



**Aluminum**

the  
Element  
of  
Sustainability

## Aluminum: The Element of Sustainability

One hundred and twenty-five years ago, Charles Martin Hall discovered a method to create aluminum by separating it from bauxite ore through electrolysis. Nearly 75 percent of the aluminum produced since then is still in use today—a testament to the material’s durability and recyclability. Aluminum has transformed modern society, helping people and the economy to operate more efficiently by enabling advancements in air, road, rail, and sea transport; food, beverage, and pharmaceutical packaging; construction; electronics; and electricity transmission.

No other metal can match aluminum’s sustainability advantage or its combination of useful physical properties, which include:

- **Strength:** Pure aluminum is soft enough to carve but, mixed with small amounts of other elements to form alloys, it can provide the strength of steel at only a third to half the weight.
- **Durability:** Aluminum is tough enough to withstand the rigors of space flight, the high temperatures required of cookware, and challenging climatic conditions such as those found in the Arctic or seaside (salty/damp) environments.
- **Flexibility:** Its physical properties allow aluminum and its alloys to be shaped easily by any of the primary industrial metalworking processes—forging, casting, rolling, or extrusion.
- **Impermeability:** Aluminum forms a superior barrier for food and beverage packaging by preventing air, water, light, and microorganisms from reaching the contents inside.
- **Downweighting:** Aluminum can be used to downweight vehicles, reducing fuel use and emissions; lighten structures’ “dead load”; and in packaging applications shrink the environmental footprint associated with shipping.
- **Corrosion Resistance:** The metal’s natural aluminum oxide coating provides highly effective protection against degradation from water, salt, air, and temperature variation.
- **Recyclability:** Once manufactured, aluminum can be recycled repeatedly, using only 5 percent of the energy, and generating only 5 percent of the emissions, associated with primary production.

## Aluminum Association Sustainability Initiative

Sustainable development has been defined as meeting the needs of the present without compromising the ability of future generations to meet *their* needs.

As issues relating to climate change and energy security have gained urgency over the past two decades, so too has the call for industry and business to formulate policies and products that promote sustainability.

In 2008, the Aluminum Association formally launched its Sustainability Initiative, to develop the framework with which to respond to the informational needs of its customers and product market segments. The initiative involves the assessment of aluminum’s performance throughout its life-cycle, with the goal of developing a complete understanding of the energy and environmental impacts associated with aluminum through its production, use, and recycling phases.

In the three years since, a number of technical studies have been launched, including an aluminum can life-cycle assessment (LCA), an aluminum material flow analysis, and an LCA of semi-fabricated aluminum and auto products.

- The Aluminum Beverage Can Life Cycle Assessment, completed in 2010, updated a similar study completed in 1993 and documented a reduction in overall carbon footprint of the aluminum can of 43%.
- A second ongoing LCA, of semi-fabricated aluminum and auto products, is examining life-cycle environmental footprints of semi-fabricated aluminum products, including flat-rolled, extruded, cast, and forged products.
- A material flow analysis is being undertaken to understand the industry's resource preservation performance in North America—with particular focus on documenting historical productions, current in-use stocks, and the overall losses of aluminum.

These efforts reflect the commitment of the Association and industry to the initiative and to the larger goals of sustainability—and will help guide the industry's future directions on sustainable development.

## Upstream Operations

**Resource Conservation:** Material industries such as aluminum require extraction of resources from the land, which can be of potential environmental concern. According to a multi-year International Aluminium Institute survey and assessment study on global bauxite mining, on average, approximately 162 square meters of land is required to produce 1,000 tons of bauxite. This translates to 0.8 square meters of land use per metric ton of primary aluminum produced. To offset land use and environmental disturbance, the industry rehabilitates the same square footage of finished mining sites, yielding a net rehabilitation approaching 100%.

**Energy Efficiency:** Electric power consumption is the most critical energy-related issue in primary aluminum production, accounting for about 80% of the total energy requirement. The industry has made significant technological progress over the past several decades to reduce electricity consumption in the smelting process. Today's electric power consumption per ton of aluminum is about half of what it was 50 years ago and 7% lower than it was 20 years ago.

About 70% of electricity consumed in smelting facilities comes from hydroelectric sources. Overall, in terms of secondary, or useful, energy, the share

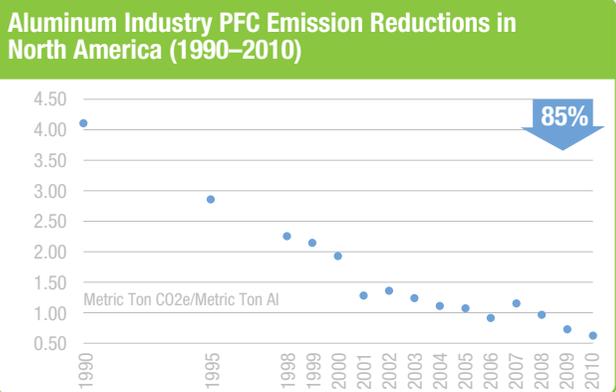
of renewable energy in the production of primary aluminum is greater than 50%—higher than any other common material in production, including glass, concrete, steel, plastics, magnesium, composites, and copper.

**Emissions:** Greenhouse gases emitted in the aluminum smelting

**Electric Power Consumption in Primary Aluminum Smelting Has Decreased 7% in North America Since 1990**



process include carbon dioxide (CO<sub>2</sub>) and perfluorocarbons (PFCs). Over the last 20 years, North American primary producers, through a voluntary program in cooperation with the Environmental Protection Agency, have reduced PFC emissions by 85%.



## Energy Efficiency and Environmental Improvements

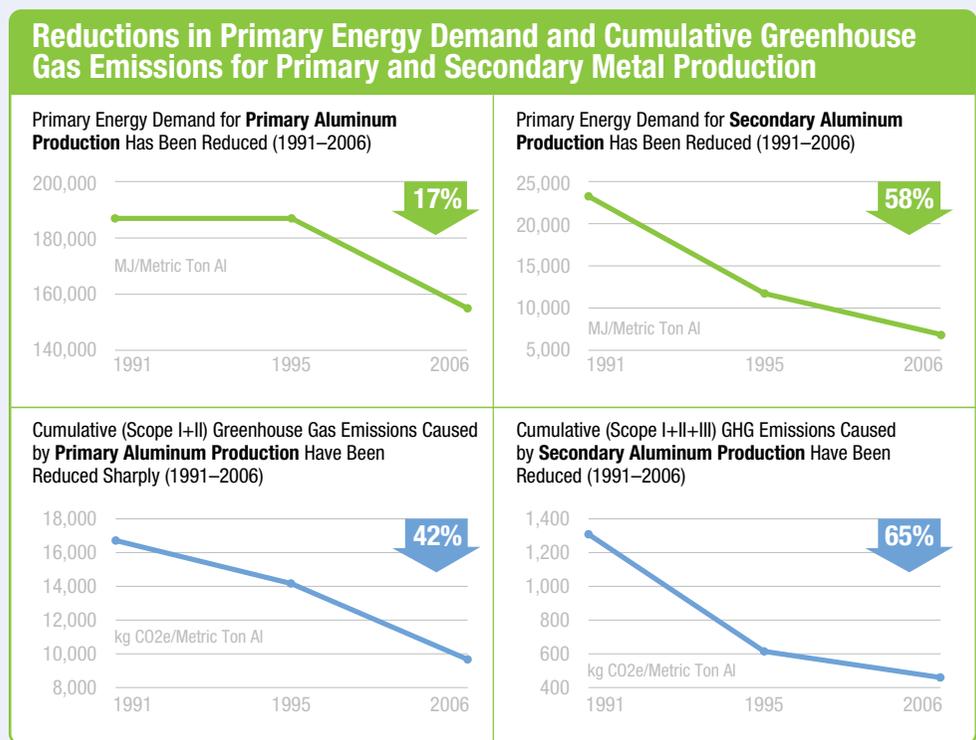
The North American aluminum industry has made consistent improvement in the production process over the past two decades as measured by primary energy demand and greenhouse gas emissions per ton of aluminum produced.

### Primary Metal:

- Primary energy demand—17% reduction
- Cumulative greenhouse gas emissions—42% reduction

### Secondary Metal:

- Primary energy demand—58% reduction
- Cumulative greenhouse gas emissions—65% reduction



## Sustainable Solutions for Society

Aluminum's use in the product phase of its life-cycle helps to greatly "neutralize" the environmental impacts associated with the industry's production activities—particularly with respect to its application in the transportation sector.

Specifically, aluminum's use in road vehicles in 2009 offset:

- 87% of the energy consumption associated with all aluminum production;
- 92% of cumulative greenhouse gas emissions associated with all aluminum production.

### Energy Neutralization in 2009 through Use of Aluminum for Road Transportation Downweighting (millions of barrels of crude oil equivalent)

Total Energy Savings from Use of Aluminum for Road Transportation Downweighting



Total Energy Demand for All Aluminum Production

-108

121

0

### GHG Emission Neutralization in 2009 through Use of Aluminum for Road Transportation Downweighting (millions of metric tons of CO<sub>2</sub>e)

Total GHG Avoidance from Use of Aluminum for Road Transportation Downweighting



Total GHG Emission for All Aluminum Production

-44

46

0

A vehicle light-weighting study, jointly sponsored by the Aluminum Association, IAI, and the European Aluminium Association, found that, on average, each kilogram of aluminum used in substitution of mild and high-strength steel and cast iron in passenger cars and light trucks saves up to the equivalent of 6.9 gallons of crude oil throughout the lifetime of that vehicle. In the case of commercial vehicles such as buses, medium and heavy trucks, and truck trailers, the lifetime energy savings is up to the equivalent of 7.2 gallons of crude oil. The lifetime greenhouse gas emission avoidance resulting from the substitution of aluminum for steel averages approximately 22 kg CO<sub>2</sub> equivalent across all vehicles.

It is estimated that the total aluminum use in the current vehicle fleet in the United States and Canada amounts to 32 million metric tons. Compared with a fleet of steel vehicles, this aluminum use enables an annual net saving of approximately 108 million barrels of crude oil equivalent of energy and an avoidance of 44 million tons of CO<sub>2</sub> equivalent in greenhouse gas emissions.

## Making Aluminum Last Forever

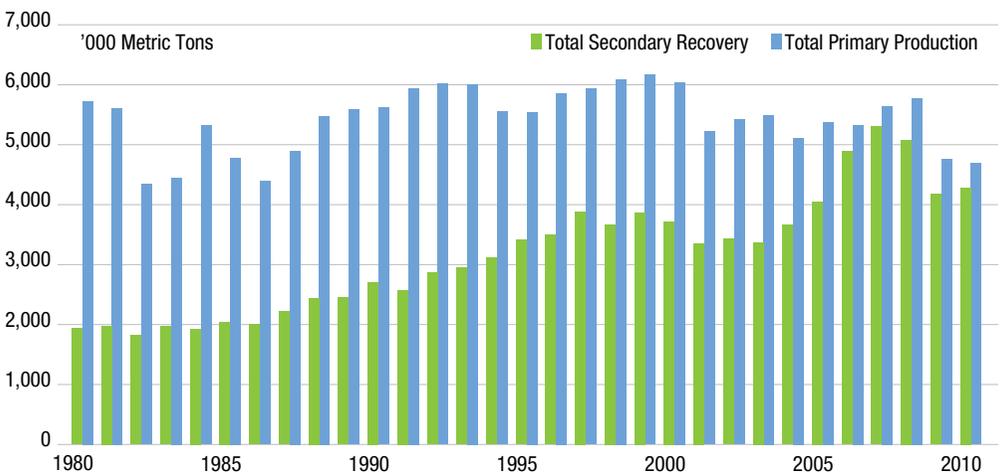
Recycling is a core business operation of the aluminum industry. In North America, the industry recycles approximately 5 million tons of aluminum each year, of which about 3 million tons is melted and cast domestically and about 2 million tons is exported in the form of aluminum scrap and ultimately melted and cast in other countries and regions. While primary aluminum still accounts for the larger share of the industry, domestic secondary aluminum production (domestic melting and casting, excluding exported scrap) is increasingly significant, having grown from 22% of total consumption in 1980 to 38% today.

Recycling is essential to aluminum's sustainability proposition. Recycled aluminum uses only 5 percent of the energy, and generates 5 percent of the emissions, associated with the production of aluminum from virgin ore.

Moreover, each ton of aluminum recycled (rather than produced from ore) saves:

- 24 barrels of crude oil equivalent of energy
- Over 15 tons of fresh or sea water use
- More than 9 tons of CO<sub>2</sub> equivalent of greenhouse gas emissions
- 2.5 tons of solid waste (including recyclable solid waste).

### Total Primary Metal Production & Secondary Metal Recovery (Including Metal Recovered from Net Exported Scrap) in North America



## Toward a Sustainable Future

Looking ahead, challenges remain that will require producer and consumer action to achieve a truly sustainable society. Aluminum producers must continue to make improvements in energy efficiency and environmental releases associated with their upstream operations. Moreover, the industry is obliged to encourage the use of aluminum more extensively for sustainable solutions—to downweight vehicles, construct greener buildings, and reduce the environmental footprint associated with the shipment of packaged goods. Finally, the industry must work to increase recycling rates at the end of products' useful life. The achievement of these goals constitutes a key focus of Aluminum Association efforts going forward.