was founded, some form of management that had progressive vision for the company, the wish that the employees take pride in the company (and invest their time and efforts in a productive manner) or because the working environment is where the employees live and spend a large percent of their life. There were also many mentions of management, whether it was a board or an individual who pushed the company to take risks in improving environmental quality and made it a part of business.

4) *International Norms*

Currently, sustainability and environmental quality are a part of the business model-part of the international norms. One of the most prevalent messages received from the interview process was that currently, a commitment to environmental quality is a part of the business model of these companies. Especially due to the fact that the aluminum industry is a high-impact industry and that most of the aluminum is for international market, respondents all considered the concept of sustainability is currently a prevalent part of the standard business considerations.

International conventions, such as the Earth Summit and the signing of the Kyoto Protocol, were discussed by respondents as turning points in terms of the international norms discussed above. In addition to the more formal conventions and organizations created by those conventions, respondents also discussed the fact that the social movements that fueled them and continued after them had strong influences in their industry.

There was also discussion of what respondents considered the most recent groundswell of support for environmental quality and the emergence of terminology such as sustainability into mainstream acceptance. Also, if the work of NGOs that have shaped these institutions were considered a part of international norms, it would have been weighted as heavily as clients.

5) *Legal Requirements*

In Brazil, many of these companies surpass most current legal requirements; therefore the legislative implications were rarely discussed in length. Although, in the US, it was discussed that because of the stringent regulations and monitoring from the EPA puts

significant pressure of the operations, which was described as a major difference between operations in the US and abroad.

6) *Cost Savings*

While the concept of economic advantage because of cost savings from environmental management is interesting and worthy of its own research and attention, it is not necessarily as applicable to the objective of this research. Nonetheless, it is encouraging that many environmental impacts are considered a liability and a cost, which causes these companies to invest seriously in reducing environmental impacts and they are finding that in many instances, it saves them money.

7) *Competitiveness*

Currently, these companies need to demonstrate a certain level of environmental competence in order to be a player in the global marketplace; environmental quality is now a norm. All the respondents discussed the importance of the environmental certifications their respective companies received. When pressed, the main motivation for obtaining these certifications was the desire to be more competitive in the global market. There were more market opportunities with these types of certifications. Also discussed was the emergence of the Dow Jones' Sustainability Index; and how this is a relatively new bar to be set that affects their competitiveness on the global market.

While the concept of competitiveness is related to the concept of international norms, it varies slightly in effect. From the internal perspective, environmental quality has been a 'race to the top' type of effect. It is a matter of consciousness and protecting against liabilities. One company in the industry sets a bar and others are pressured to follow suit.

The companies take a financial risk in investing in and adopting new environmental quality measures. But once certain practices are considered a part of the standard business practice, or adopted into the norms, a company runs the risk of needing to play catch-up if they did not invest initially. Respondents discussed the dichotomy of attempting to stay ahead of international norms and staying financially responsible.

One example was discussed in terms of possible future trends in environmental quality standards is emissions. Without economic disincentives and industry norms, there is not a strong incentive to invest in emissions reductions.

Respondents discussed that sustainability gives you an economic edge, but it is hard to measure that advantage per unit of input, and thus new environmental spending is sometimes hard to adopt, but several respondents explained it has become increasingly clear that environmental responsibility is tied to the future of the company.

8) *Integrated Management*

The concept of Integrated Management was adopted to consider all stakeholders, in the broader sense of the term, including those economically invested in the company, but also those who are impacted negatively or positively as externalities of the company doing business. It was discussed that the application of Integrated Management policies is a compilation of most of the other interests discussed here, which is meant to guide companies in terms of all aspects of the business.

Below are other relevant considerations discussed by respondents that were not mentioned as one of the main reasons for investing in environmental quality, but are other relevant considerations discussed in follow-up questions:

- 1) *Being in the Amazon region, there is even more scrutiny and oversight because of the international significance of the ecosystem.*
- 2) *Everyone was persistent in that fact that their respective company was founded with strong environmental consciousness; but everyone also acknowledged that their company's environmental awareness has greatly evolved over time, with large improvements in environmental quality or environmental consciousness.*

This protectionism of respondents' respective company history was expected. Nonetheless, it was clear that there have been major changes in these institutions' environmental consciousness. When this point was explored, most frequently the respondent would lead to the fact that the public, international conception of environmental protection has changed, and these companies have been responding accordingly.

For example, in 2008, Alcoa created the position of COS, Chief Officer of Sustainability. Alcoa is setting an unprecedented bar Juruti through its compensation to communities. In 2012 Alunorte is hoping to launch a pilot program to reuse the red-mud, bauxite residue as the base for ceramics.

- 3) *Events in which the companies appeared in the news because of environmental harm or related social demonstration were discussed as reasons and as major turning points for various companies.*

Although detailing these specific events would reveal company affiliations, there were instances in which one event shaped future corporate policy in a dramatic way.

- 4) *With the current global economic downturn and the steep drop in the price of aluminum, all of these companies are feeling high economic pressure.*
- 5) *A few respondents discussed future improvements in environmental quality, including reducing GHG emissions and preserving biodiversity.*

Finding an Indicator for Consumer Awareness

Most studies that attempt to track consumer awareness do so through surveys and other polling (Kimenju, 2005; Eckel, 2009). Because of the historical perspective of this research, polling was not a viable method; so another method that integrates historical consumer awareness was necessary to developed.

In order to find what an indicator for consumer awareness would be for environmental issues relating to the aluminum industry, first a constructing a conceptual map of how these complex, conceptual factors interact with each other. In what possible avenues could consumers' attitudes be shifted into corporate policy? On the other end of that question, what factors contribute to consumer understanding and concern about far-removed, complex factors?

Below is the conceptual map that was drawn that led to the concept of using media as a filter of the information and factors that contribute to environmental awareness. This is a crude simplification of complex, inter-exchanging relationships.

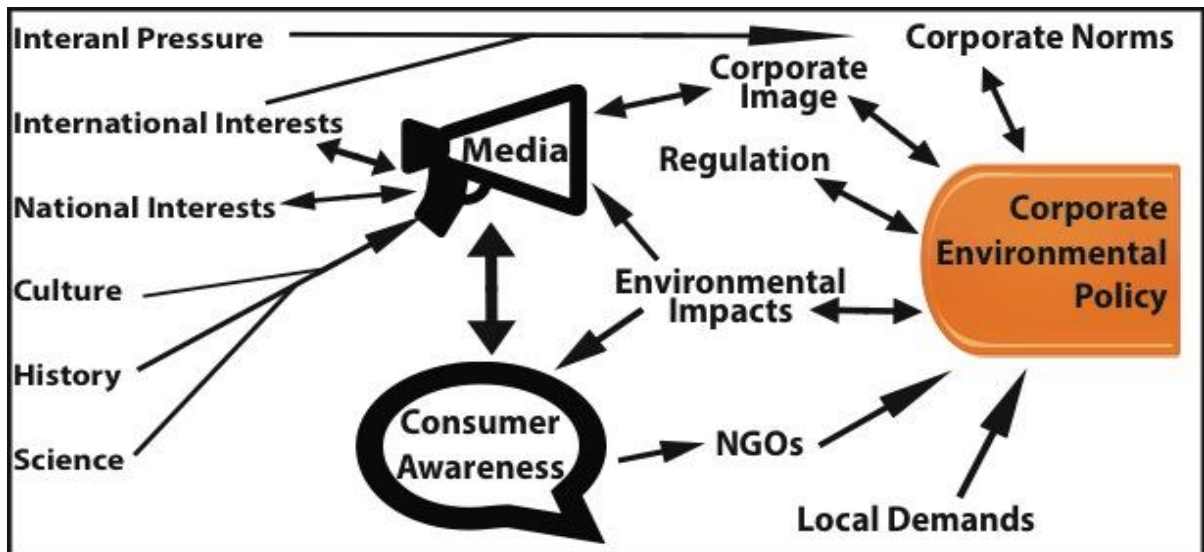


Table 5. Relationship Between Consumer Awareness and Corporate Environmental Policy, Media as a Filter

Especially in regards to things that consumers do not directly see, media outlets can act as a filter for events and corporate motives. But not only that, media can provide for the space to display and construct the complex reactions that consumers have to these multi-faceted situations. After this idea was brought out of the above visual depiction, it called for a thorough investigation of any literature about media and the relationship between media and environmental consciousness.

Media as an Indicator of Consumer Awareness in Research

“Mass media content is a socially created product, not a reflection of an objective reality” – Shoemaker, 1998

“If one is interested in public opinion, then media discourse dominates the larger issue culture, both reflecting it and contributing to its creation.”-Gamson, 1989

Is media a driver of public opinion, with a one-way flow direction of information, or is media also shaped by public opinion? There is a substantial amount of research on how media affects public opinion, but there is also a large body of work that considers the intricate interaction between the two. Many of these studies have asked questions about the complex systems of framing and agenda setting.

Gamson and Modigliani, in their study on the relationship between media discourse and public opinion, have called the different media channels as “forums for public discourse” (Gamson, 1989). They described the relationship as an interaction of dialogues:

“Each system interacts with the other: media discourse is part of the process by which individuals construct meaning, and public opinion is part of the process by which journalists and other cultural entrepreneurs develop and crystalize meaning in public discourse.” (Gamson, 1989)

Shoemaker and Reese also involve public opinion and public discourse as a key in their model of what influences media, under what they call extra-media influences. This involves several theoretical frameworks, including a market approach, which postulates that media networks wish to deliver the information that audiences want, in order to ensure audience retention (Shoemaker, 1996). This is an echo of other scholars, including Gamson and Modigliani who

explained that the more specific audience a media source has developed, the more they will “reflect the interests of that audience” (Gamson, 1989).

In terms of environmental awareness, the media have an important role to play in the shaping of our collective consciousness. Because we rarely experience environmental harms because of the diffuse and long-term nature of many environmental problems, the media plays an important role in framing and presenting environmental harms in the context of society (Arlt, 2011). Many environmental issues involve risk and risk perception; in other words, humans equate certain levels of risk to environmental problems (Cox, 2010; Hulme, 2009). Especially in terms of the environmental impacts of aluminum production, the general public does not have a daily interaction with it. Media sources are generally have more of an influence on the issues such as these that the public does not form strong opinions through their own experiences (McCombs, 2005).

There is research to support the idea that media can alter public perception and awareness of risk issues. For example, there was a study done in 2010 involving a media campaign surrounding smoking bans, in which they found that change in support for smoking bans mirrored the level of support that the media gave overall, while increasing awareness of the risk factors (Nagelhout, 2012). On the other hand, issues like the environmental impacts of aluminum production are probably not covered as widely as other more salient issues, such as elections or the economy. Nonetheless, media sources have the ability to increase salience of issues which can lead to public awareness (Downs, 1972).

Most research in media and environmental awareness does so around the topic of climate change. German researchers Dorothee Arlt, Imke Hoppe and Jens Wolling investigated a wide

range of studies on media's effect on climate change perception, which showed that media does have an effect on the level of awareness about climate change, but not necessarily action as a result of said awareness (Arlt, 2011). Below is the model that Arlt et al. configured based on their literature review in order to explain the interaction between climate awareness and media:

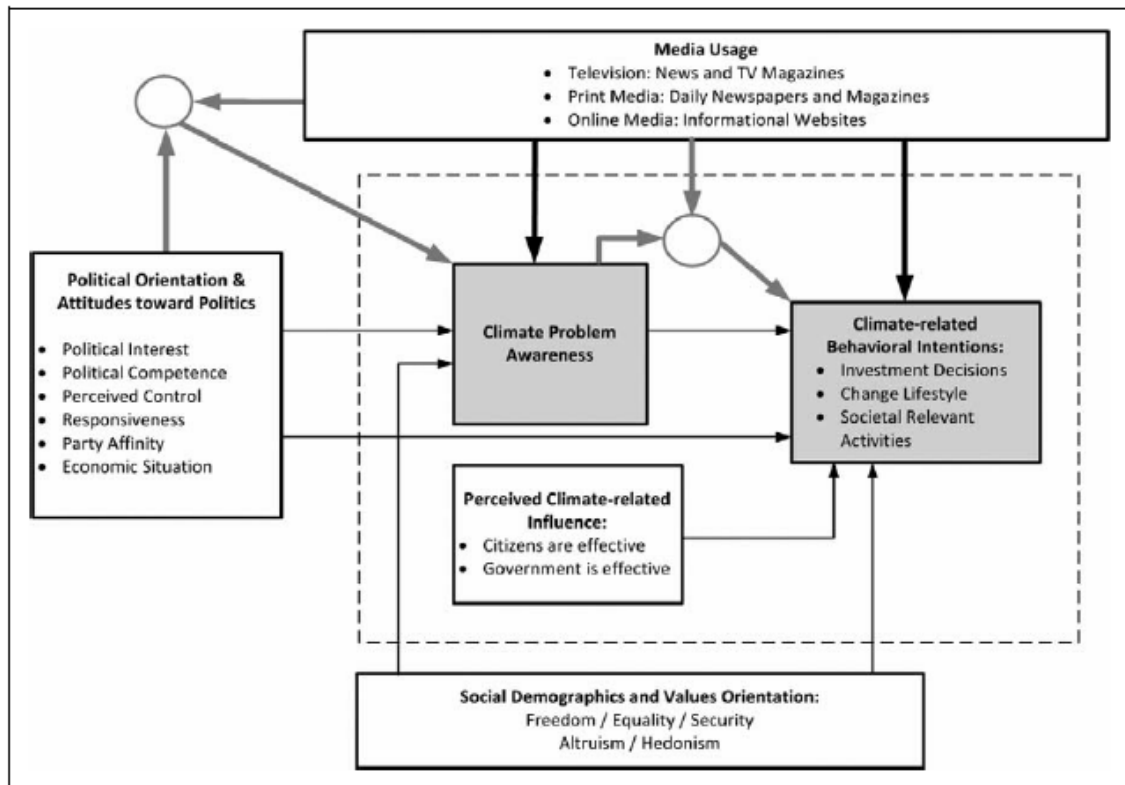


Figure 15. Media and Climate Change Model (Arlt, 2011)

Although there seems to be substantial research and evidence that media coverage affects the level of awareness on certain issues, this research aims to also ask if awareness actually effects media coverage. For example, Carvalho's research considered the UK's public perception of climate change through newspaper media outlets, and argued that the media filters perspectives of social actors and events, largely through their own ideological perspectives, to form public understanding and awareness. "The mass media play a central role in the social construction of risk" (Carvalho, 2005).

“The complex and “diffuse” nature of the problem [climate change] leaves scope for media sources to have a very influential role in shaping media agendas and discourses on this issue.” (Carvalho, 2005)

Many of the variables that make awareness of climate change difficult to measure hold true in terms of environmental issues relating to aluminum production. Most consumers have not seen a bauxite mine or a primary production plant; most consumers do not even buy products from the companies that do the producing. The media is probably the main outlet that consumers get their information, if they get any, from which their opinions form.

Potential Problems of Media as an Indicator of Consumer Awareness

It is clear that media coverage is by no means an entirely accurate depiction of the level of consciousness that consumers have. There are well documented and researched influences of what causes media to cover certain concepts and events. First of all, the well known bias towards covering events as opposed to overall problems is inherent in media and journalists routines. Along those lines, it is not just events in general that are more likely to be covered, but events that fit into journalist schedules and adhere to media timetables (Shoemaker, 1996). In the case of environmental impacts of the aluminum industry, unless there is a catastrophe or it somehow affects people directly, it is probably hard for journalists to justify covering the long-term environmental risks.

There are certain ingrained systems that have great influences on media coverage of environmental issues. There are many dimensions to the way journalist report on environmental issues that generally create biases against high frequency, low-impact environmental issues

(Boykoff, 2004), which this research will not consider. Robert Cox discusses the media bias away from what he labels as “unobtrusive” environmental threats, which he explained as ongoing long-term environmental threats that may not appear to have personal effects (Cox, 2010). Cox explained that there is a tendency to wait to cover these issues when they coincide with some event such as a scientific discovery or if they can be linked to people or charismatic fauna such as a polar bear. This also reinforced by Anthony Down’s theory of the issue-attention cycle, which describes the way the general public reacts to environmental issues and loses interest after some event or campaign brings increases awareness (Downs, 1972). Shoemaker also explains that, “events are more likely to be covered than issues. Journalists can more easily defend covering events than issues, which by definition are more ambiguous. Covering events is so common in journalism that covering events has itself become a routine” (Shoemaker, 1996).

There is also the effect from the influence of what Shoemaker labels as “extramedia” influences, which Zaller also contributed to in his discussion of the effects that elite dialogues have on media coverage (Shoemaker, 1996; Zaller, 1992). In this “extramedia” category lays the influences from advertisers; it has been shown that the advertisers can influence amount of coverage and framing a particular source uses (Shoemaker, 1996). The sources for information and the relationship they create with journalists also tend to have a large influence on coverage (McCombs, 2005).

Nonetheless, despite faults in the theory, media has been used time and again as an indicator for public opinion and consumer awareness (JingJing, 2004; Soroka, 2003). Although media is being used as an attempt to gauge consumer awareness on the environmental impacts of aluminum, it is clear that it is not a perfect reflection and the effects of this should be scrutinized.

Tracking Consumer Awareness over Time

The following section will discuss and display data about media coverage collected from Lexis Nexis and Factiva's databases. Below are the various graphs created in order to attempt to depict the general trends in media coverage, shown as a proxy for consumer awareness. The data represents 3980 stories between 1980 and 2010. The Lexis Nexis database for 'Major World News Publications' contains 158 newspapers from the regions outlined in chart 3 below. The largest change in media coverage happened between 2005 and 2008.

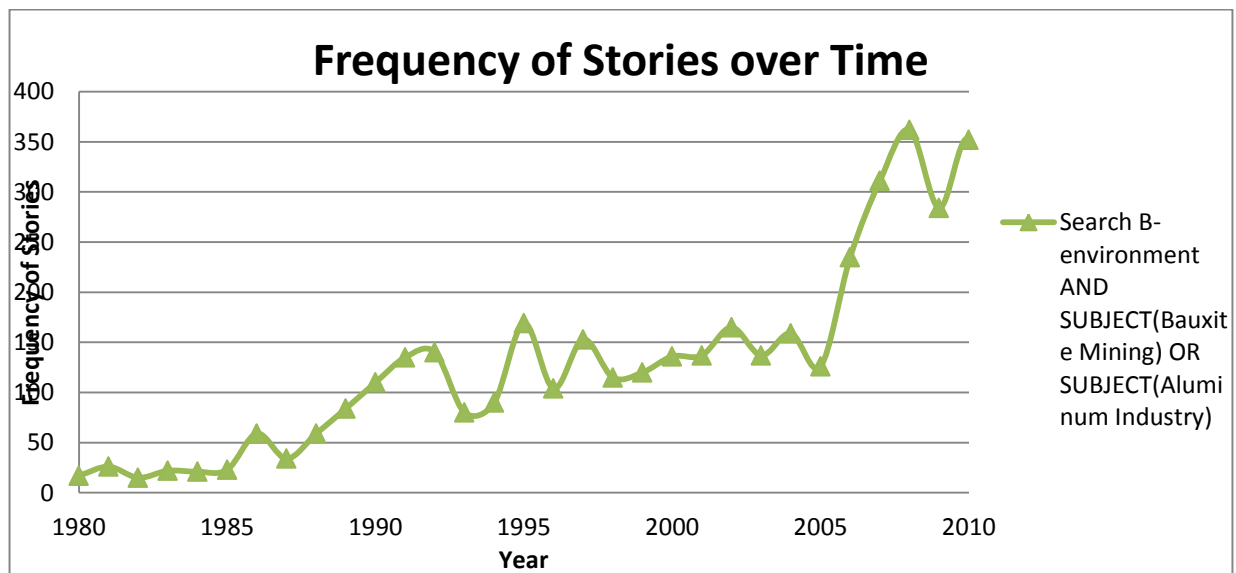


Chart 1. Frequency of Stories over Time

Chart 2, shown below is depiction of the volume of stories broken down into region. It is clear that there is a clear bias towards the media in Australian media. Along that vein, it is clear that this media coverage is dominated by Australia, Canada, the United Kingdom, and the U.S., which do represent high per capita consumers, but not necessarily the largest aluminum markets.

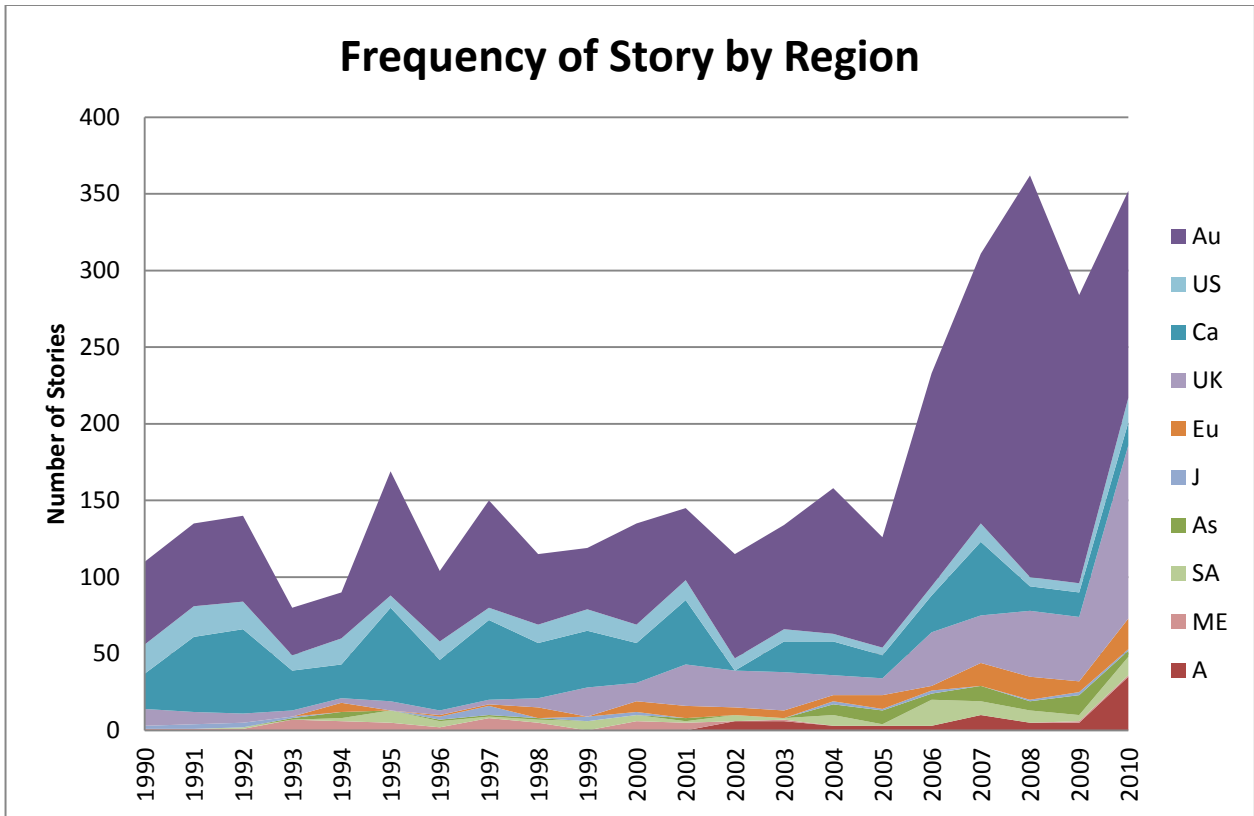


Chart 2. Frequency of Stories by Region

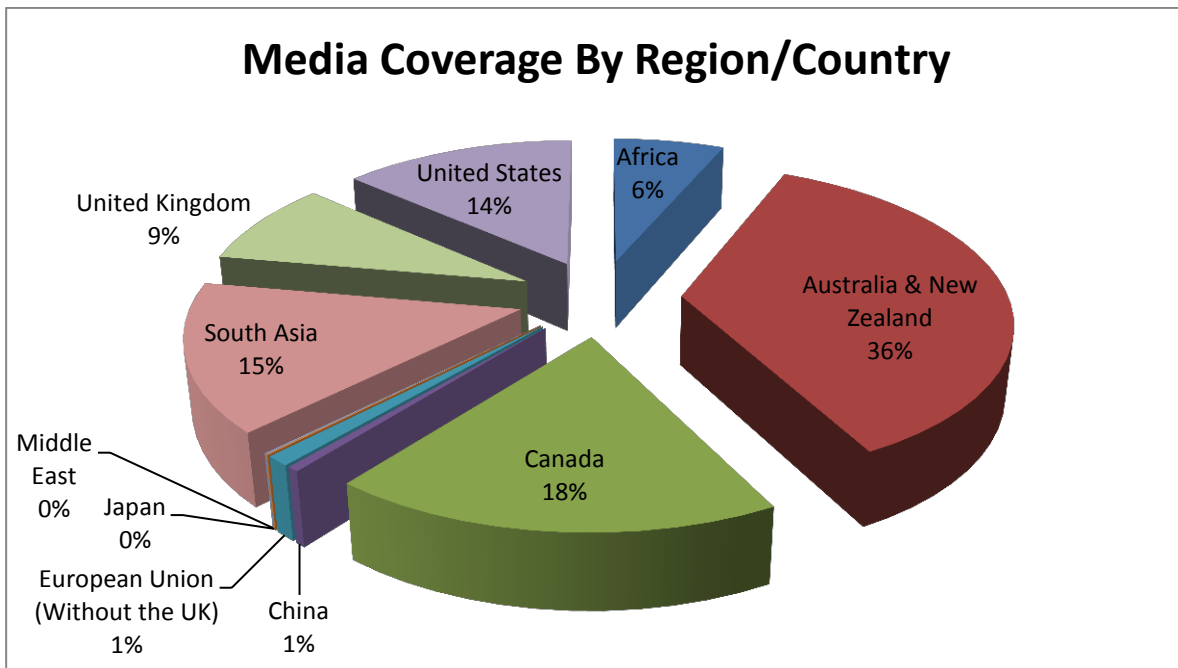


Chart 3. Media Coverage by Region

Below is the total number of newspapers in the database and then ratio of stories to the number of newspapers in the database for each year. This was done in order to ensure that the coverage was not simply increasing or decreasing over time because the available data was increasing or decreasing. This gives insight into the nature of this information. In the decade from 1990 to 2000 from the overall frequency data in figure 3 above seems to be relatively flat, whereas the ratio shows that there was actually a decrease in coverage. Nonetheless, the spikes in 1995 and 1997 are shown in each set.

Also, the trends between 2000 and 2010 are relatively consistent with each other because there was no significant increase in newspapers in the database over that time period. The notable exception is 2010, in which 30 newspapers were added into the database from Africa, which is what partially caused the uptick in coverage in 2010.

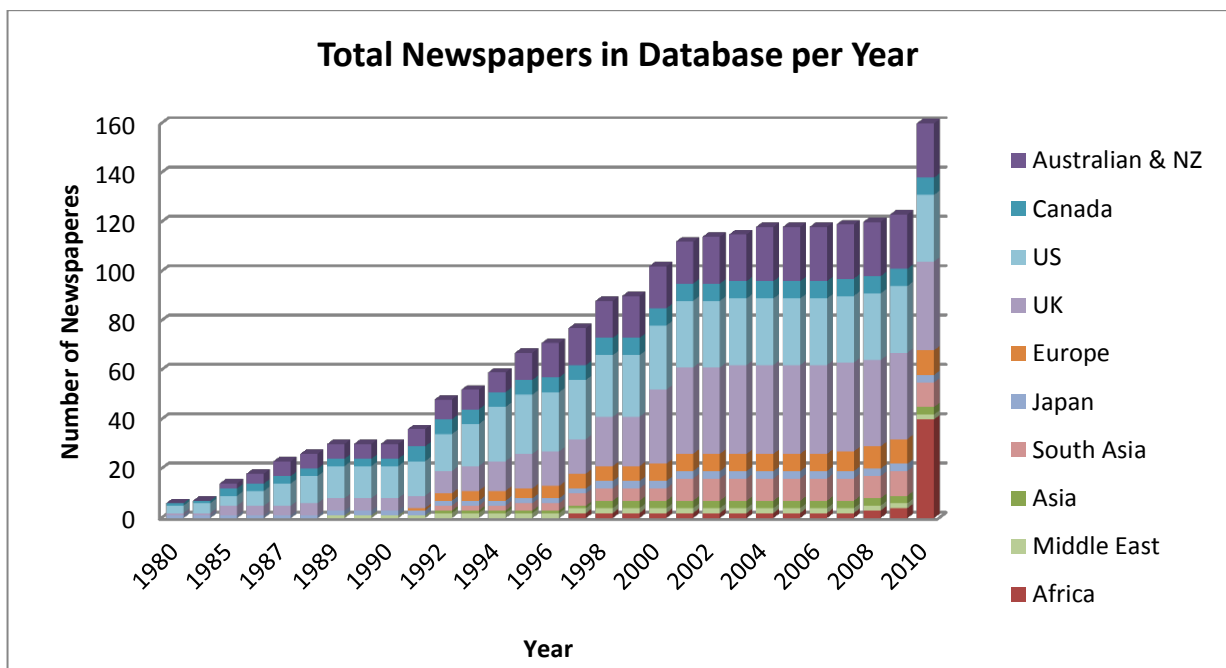


Chart 4. Total Newspapers in Database

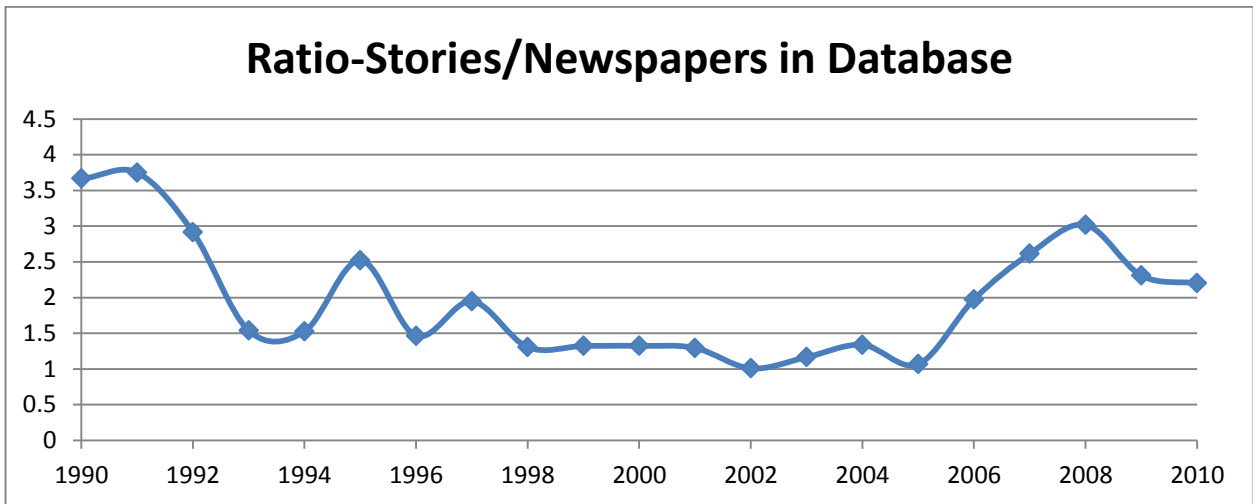


Chart 5. Ratios of Stories to Newspapers

The following ratio in Chart 6 was conducted in order to understand the saturation of stories within certain newspapers. The higher the ratio is, the less dispersed these stories are across a wide range of newspapers, and therefore it is more likely to be influenced by newspaper biases, such as advertising and source relationships as discussed above.

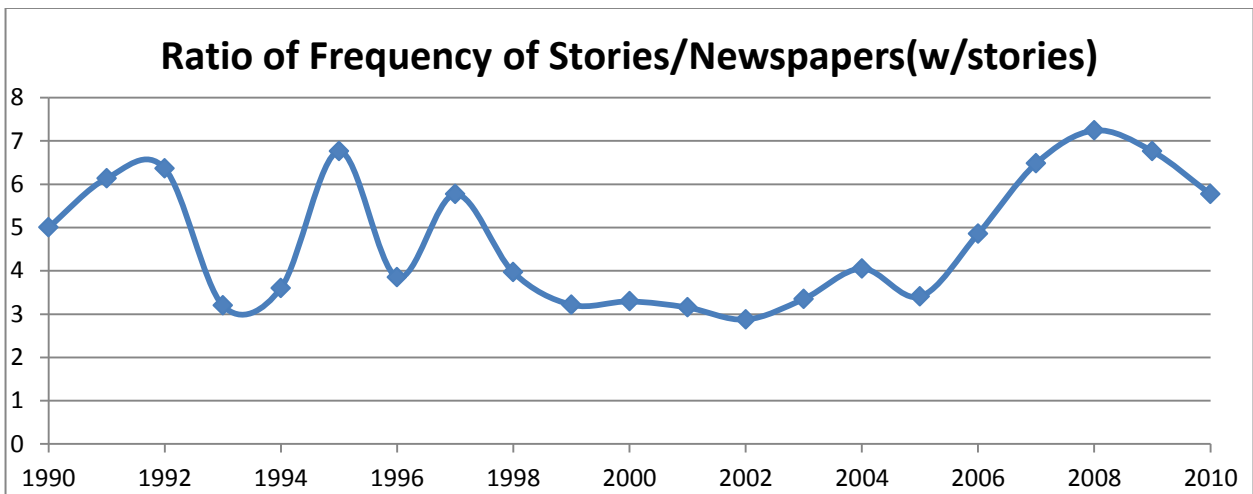


Chart 6. Ratio of Stories to Newspapers with Stories

Analysis of Newspaper Stories

Top Aluminum Consuming Countries

The first consideration to analyze the media coverage is to take into account the countries which consume the most amount of aluminum annually. Below are the consumption statistics for the top four consuming countries:

Table 6. Highest Aluminum Consuming Countries, Data from USGS, 2010

	US	China	Japan	Germany	World
Consumption (Thousand metric tons/year)*	9,173	8,648	3,393	2,619	40,000
% of Total	22.9325	21.62	8.4825	6.5475	100

The US, China, Japan and Germany combined account for nearly 60% of the world's consumption of aluminum. Because of the high concentration of consumers in a relatively small number of countries, this study analyzed media coverage in these countries in order to get a gauge of consumer awareness.

Representative Newspapers in Top Consuming Countries

As mentioned in the methods, for each country, newspaper(s) were chosen based on other scholarly work, which investigated newspaper content in a similar style. When available, with careful consideration, English versions were given preference. The only non-English newspaper used was Germany's *Süddeutsche Zeitung*, in which a simple translation was used.

Table 7. Representative Newspapers Chosen for High Consuming Countries

Country	Newspapers Chosen	Scholarly work	Comments
US	New York Times Washington Post	(Yang, 2003) (Haung, 2011)	
China	The China Daily	(JingJing, 2006) (Haung, 2011) (Han, 2010)	China Daily is English version of the People's Daily, but is "reliable and representative" (framing aids)
Germany	Süddeutsche Zeitung	(Kinnebrock, 2010)	German Version used (Search used: 'aluminium' and 'umwelt')
Japan	Yomiuri Shinbun	(Shineha, 2008)	English Version used

The results from this weighted media coverage are displayed in chart 7 below, but for the data on coding, see the appendix. This information was compared to the worldwide frequency in order to see how well the trends in the weighted coverage of the top aluminum consuming countries aligned, shown in Chart 8 and 9. The weighted media coverage is actually surprisingly similar to the world media coverage, with a similar rise between 2005 and 2008, although the weighted coverage peaks in 2007.

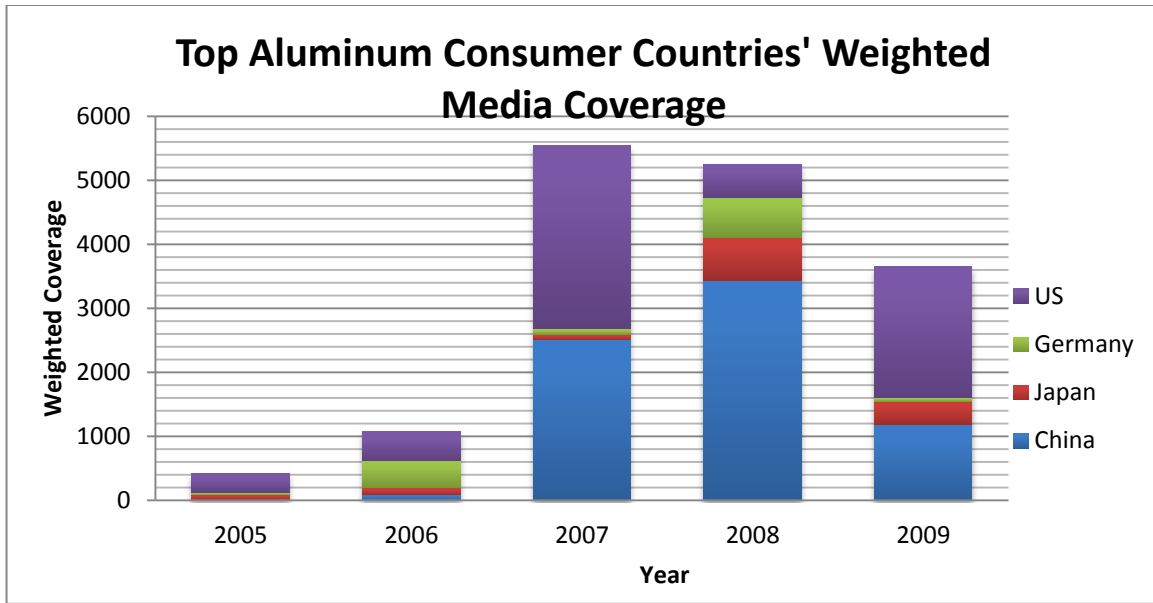


Chart 7. Weighted Media Coverage of Top Aluminum Consuming Countries

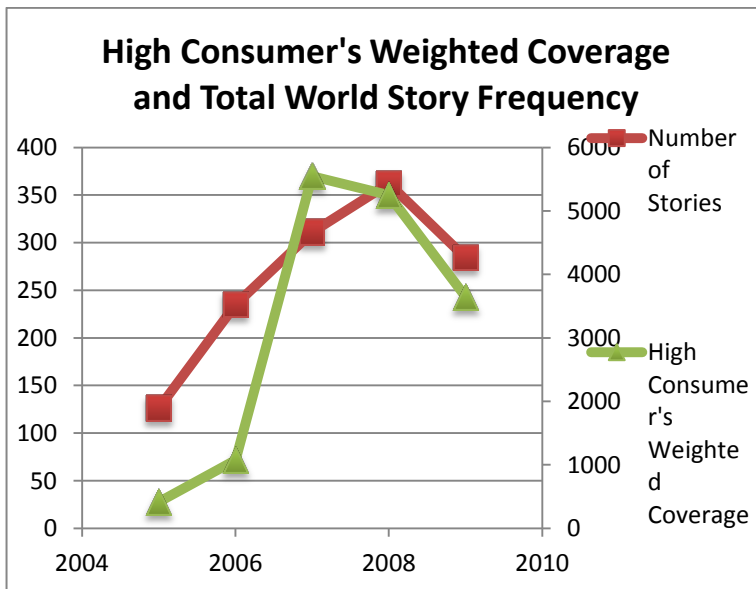


Chart 8. Top Consumer's Weighted Coverage and World Coverage

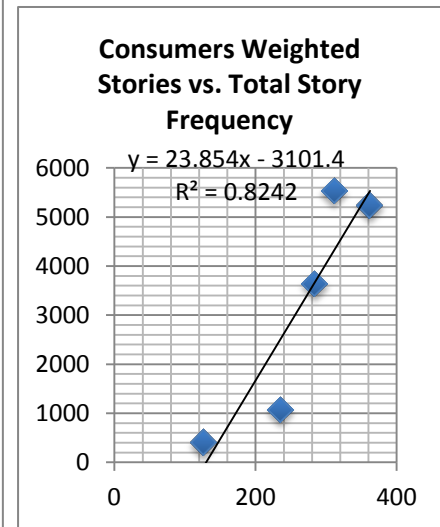


Chart 9. Regression- Top Consumer's Weighted Average and World Coverage

The relationship between the top consuming countries' media coverage is relatively strong, with a coefficient of determination of .824. It can be assumed that the world news coverage is predictive enough of the top consumer's media coverage; therefore the data for the years beyond 2005-2009 can be used as a representation of the top consumers' media coverage.

Environmental Corporate Spending over Time

The following information was collected from the respective company's Annual Reports. Unfortunately, not all years of operation were available to the public, so below is the available information. The sporadic reporting of information, the unavailability of information for companies, or the inability to de-couple practices in the Amazon region from the larger parent company resulted in a narrowing of the research scope for this element. Below is the information found for all years and companies that were available. For more details, all data collected is shown in the Appendix. Notice the overall increase in spending over time, but also the similar spike in spending between 2005 and 2008, which nearly every company displays.

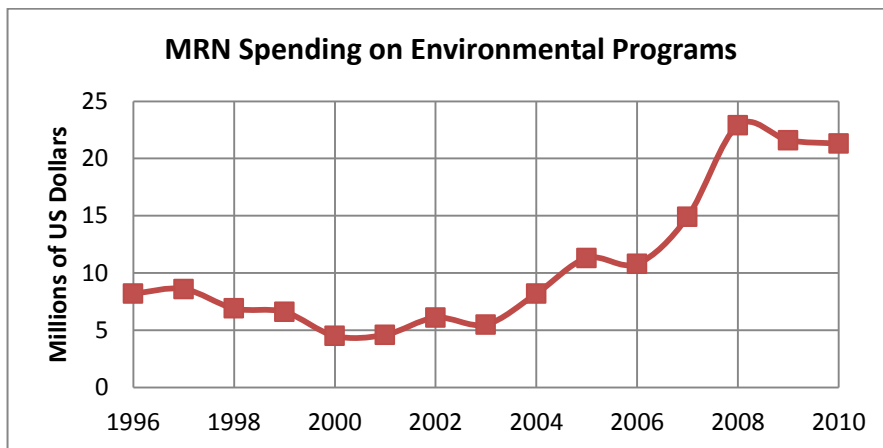


Chart 10. MRN Spending

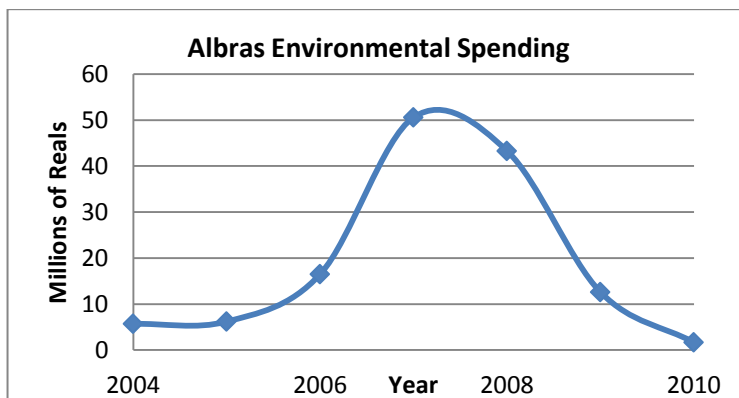


Chart 11. Albras Spending

Hydro has interesting reporting techniques, in that the amount of environmental spending is not reported, but on the other hand, they actually report their annual amount of CO_{2eq} per year. Keeping with their metric, reported below in Chart 12 is eco-efficiency, or rather ratio of the operating revenue in NOK millions to the millions of tones of CO_{2eq} per year. Hydro also reports their CO_{2eq}, which is shown in Chart 13.

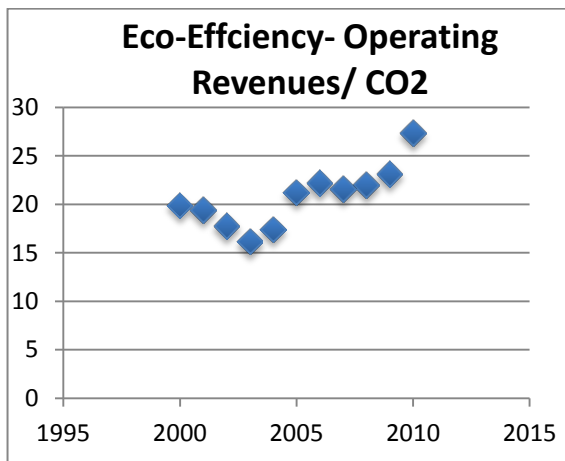


Chart 12. Hydro Eco-Efficiency

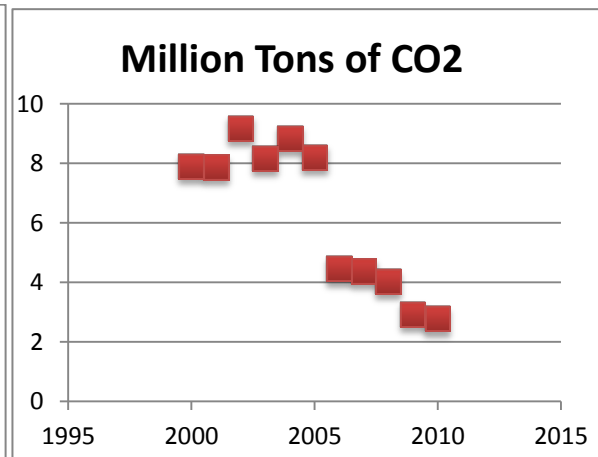


Chart 13. Hydro CO2 Emissions

Alcoa had the most detailed description of environmental spending. Alcoa's annual reports broke down their spending into remediation and investment. This was helpful in some sense because this research is more interested in what investment in environmental quality these companies make in order to reduce environmental impacts and subsequently reduce the need for remediation. Nonetheless, Chart 14 shows the spending from remediation, investment, and total spending, whereas Chart 15 shows only the investments.

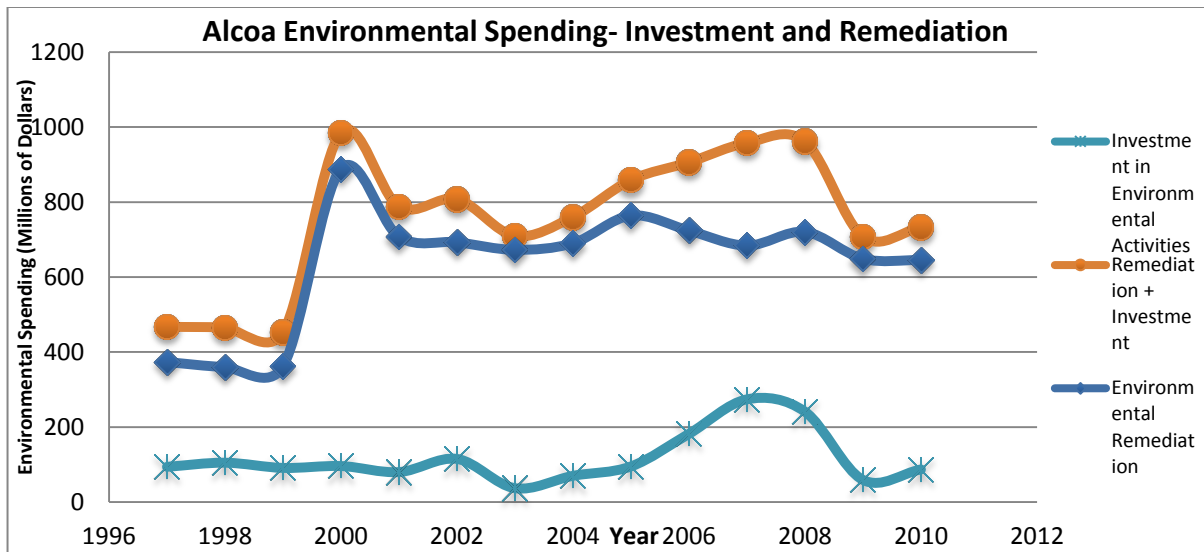


Chart 14. Alcoa Spending

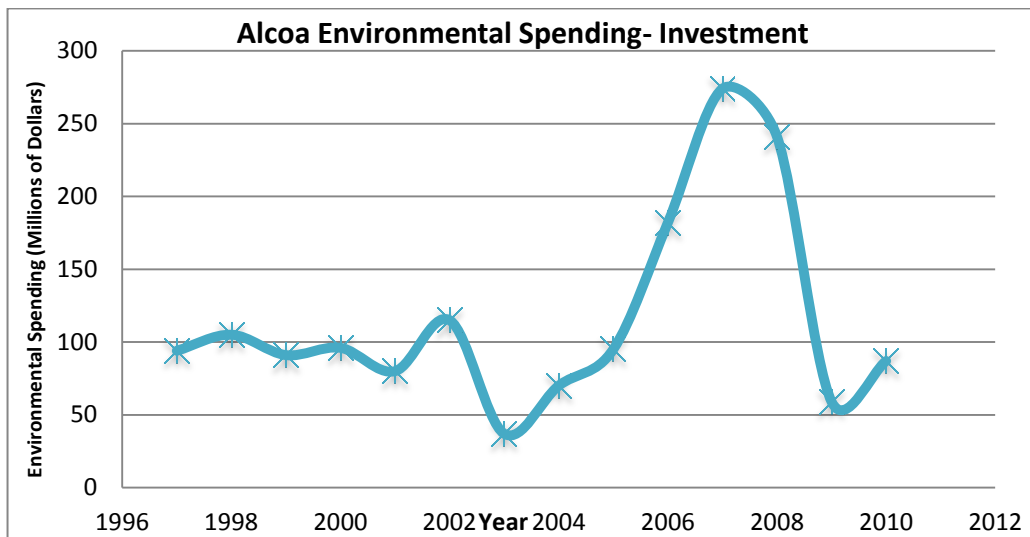


Chart 15. Alcoa Investment

Relating Environmental Awareness to Corporate Environmental Spending

The following is the graphical representation of the relationship between environmental spending and media coverage for each aluminum industry members. As discussed in the methods, these graphs are for visualizing general trends in spending and media coverage. The companies spending is representative to the value they place on environmental quality, while the media coverage is representative, although not perfectly, of the level of consumer awareness. Below, one can see that some trends are closer than others.

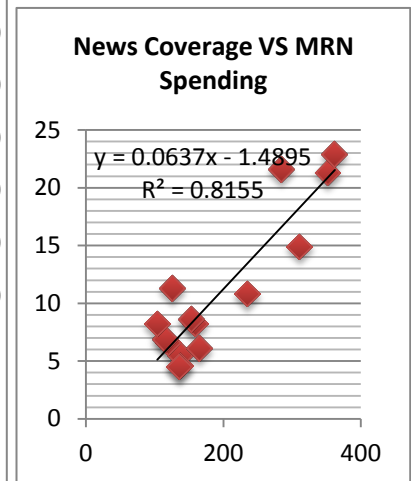
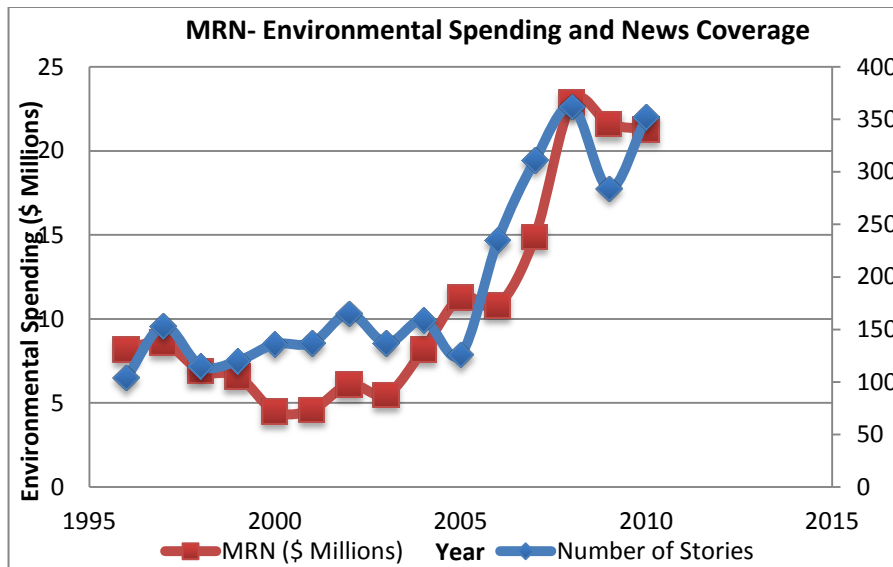


Chart 16. MRN Spending & Media Coverage

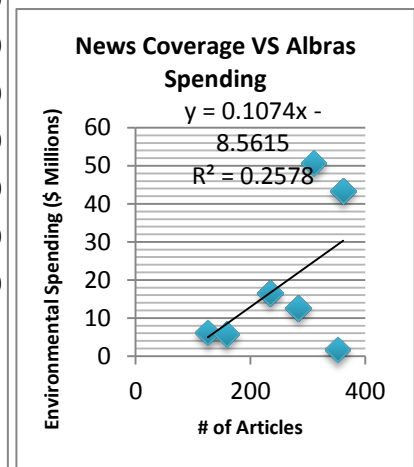
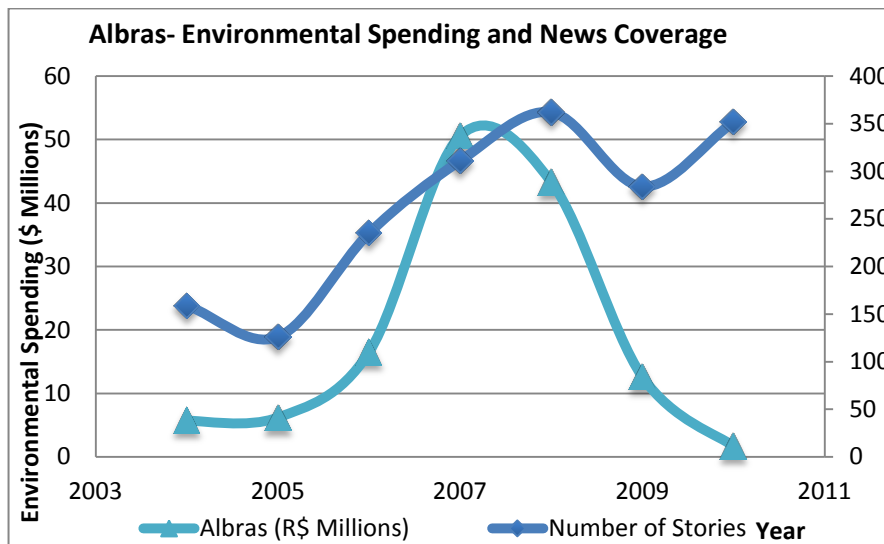


Chart 17. Albras Spending & Media Coverage

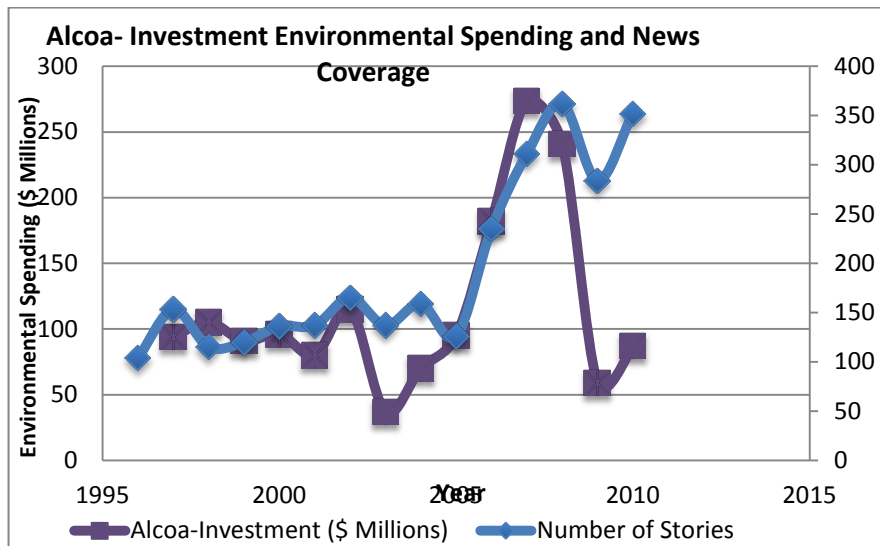


Chart 18. Alcoa Investment & Media Coverage

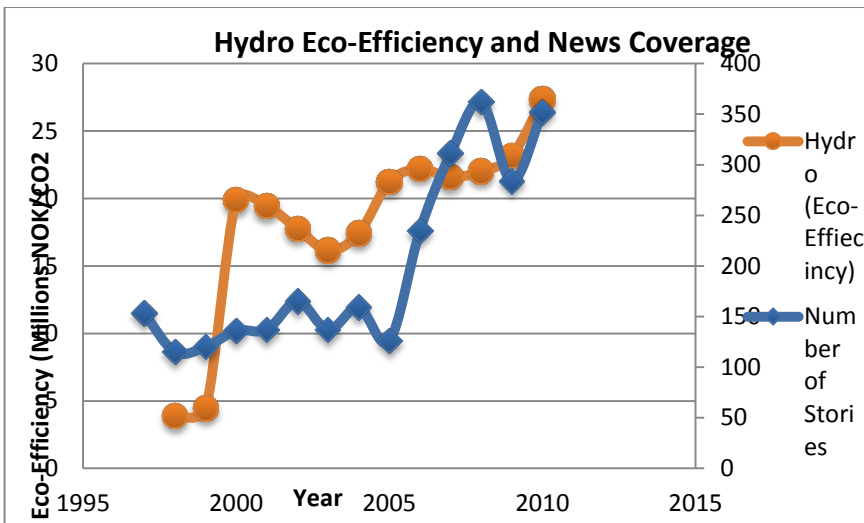
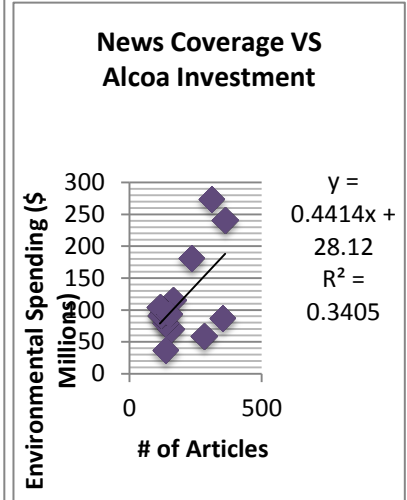
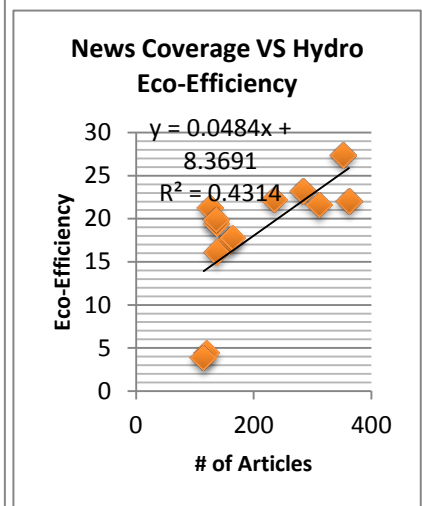


Chart 19. Hydro Eco-Efficiency & Media Coverage



The average r^2 value, or coefficient of determination, for these data is .461, which is a relatively high value considering the multitude of inputs and pressures on corporate spending. MRN seems to have the strongest relationship, with an r^2 value of .81, whereas Albras shows the weakest relationship, with an r^2 value of .25.

Another thing to note is the y-intercept value for the equations for the line of best fit for each regression line. While the data for MRN and Albras have a negative value for the y-intercept,

Alcoa and Hydro have a positive value. This is noteworthy because, as mentioned in the methods, if increased media coverage led to increased corporate spending, we would expect to see a negative number for this value.

The following are the graphs displaying the weighted coverage and environmental spending. As stated above, these graphs are all comparing the same weighted coverage for the same years, and unlike the data displayed above, the coverage is supposed to be more representative of the end-consumers.

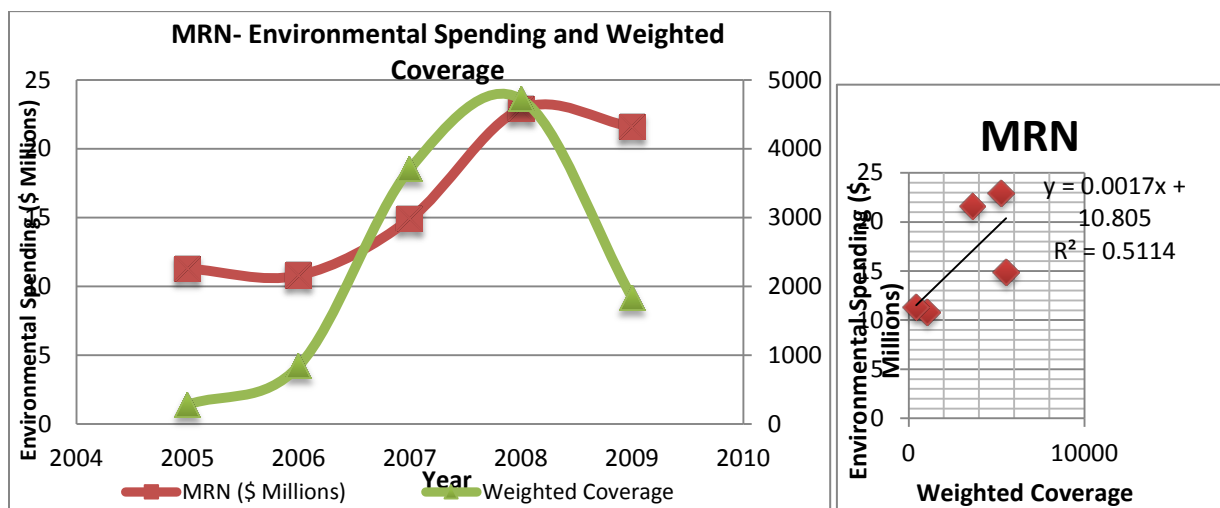


Chart 20. MRN Spending & Weighted Coverage

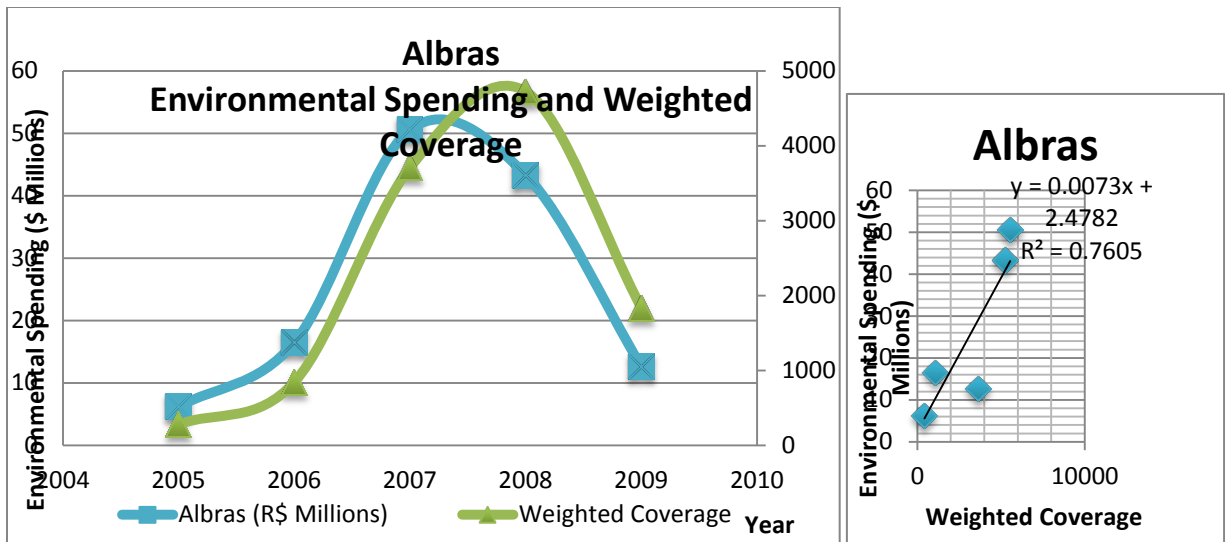


Chart 21. Albras Spending & Weighted Coverage

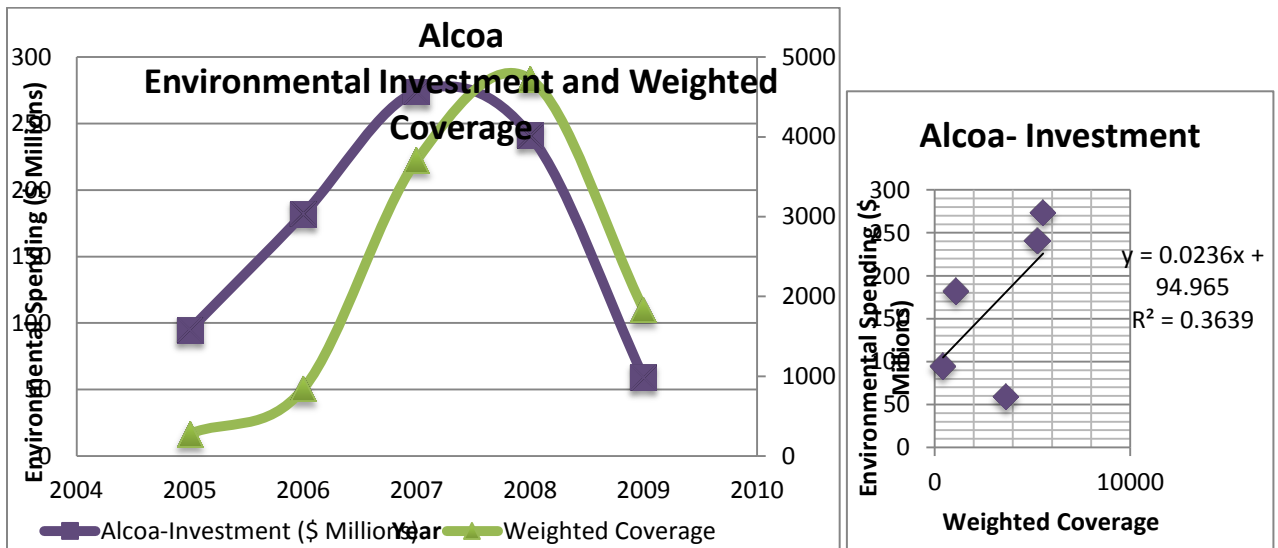


Chart 22. Alcoa Investment & Weighted Coverage

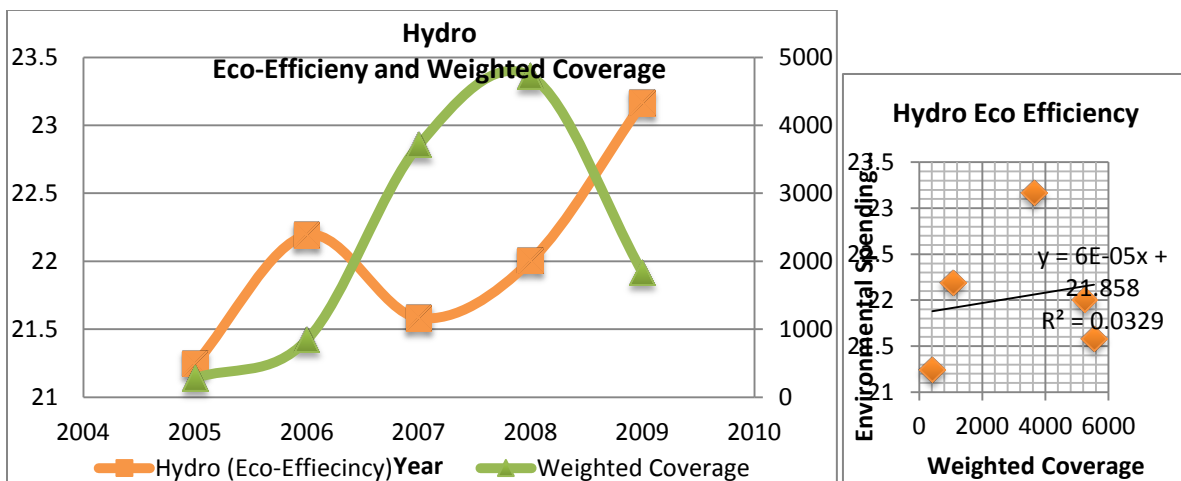


Chart 23. Hydro Eco-Efficiency & Weighted Coverage

As you can see, some relationships seem stronger than others. The average r^2 value was .415, which is slightly lower than the relationship with the world media coverage. Notably, Hydro seems to have a very weak relationship, with an r^2 value of .03, which is incredibly low. Interestingly, below also displays the relationship to Hydro's CO₂ emissions and weighted media coverage, which shows a significantly stronger relationship, with an r^2 value of .416. As mentioned above, it is important to note the y-intercepts, which are all positive in with the weighted coverage.

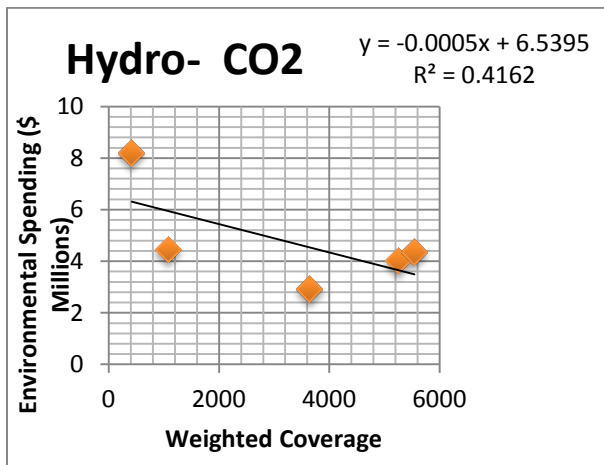


Chart 24. Hydro CO₂ emissions & Weighted Coverage

Discussion

Through this investigation into the role of consumers into corporate policy, it seems to be clear that there is some effect from consumer awareness on corporate environmental policy. While the layers of the supply chain may seem impenetrable for consumers, the internal perspective from the environmental managers of these companies did explain that they need to be somewhat in tune with what the public is thinking. On the other hand, the data that compared media coverage to corporate spending indicated that changes in corporate spending lead the changes in media coverage, which could indicate that changes in corporate spending causes changes in media coverage and not the other way around.

Internal Perspective on Corporate Environmental Policy

As described above, the employee perspective illustrates a multi-faceted system of considerations for corporate environmental policy. The point that everyone agreed upon was that commitment to environmental quality has increased over time and some did directly relate that to consumer awareness increasing over time. One tread that ran through the respondent's reasoning was the need to invest in environmental quality in order to have clients and be competitive, which are factors that keep these corporations in business, making profit. Because environmental management and sustainability is a part of international norms, which translates into consumer awareness, the international forces create the demand for environmental quality. Not only was environmental quality perceived as a good public relations standpoint, but really at the core of their ability to operate profitably.

Through the interview responses, it was clear that they considered the competition more in terms of which company can achieve more environmental quality, with positive feedback

loops of influences. When a new technology is adopted by a company and accepted as an international norm, other companies are nearly obligated to follow suit. Of course there are environmental quality factors that are currently not considered, which could be the future of environmental quality for the aluminum industry, such as GHG emissions reduction and finding re-use markets for some of the by-products of the industrial process.

As expected, there were clear biases in terms of positive outlook and representation of each respective company; in this data, there is probably an over-inflation of the importance of environmental responsible action solely for the sake of morals and company standards. Because of the nature of the employees interviewed, being high-level environmental managers, there was also a clear bias of a positive perception on environmental management strategies.

Overall, the most important perspectives gleaned from the internal perspective in terms of understanding the relationship between consumer awareness and corporate policy was that the demands of the consumer are passed through the levels of the supply chain, all the way back to the bauxite mines. To add to that, awareness and demand for environmentally friendly products has been increasing and these companies are being innovative in their responses to that demand.

Media Coverage and Consumer Awareness

The first objective of this leg of the research was to find out if consumer awareness on the environmental issues in the aluminum industry had changed over time, and in order to do this an indicator of consumer awareness needed to be found. In terms of using media as an indicator of consumer awareness of the environmental impacts of the aluminum industry, it seems that there are clear benefits and downsides. Media is a main source of communication

through which the public gets information on subjects that they are not directly affected by and is a filter of elite and prevalent perspectives. On the other hand, the media structure highly biases events to on-going environmental issues and media can be significantly influenced by advertising and corporate influences that does not necessarily reflect public opinion. Media is not an accurate representation of consumer awareness, but was merely used in order to track possible trends in consumer awareness.

Nonetheless, to answer the specific research question, overall it does seem that media coverage did generally increase over time. There was a large spike in coverage between 2005 and 2008, which was followed by a slight decline. When this data was compared to the internal perspective from the industry members interviewed, the assumption that the overall awareness on environmental issues in the aluminum industry has increased over time is reinforced. Although there was an overall upward trend in media coverage, the level of coverage was still particularly low, with an average of 28.4 articles per year for the top consuming countries for the five year study period for all five of the representative newspapers. This is indicative of the low level of awareness of the environmental impacts of aluminum production.

The next specific research question was concerning the environmental spending in the aluminum industry. From the data available, it seems that spending on environmental management has increased overall, although there was a steep decline in from most of the companies sampled after the 2008 financial crisis. Because of the economic downturn and the subsequent crash of the price of aluminum, the commitment to environmental investments declined precipitously throughout these companies. While the general increase leading up to the financial crisis is encouraging in terms of reducing the environmental impacts of aluminum

production, the decline in some sense reveals the fragile nature of the industries commitment to environmental quality. This sentiment was echoed from several of the interviewees; they believed that although environmental programs are increasingly becoming standard business practices, they are still under scrutiny and at times are seen as a cost as opposed to an asset. The long term trends following the financial crisis are important to continue to monitor to see the full effects on the trends in the industry.

One of the major biases in regards to this information is the problem of available data. Information on environmental spending is not mandated and many companies in the aluminum industry simply do not report this type of information. The companies which have decent records to report on are most likely the ones which have reported and therefore are included in this study. Something to note is that out of the companies from which data was solicited, there were a few which were not included because they just recently started reporting environmental spending. Although in these instances they did not supply enough data to use for this study, this may be indicative of the wider movement for increased accountability and transparency from industry players and another indication that environmental impacts are increasing being considered as an important value.

The last of the specific research questions by far the most difficult to answer; the last question asked whether corporate environmental spending and the indicator for consumer awareness are related. Through methods employed, it seems that there is a relationship between the two variables that is rather strong, although the data showed that the trends in corporate spending generally lead the trends in media coverage, which cannot be used to conclude that increased media coverage affects corporate environmental spending.

First of all, the strength in the relationship between media coverage and corporate spending, which was shown by the coefficient of determination, was particularly strong given the complex influences on media coverage and corporations. The average r^2 value for spending and media coverage, weighted and overall, was .439, which is not a perfect correlation, but it does indicate some pattern. Considering the plethora of influences on corporate spending, the fact that these data came to show that 43% of the variation in environmental spending was explained by media coverage, this is a relatively high relationship.

It was expected that these values would not be perfectly correlated, because it was discussed above that there are many inputs into corporate decision making besides consumer demand, such as market conditions. Although the years 2005 to 2009 were chosen because of the large spike in media coverage shown in Chart 2, it may have been wise to avoid the 2008, 2009 years to avoid the factor of the financial crisis which caused the crash in the price of aluminum. In fact, when the data from 2009 was excluded, the r^2 value for the correlation between environmental spending and world coverage and weighted coverage rose to .68 and .72 respectively.

Also, Hydro's Eco-Efficiency data showed the least correlation, which was interesting. If the data from actual spending or investments were available, it would have been interesting to compare the data from their Eco-Efficiency to see if the spending is correlated. It may be that the efficiency numbers are delayed compared to the investment due to the time it takes to put into place emission reductions. On the other hand, it could be that while spending shows some correlation, there is little relationship between actual environmental impacts and consumer awareness. On the other hand, Hydro is an interesting case because of its long-

standing commitment to environmental quality. In the past, Hydro has set the standards for environmental management and responsibility; reducing environmental impacts has been integrated into their business structures.

Although the relationship overall is relatively strong, it seems that the trends in media coverage actually lagged the corporate spending, which is counter the assumptions made that would indicate that changes in consumer awareness result in changes in corporate policy. This was shown graphically and through the y-intercept of the linear regression. All but two of the y-intercepts were positive, indicating that the changes in corporate spending lead changes in media coverage.

This leads to several conclusions and new assumptions about this relationship. These results could be coming from an effect of the public relations of these companies wanting to share their environmental progress, instead of the companies responding to the increased awareness caused by or shown in media coverage. Because of this possibility, it would be interesting to conduct a framing study of the media coverage to discover whether the increased coverage was focused on positive environmental aspects of the aluminum industry or if it was focused on negative environmental impacts. Another way to understanding what these results tell us is to dissect the companies covered in these articles in order to investigate these possible influences. If there were clear positive biases it would support the theory that the elite have a large influence into public opinion.

It is important to note that the two relationships that showed corporate spending coming before world media coverage were MRN and Albras, which are relatively small in comparison to Alcoa and Hydro. While the smaller operations indicated that changes in their environmental

spending was somewhat behind changes in media coverage, the larger companies showed that the increases and decreases in spending preceded increases and decreases in media coverage. This would support the concept that we see this relationship in media coverage and environmental spending because of media campaigns from the large industry players, which in this case are Alcoa and Hydro.

If media coverage is solicited from these large companies, it is useful to consider the motivations that were discussed through industry members as to what motivates environmental spending in order to extrapolate the motivations for soliciting media support for environmental programs. Reputation was discussed twice as a reason for environmental spending, which may be driven by clients or investors and stakeholders.

This relationship with media and spending does not support the theory that consumer awareness leads to corporate policy, but it does not necessarily reject that hypothesis either. While these data do not show us that media coverage may lead to increased environmental spending, it does indicate that environmental spending may lead to an increase in media coverage. Nonetheless, this insight into the direction of the relationship may shed more light onto the complex interactions between media sources and corporations.

Future Research Considerations

- a. Compare this data to other indicators for consumer environmental awareness.
- b. Compare environmental awareness with environmental performance, not environmental spending.
- c. Get perspective of other sectors within the companies, eg. Accounting, Operations, Human Resources.
- d. Conduct a framing study of the media coverage, in order to understand the influences from any media biases.
- e. Research regarding consumer perception of impact of their environmental awareness on corporate environmental policies.
- f. Research consumer choices and if and how values are reflected in consumption.

Conclusion

This research delved into the complex relationship between consumers and producers. While there are no particularly novel findings that emerged from this research, it did reaffirm the idea that consumers get what they demand from products; over time consumers have been demanding more environmentally conscious production, and these large-scale, international companies have been responding with their investment, rhetoric, and programs.

Above all, through this research, a greater understanding was gained of the progress that the aluminum industry has made and is making. There is significant investment and shifts in corporate norms that are improving environmental quality of aluminum products, although there is still great room for improvement.

The companies that operate in the aluminum industry are responding to the environmental demands of parties all along the supply chain, but are ultimately held accountable to be end-consumer. Although it may be passed along through different actors through the supply chain, the operations as far removed as the mines are pressured through a multitude of actors, including the consumers, to prioritize environmental quality.

Whether or not consumers as a collective will demand environmental quality is a different question entirely, but one that should be asked. While consumers do have other priorities, the more consumers do change purchasing patterns to reflect environmental values, it seems that industry will respond.

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Appendix

The sheets on the pages below are the coding data for the top consuming countries. Each line represents one article, which is broken down through the headline, lead paragraph, and body. For an Xcel file of this information, please contact Christina Gosnell at gosnellc@colorado.edu.

US Coding Data

					Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Headline	First Paragraph	Body	Weighted Total
Country	Date	Title	Newspaper	comments																																		
US		60		nyt												1			1								1			1					0	0	2	2
US		57	Why Spots Without Green Climate Change	nyt					1							1				1							1							1	0	2	7	
US		52	Climate Change: The Road to a Better Future	nyt												1											1							0	0	1	1	
US		35	Climate Change: The Road to a Better Future	nyt				1								1			1			1					3		5			1			1	3	9	20
US		29	Unsettling Drinking Packages	nyt	economic environment														1							1	3			3				0	1	7	9	
US		28	Climate Change: The Road to a Better Future	nyt																							4							0	0	0	0	
US		26	Climate Change: The Road to a Better Future	nyt													1					1						4		2	2		2		0	2	10	14
US		26	News Summary	nyt																								1				1			0	0	2	2
US		20	TODAY IN BUSINESS	nyt	just about alcoa																													0	0	0	0	
US		18	Climate Change: The Road to a Better Future	nyt												1					1						1			1			0	2	2	6		
US		17	Climate Change: The Road to a Better Future	nyt																							1							0	0	1	1	
US		14	Climate Change: The Road to a Better Future	nyt																							1							0	0	3	3	
US		12	Climate Change: The Road to a Better Future	nyt																							2			3				0	0	5	5	
US		12	Climate Change: The Road to a Better Future	nyt																							1			1				0	0	2	2	

Country	Date	Title	Newspaper	Comments	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Headline	First Paragraph	Body	Weighted Total		
US		59 For blm	Washington Post													1											1							1	0	2	7			
US		58 AES ta	Washington Post													1						1					1							1	0	2	7			
US		58 Windov	Washington Post																																1	0	2	7		
US		57 Beer vs	Washington Post														2	1	1									2							1	0	2	7		
US		55 When t	Washington Post													1	1		1			1						1							1	0	2	7		
US		54 For an	Washington Post													2	3		2		1	2	1					1						1	0	2	7			
US		53 Develo	Washington Post														1				1		1					1							1	0	2	7		
US		52 India R	Washington Post													1			1			1							0	0	1	1				0	0	1	1	
US		50 Scienti	Washington Post														1						1					1	3	9					1	3	9	20		
US		50 Can On	Washington Post														2		1		1								0	1	7				0	1	7	9		
US		47 Proble	Washington Post														1	1											0	0	0	0				0	0	0	0	
US		46 Death P	Washington Post														1				1								0	2	10				0	2	10	14		
US		43 Green	Washington Post														1												0	0	2				0	0	2	2		
US		39 The La	Washington Post														1				1	1							0	0	0	0				0	0	0	0	
US		38 A Glari	Washington Post														1					1							0	2	2				0	2	2	6		
US		37 Stimul	Washington Post													1			1										0	0	1	1				0	0	1	1	
US		36 Replen	Washington Post							1							1													0	0	3				0	0	3	3	
US		36 What I	Washington Post														1					1								0	0	5				0	0	5	5	
US		35 Slate: I	Washington Post														1												0	0	2				0	0	2	2		
US		35 An Incc	Washington Post														1		1											0	0	2				0	0	2	2	
US		34 Dig to F	Washington Post														1						1						0	0	0	0				0	0	0	0	
US		34 IN BRIE	Washington Post														1					1								0	0	0	0				0	0	0	0
US		33 Let's Ai	Washington Post														1					1								0	2	9			0	2	9	13		
US		30 Conser	Washington Post														1				1								2	2	6				2	2	6	20		
US		29 Icy Isla	Washington Post													1						1		1					0	2	0				0	2	0	4		
US		28 Homeo	Washington Post														1		1										1	1	11				1	1	11	18		
US		27 Trashy	Washington Post														1				1									0	0	6				0	0	6	6	
US		25 With T	Washington Post														1				1								1	0	2				1	0	2	7		
US		23 A Mine	Washington Post														1					1								0	0	1				0	0	1	1	
US		17 As Oil	Washington Post													1			1										1	0	2				1	0	2	7		
US		14 Don't T	Washington Post														1						1							0	0	2				0	0	2	2	
US		12 Nano	Washington Post														1					1								0	0	2				0	0	2	2	
US		7 Choos	Washington Post															1												0	0	2				0	0	2	2	
US		4 Curbsi	Washington Post							1							2				1	1	1							0	0	2				0	0	2		

Chinese Coding Data

[illegible]

[illegible]

Germany Coding Data

Country	Date	Title	Newspaper	comments	Headline										First Paragraph										Body										Headline	First Paragraph	Body	Weighted Total
					Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters				
Germany		60	suddeutsche Zeitung																											0	0	2	2					
Germany		55	suddeutsche Zeitung																											0	0	2	2					
Germany		55	suddeutsche Zeitung																											0	0	3	3					
Germany		51	suddeutsche Zeitung																											0	0	2	2					
Germany		47	suddeutsche Zeitung																											0	0	2	2					
Germany		47	suddeutsche Zeitung				1	1						1																2	1	4	16					
Germany		45	suddeutsche Zeitung				1	1																						2	0	2	12					
Germany		45	suddeutsche Zeitung							1						1														1	1	4	11					
Germany		45	suddeutsche Zeitung																											0	0	3	3					
Germany		45	suddeutsche Zeitung														1			1										0	3	0	6					
Germany		44	suddeutsche Zeitung																											0	0	2	2					
Germany		41	suddeutsche Zeitung																											0	0	3	3					
Germany		41	suddeutsche Zeitung														1				1									0	2	4	8					
Germany		40	suddeutsche Zeitung																											0	0	2	2					
Germany		39	suddeutsche Zeitung																											0	0	2	2					
Germany		39	suddeutsche Zeitung				1	1																						2	1	2	14					
Germany		39	suddeutsche Zeitung																											0	0	3	3					
Germany		37	suddeutsche Zeitung																											0	2	4	8					
Germany		37	suddeutsche Zeitung																											0	0	2	2					
Germany		34	suddeutsche Zeitung																											0	0	2	2					
Germany		29	suddeutsche Zeitung																											0	0	3	3					
Germany		27	suddeutsche Zeitung																											0	3	2	8					
Germany		23	suddeutsche Zeitung																											0	0	2	2					
Germany		23	suddeutsche Zeitung																											0	2	0	4					
Germany		22	suddeutsche Zeitung																											0	0	2	2					
Germany		21	suddeutsche Zeitung																											0	1	2	4					
Germany		19	Das geht doch auch Zeitung																											0	0	4	4					
Germany		19	Ökonomie gegen Ökoinseil Zeitung	**		1																								2	4	10	28					
Germany		18	Ökoinseil in der Deutschen Zeitung								1																			1	0	3	8					
Germany		15	Haar streicht Entscheidung Zeitung																											0	0	2	2					
Germany		15	Elektroschrott: Entscheidung Zeitung																											0	2	2	6					
Germany		15	Elefanten auf Welt Zeitung																											0	0	2	2					
Germany		14	Keine einheitliche Entscheidung Zeitung																											0	0	2	2					
Germany		11	Seit mehr als 30 Jahren Zeitung																											0	0	2	2					
Germany		1	Schädigung der Umwelt Zeitung																											0	0	2	2					

Japanese Coding Data

Country	Date	Title	Newspaper	comments	Headline										First Paragraph										Body										Headline	First Paragraph	Body	Weighted Total			
					Aluminum Production	Aluminum Products	Energy Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Energy Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters	Aluminum Production	Aluminum Products	Energy Efficiency	Energy Reduction	Reduction in Pollution/Byproducts	Recycling	Environmental Degradation	Pollution	Man-Made Disasters	Natural Disasters							
Japan		60	Yomiuri		1										1											1	3	1							1	1	5	12			
Japan		56	Yomiuri												1											1							3			2	3	4	20		
Japan		55	Yomiuri																														2	1		1	1	3	10		
Japan		42	Yomiuri							1																	1	2	3	5	2				1	4		1	0	13	18
Japan		41	Yomiuri																							1							1	4			0	1	6	8	
Japan		39	Yomiuri							2																	2	1		5	5		1	1			2	2	15	29	
Japan		37	Yomiuri				1																				3	3	5	8						1	0	19	24		
Japan		34	Yomiuri											1													2	2		1						0	1	5	7		
Japan		27	Yomiuri																													2	1			0	0	3	3		
Japan		18	Yomiuri	steel production																																0	0	0	0		
Japan		16	Yomiuri					1																			1		5						1	1	6	13			
Japan		14	Yomiuri	not about aluminum																																0	0	0	0		
Japan		14	Yomiuri	steel production																																0	0	0	0		
Japan		11	Yomiuri																								2		1							0	0	3	3		
Japan		10	Yomiuri	steel production																																0	0	0	0		
Japan		8	Yomiuri																								1				1					0	0	2	2		
Japan		4	Yomiuri																												1					0	0	2	2		
Japan		2	CHEMICALS											1													1	1							0	1	2	4			