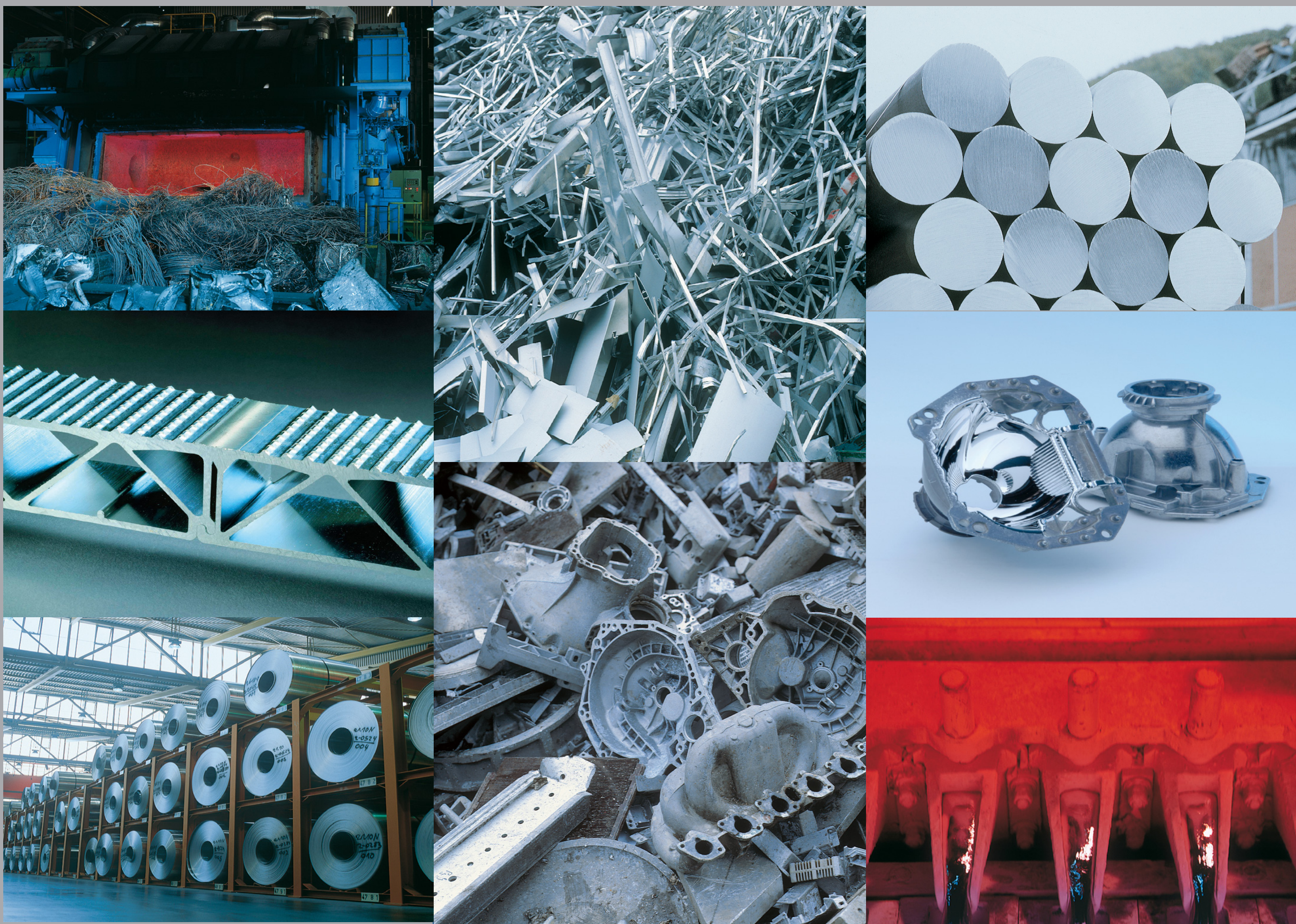
Global Aluminium Recycling:

A Cornerstone of Sustainable Development



european aluminium association

INTERNATIONAL ALUMINIUM INSTITUTE

Organisation of European Aluminium Refiners and Remelters

Credits

The Global Aluminium Recycling Committee (GARC)

GARC brings together aluminium producers and regional and national aluminium associations to highlight the substantial advantages aluminium enjoys relative to competing materials in terms of recyclability and sustainable development. The committee collects global statistics and models future flows in order to predict scrap volumes from applications such as transport, construction and packaging. The committee is also active in developing harmonised and generally accepted definitions, providing input data for life cycle analyses and devising common messaging on recycling matters and in benchmark aluminium's recyclability with respect to other materials.

Photos

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Preface

The international aluminium industry has adopted a global sustainability programme, the International Aluminium Institute's (IAI) 'Aluminium for Future Generations' initiative, the overall objective of which is for the aluminium industry to be in a position to continue its global growth, while optimising its environmental performance. Launched in 2003, the initiative is an undertaking by IAI Member Companies to improve their collective performance against fourteen voluntary objectives, ensuring that aluminium products continue to benefit present and future generations. Recycling is a key element of this initiative and continues to be at the core of the global industry's path to sustainable development. The recycling voluntary objective is as follows:

The IAI has developed a mass flow model to identify future recycling flows. The industry will report regularly on its global recycling performance.

1. Recycling: a Cornerstone of Aluminium Sustainability

Compared with the production of primary aluminium, recycling of aluminium products needs as little as 5% of the energy and emits only 5% of the greenhouse gas. Recycling is a major aspect of continued aluminium use, as more than a third of all the aluminium currently produced globally originates from old, traded and new scrap.

The high intrinsic value of aluminium scrap has always been the main impetus for recycling, independent of any legislative or political initiatives. For some products, in addition to this obvious economic dimension, growing environmental concerns and heightened social responsibility, over the last decade in particular, have served to boost recycling activity, in order to conserve resources and to avoid littering. The aluminium economy is a circular economy. Indeed, for most aluminium products, aluminium is not actually consumed during a lifetime, but simply used. Therefore, the life cycle of an aluminium product is not the traditional “cradle-to-grave” sequence, but rather a renewable “cradle-to-cradle”. If scrap is pre-treated and/or sorted appropriately, the recycled aluminium can be utilised for almost all aluminium applications, thereby preserving raw materials and making considerable energy savings.

In 1990 total aluminium production was around 28 million tonnes (with over 8 million tonnes recycled from scrap) and today the total is close to 56 million tonnes (with close to 18 million tonnes recycled from scrap). By 2020 metal demand is projected to have increased to around 97 million tonnes (with around 31 million tonnes recycled from scrap). Today, around 50% of the scrap is old scrap (i.e. scrap from end-of-life products).

At present, the aluminium industry itself is responsible for around 1% of the man-made greenhouse

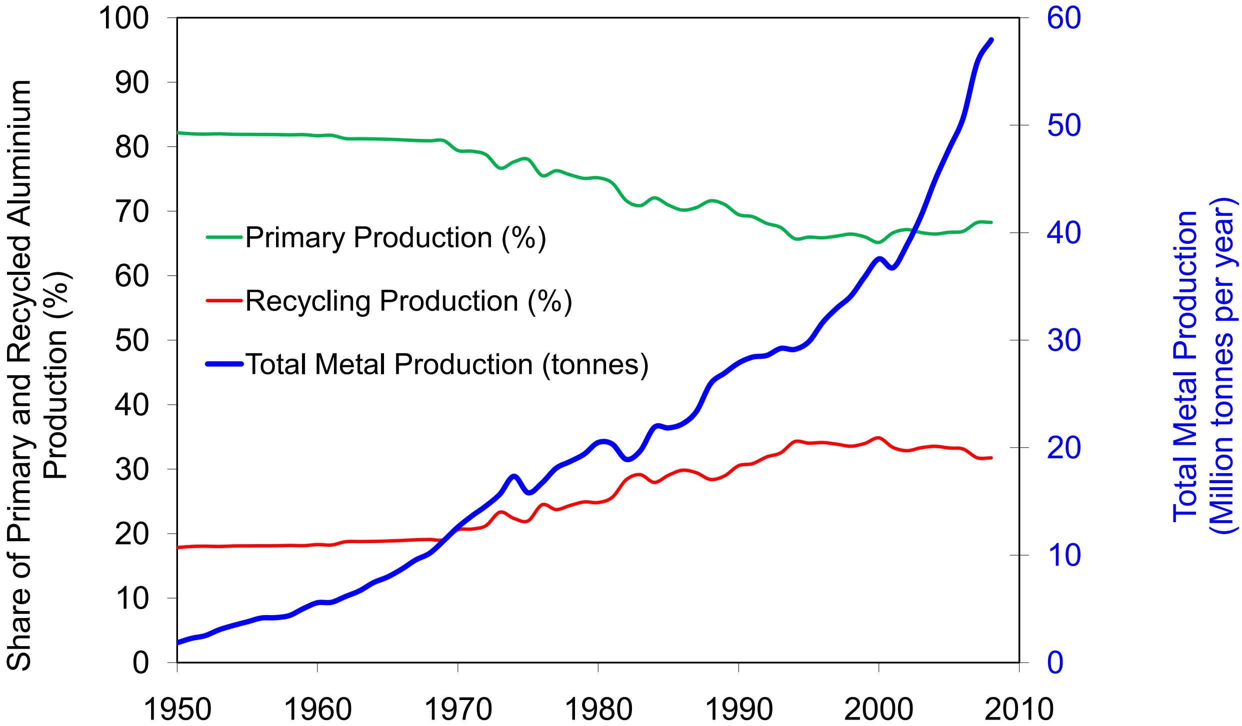


Figure 1: Global Share of Primary and Recycled Metal Production

gas emissions, around 40% of which are the result of the aluminium production process itself (direct emissions) and around 60% resulting from electricity power generation (indirect emissions).

The Directors of the International Aluminium Institute (IAI) have therefore established the 'Aluminium for Future Generations' global sustainability initiative, which employs a life cycle approach to address the challenges of climate change, focusing not only on direct emissions and the energy required to produce aluminium products, but also on the energy savings to be made through their use, recycling and reuse. The strategy includes:

1. Following an 86% reduction in its PFC emissions per tonne of primary aluminium produced between 1990 and 2006, the global aluminium industry will further reduce emissions of PFCs per tonne of aluminium by at least 50% by 2020 as compared to 2006, equivalent to a reduction of 93% compared to 1990;

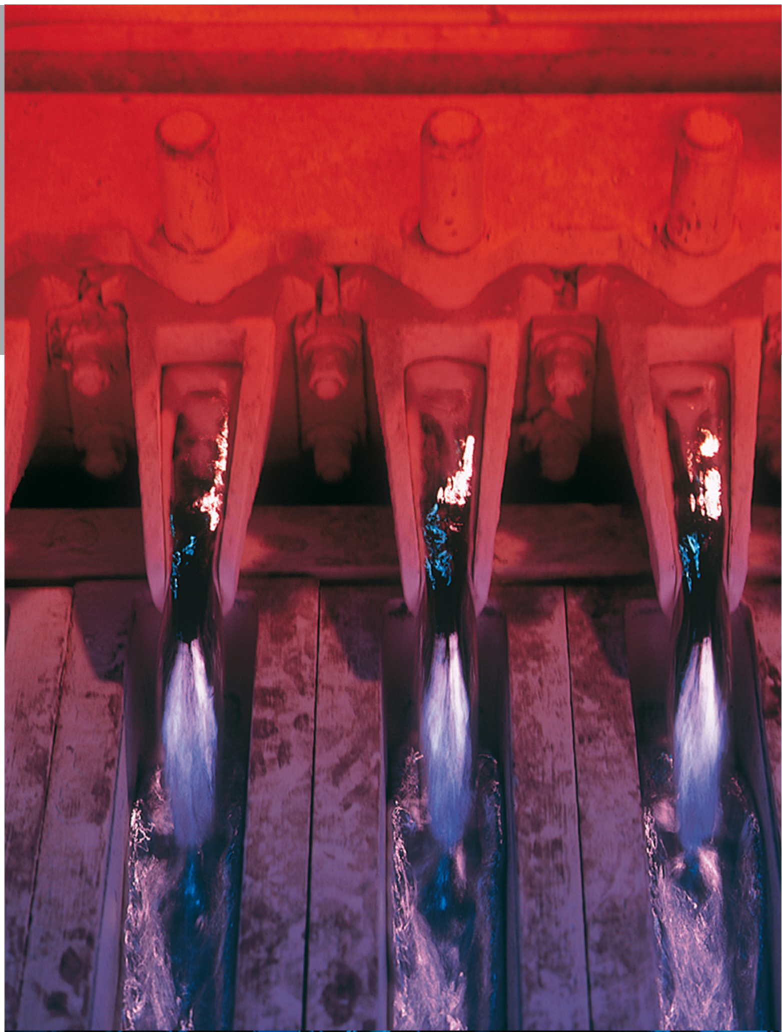
2. A 10% reduction in smelter electrical energy usage by IAI member and reporting companies per tonne of aluminium produced by 2010 versus 1990;

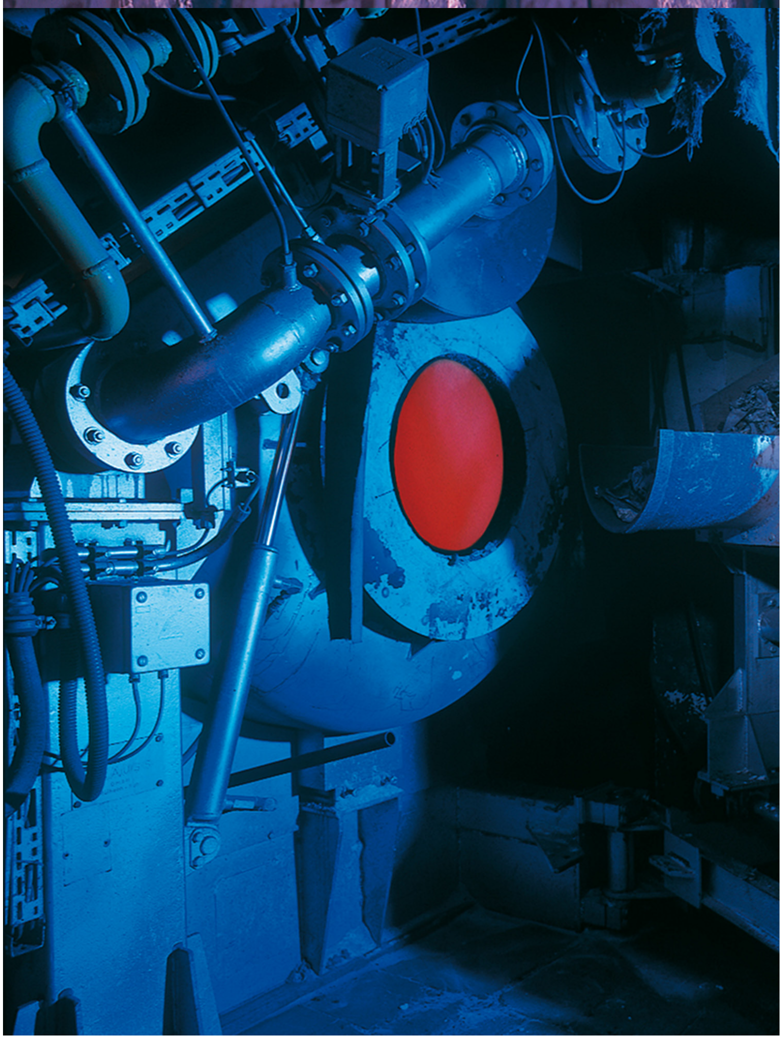
3. A 10% reduction in energy use per tonne of alumina produced for the industry as a whole by 2020 versus 2006 levels.

4. The aluminium industry will work to encourage a global recycling target of 75% for used aluminium beverage cans by 2015.

5. To promote the use of aluminium in products (e.g. vehicles and other moving parts), where greenhouse gas is saved in comparison with alternative materials, because of aluminium's specific properties – low specific mass, high electric and thermal conductivity, high reflectivity, etc.

2. Refiners and Remelters: Important Players in Recycling





Aluminium scrap is collected and melted everywhere in the world. In many of the countries worldwide there are industrial recycling facilities, but recycling plays a particularly leading role in Europe, North America and Japan. A fully developed aluminium recycling industry, including both refiners and remelters, transforms aluminium scrap into standardised aluminium. Refiners and remelters play integral roles in aluminium recycling but they, in turn, have crucial links with collectors, dismantlers, metal merchants and scrap processors who deal with the collection and treatment of scrap. The metal merchants are also responsible for handling most of the foreign trade in aluminium scrap. Refiners and remelters play vital roles for the downstream industry; in 2007 they produced close to 18 million tonnes of recycled aluminium from old and traded new scrap, including ingots for casting, rolling and extrusion

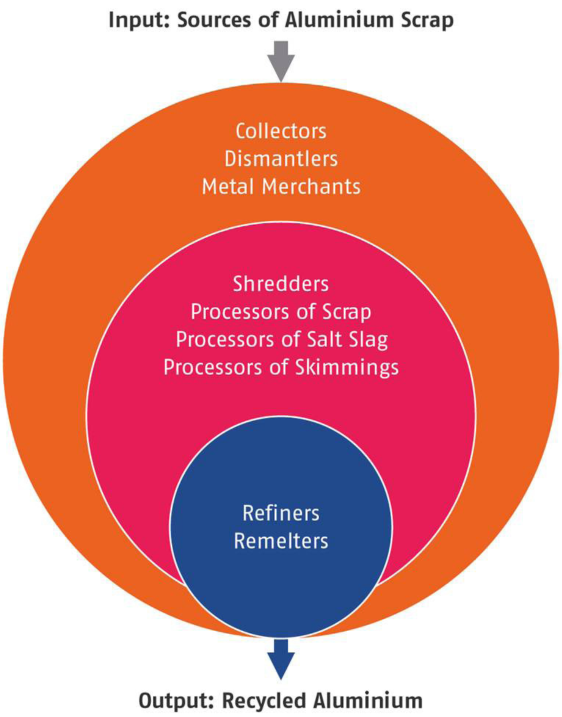


Figure 2: Structure of a Well Developed Aluminium Recycling Industry

Aluminium can be recycled over and over and over again without loss of properties. The high value of aluminium scrap is a key incentive and major economic impetus for recycling

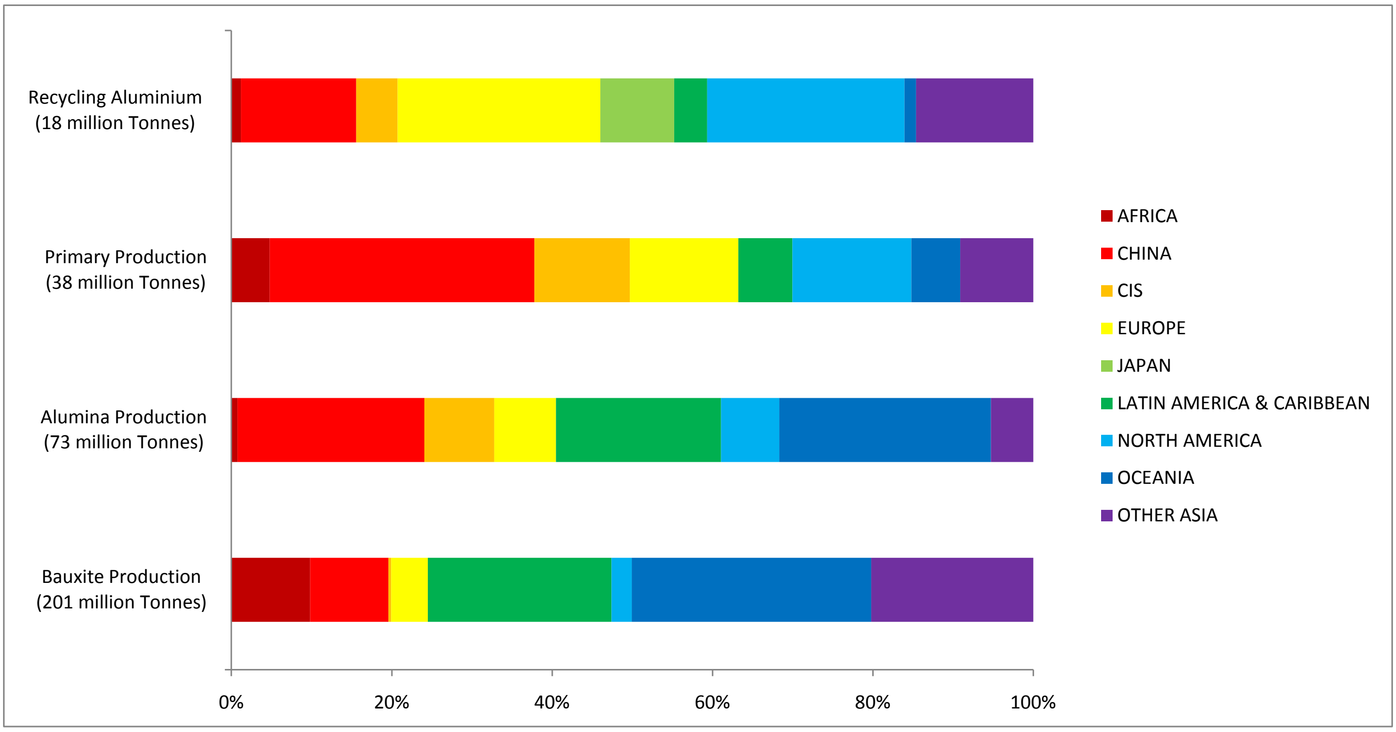


Figure 3: Regional Bauxite, Alumina, Primary and Recycled Aluminium Production, 2007

and pellets for the deoxidation of steel. This compares with in excess of 38 million tonnes of primary aluminium produced in the same year.

In the EU and North America, scrap has been generated in sufficient quantities over the past 70 years to develop an economically strong and technically outstanding aluminium recycling industry. Following the oil shocks and energy cost increases of the 1970s, Japan ceased domestic primary aluminium

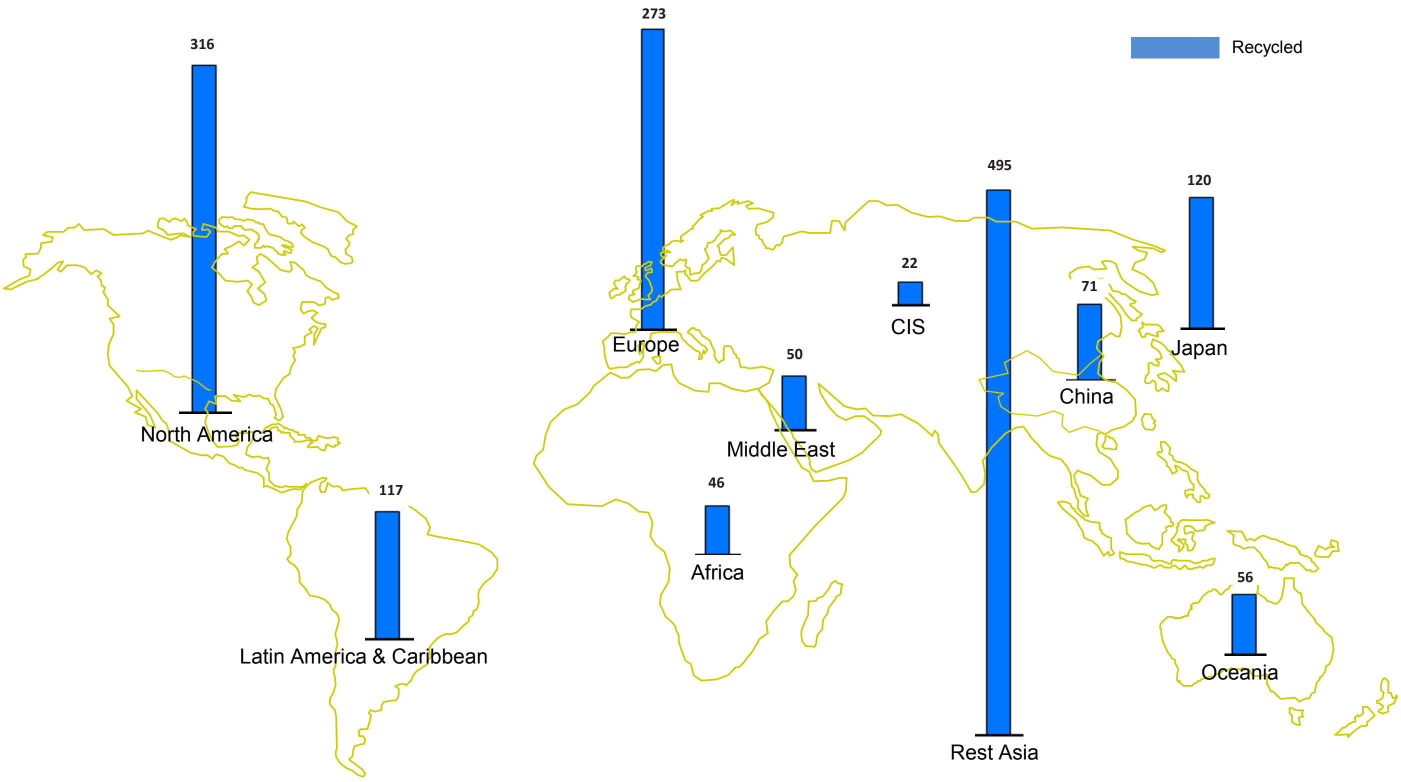


Figure 4: Number of Recycling Plants, 2008

production and switched to aluminium recycling in the 1980s. In addition to these traditional recycling centres, increasing recycling activities are evident in China, India and Russia. As shown in the regional overview, Latin America, the Middle East, Oceania and Africa focus on primary aluminium production while recycling plays a minor role, mainly due to lower domestic scrap availability. In addition, much of the aluminium scrap in some of these countries (for example, Australia and Canada) is exported to other regions where a major recycling sector exists. For most countries, there is a well-established market for recycled aluminium with firmly defined distribution chains. Hence, refiners supply foundries with casting alloys and remelters supply rolling mills and extruders with wrought alloys. Alloys are supplied according to official standards and/or customer specifications. Typical products made

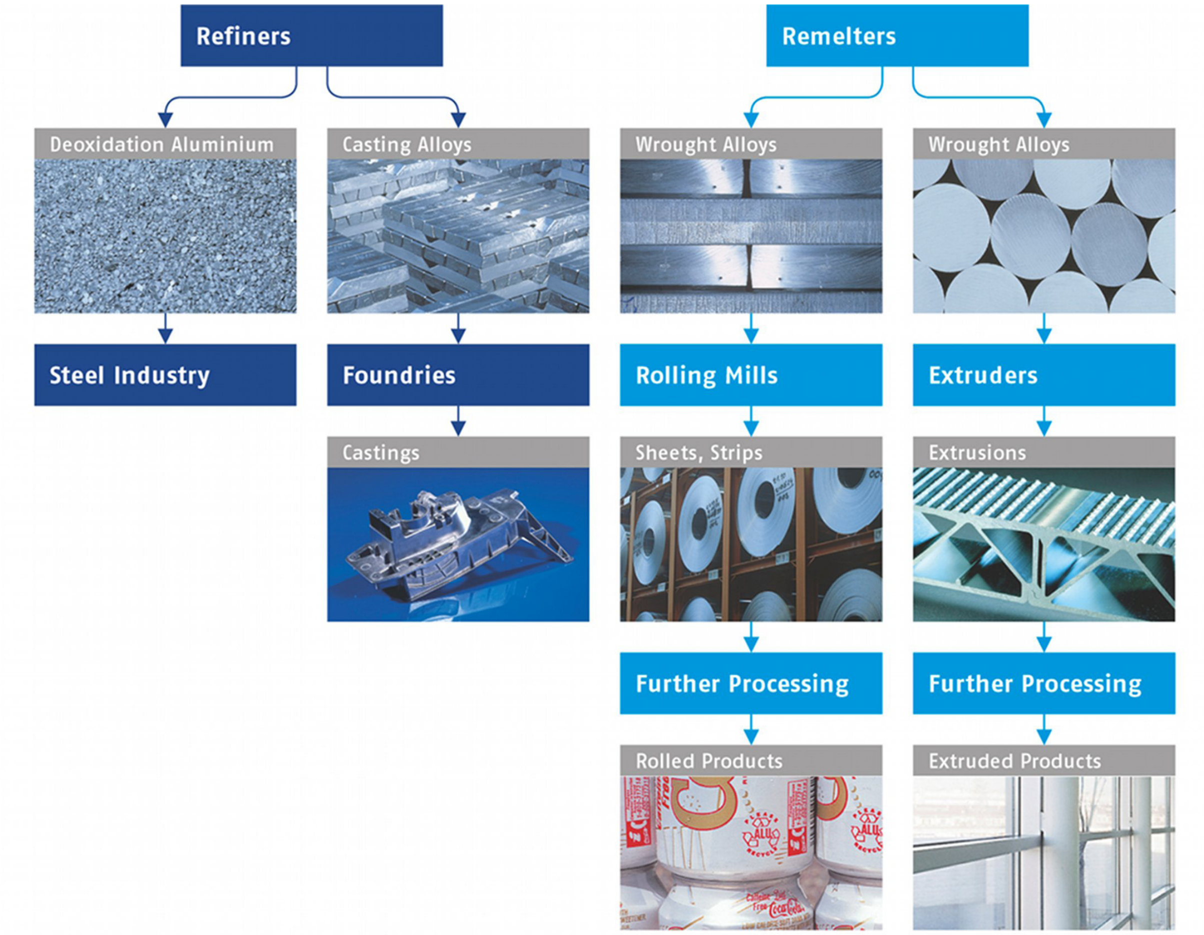


Figure 5: Customers of the Aluminium Recycling Industry

from recycled aluminium include castings, such as cylinder heads, engine blocks, gearboxes and many other automotive and engineering components, on the one hand and extrusion billets or rolling ingots, for the production of profiles, sheets, strips and foil, on the other. Another prominent use for recycled aluminium is in the steel industry, where its use is essential for deoxidation.

3. Economy: the Main Impetus for Aluminium Recycling

Aluminium scrap has considerable market value because most of the energy required for the production of primary aluminium is embodied in the metal itself and, consequently, in the scrap. Therefore, the energy needed to melt aluminium scrap is only a fraction of that required for primary aluminium production. Furthermore, if pre-treated and/or sorted, aluminium products can be recycled for use in almost all aluminium applications since the metal's atomic structure is not altered during melting.

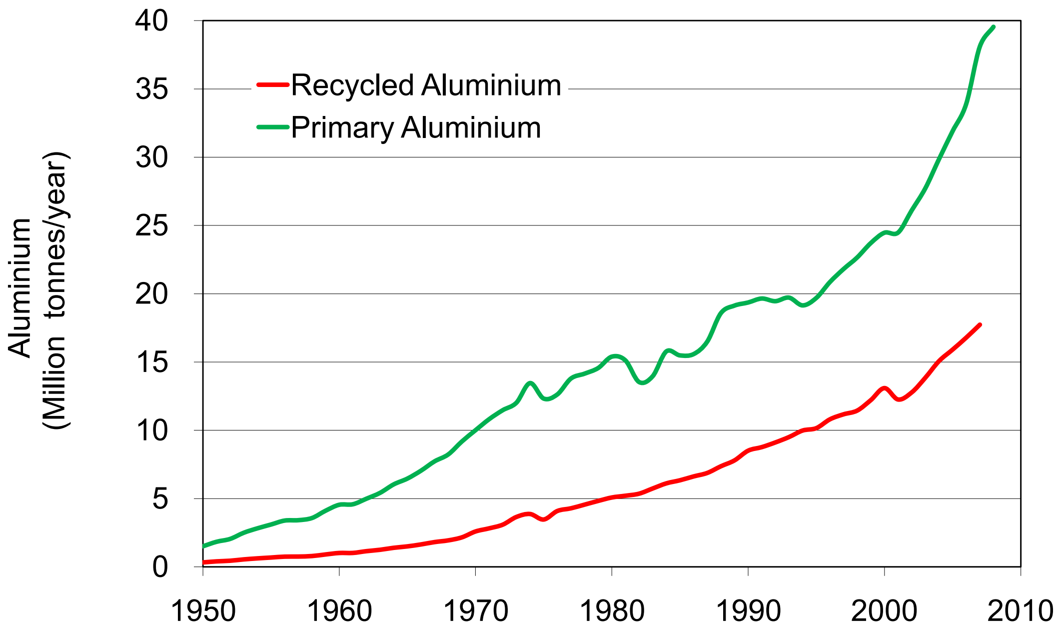


Figure 6: Worldwide Evolution of Recycled and Primary Aluminium

The aluminium recycling industry has almost quadrupled its output from 5 million tonnes in 1980 to close to 18 million tonnes in 2007 from old and traded new scrap. During the same time primary metal use has grown from 15 to 38 million tonnes.

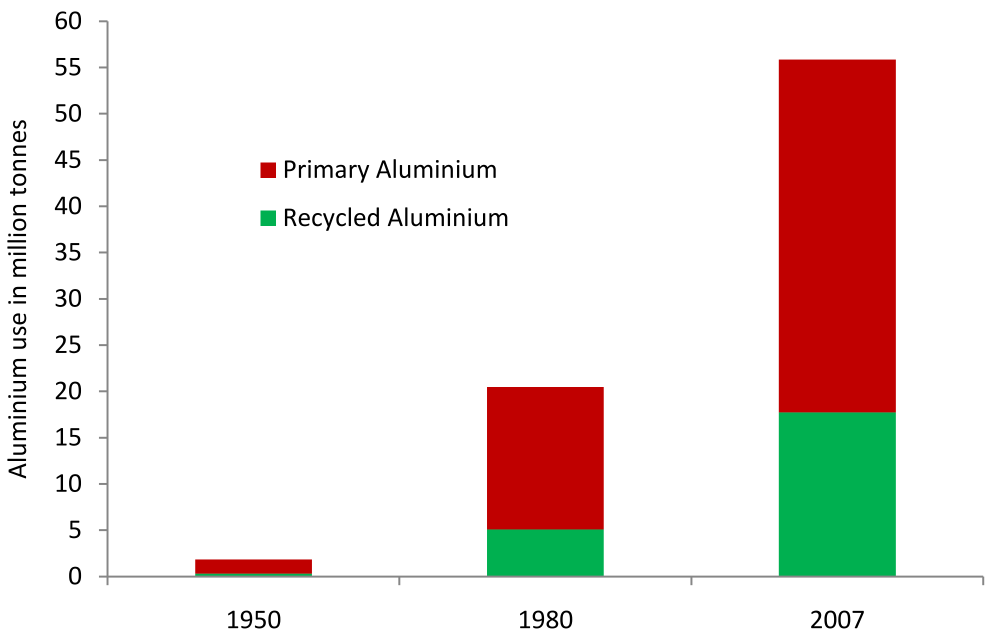
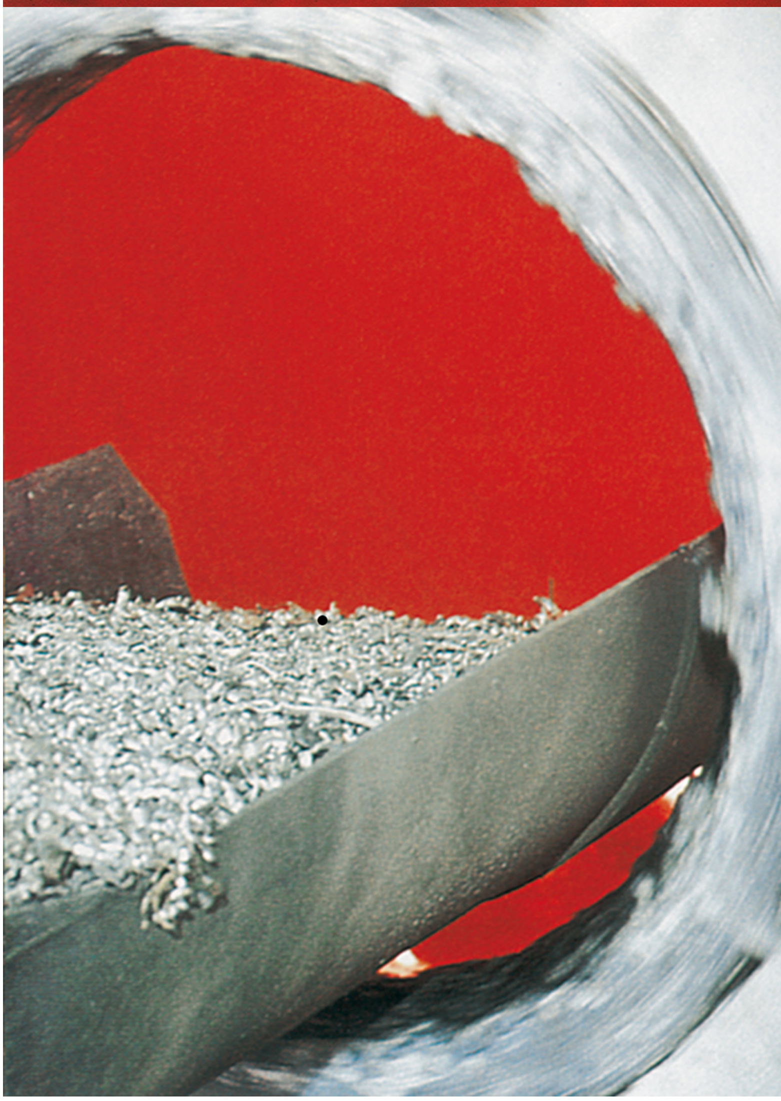


Figure 7:Global Metal Use- 1950, 1980 and 2007

4. Measuring the Recycling Performance: End-of-life Recycling of Aluminium



The recycling performance of the aluminium industry can be described by different indicators, namely the overall and the end-of-life recycling efficiency rate (see *definitions*). The latter is split into the end-of-life collection rate and the processing rate.

Separation of aluminium scrap from end-of-life products is mainly driven by market mechanisms and the high value of the scrap, which explains the high rates of aluminium from applicants such as building products or overhead cables. However, we are living in the world of "dematerialisation" and multimaterial solutions, where functions can be fulfilled with less and less material: cans get lighter, aluminium foil as a barrier material in packaging gets thinner and thinner, aluminium parts in vehicles, windows, machines, electrical and electronic equipment get smaller and/or more complex. From a sustainability standpoint this is altogether a positive development, but requires additional efforts for the collection and separation of aluminium from end-of-life products.

Societies, governments and communities need to work alongside the industry to create effective collecting systems to ensure the constant improvement of recycling rates in all applications sectors.

Usually, refiners and remelters report their (gross) metal yield by comparing their outputs of metal ingots with their scrap inputs, as values between 70% and 95%. In 2005, an aluminium mass balance for the aluminium recycling industry in the EU-15 was carried out by Delft University of Technology, taking into account foreign material (paint, paper, plastic, lubricants etc), at the input side of the scrap and aluminium recycling from skimmings and salt slag. The study has shown that the real metal losses for all scrap melted in the EU-15 are usually less than

2%, i.e. the net metal yield is above 98%. For old scrap, metal losses are between 1% and 5% depending on the scrap type and the furnace technology used.

End-of-life recycling performance and recycled metal content are often misunderstood. From a technical point of view, there is no problem to produce a new aluminium product from the same used product. There are no quality differences between a product entirely made of primary metal and a product made of recycled metal. However, recycled aluminium is used where it is deemed most efficient in economic and ecological terms. Due to the overall limited availability of aluminium scrap, any attempt to increase the recycled content in one particular product would just result in decreasing the recycling content accordingly in another. It would also certainly result in inefficiency in the global optimisation of the scrap market, as well as wasting transportation energy. The high market value of aluminium means that, if scrap is available, it will be recycled and not stockpiled.

5. End-of-Life Product Recycling: the Route to High Quality Products

At the end of their useful life, if pre-treated and/or sorted, aluminium products can be recycled for use in almost all aluminium applications since the metal's atomic structure is not altered during melting.

The aluminium recycling industry recycles all the aluminium scrap it can obtain from end-of-life products and aluminium by-products. The rate at which end-of-life aluminium is recycled varies depending on the product sector, scrap processing technology and on society's commitment to collect aluminium containing products at end-of-life. Each application sector requires its own recycling solutions and the industry supports initiatives that seek to optimise the recycling rate.

Industry continues to recycle, without subsidy, all the aluminium collected from end-of-life products as well as from fabrication and manufacturing process scrap. However, with a growing number of industry initiatives and the help of authorities, local communities and society as a whole, the amount of aluminium collected could be increased further.

Estimated recycling rates for aluminium used in the transport and building sectors are very high (85% to 95%) and represent more than 50% of finished goods entering use in 2007. Between 30% to close to 100% of aluminium cans are found to be collected and recycled, depending on the region.

The recycled product may be the same as the original product (e.g. window frame recycled back into a window frame or can to can), but is more often a completely different product (cylinder head recycled into a gearbox).

Transport

Transportation is the most important field of application for aluminium worldwide. In 2007, up to 30% of wrought and casting alloys put on the market were used in cars, commercial vehicles, aircraft, trains, ships, etc. Increasingly, aluminium products are being employed to reduce vehicle weights, without loss of performance, improving safety and reducing greenhouse gas emissions from vehicles' use-phase. In 2002 the average passenger car contained between 100 and 120 kg of aluminium, while in 2006 this figure had increased to between 110 and 140 kg. Forecast show aluminium contents of 120 to 150 kg in 2009 (Ducker Research).

A number of efficient processes are used to recover aluminium scrap from vehicles. Figure 10 shows a modern process applied to recycle a typical passenger car. Some aluminium parts, such as wheels and cylinder heads, are removed during the initial dismantling of the vehicle. The car body, including the remaining aluminium, is fed to the shredder in the course of subsequent recycling. After separating the ferrous fraction using magnets, a mixture of

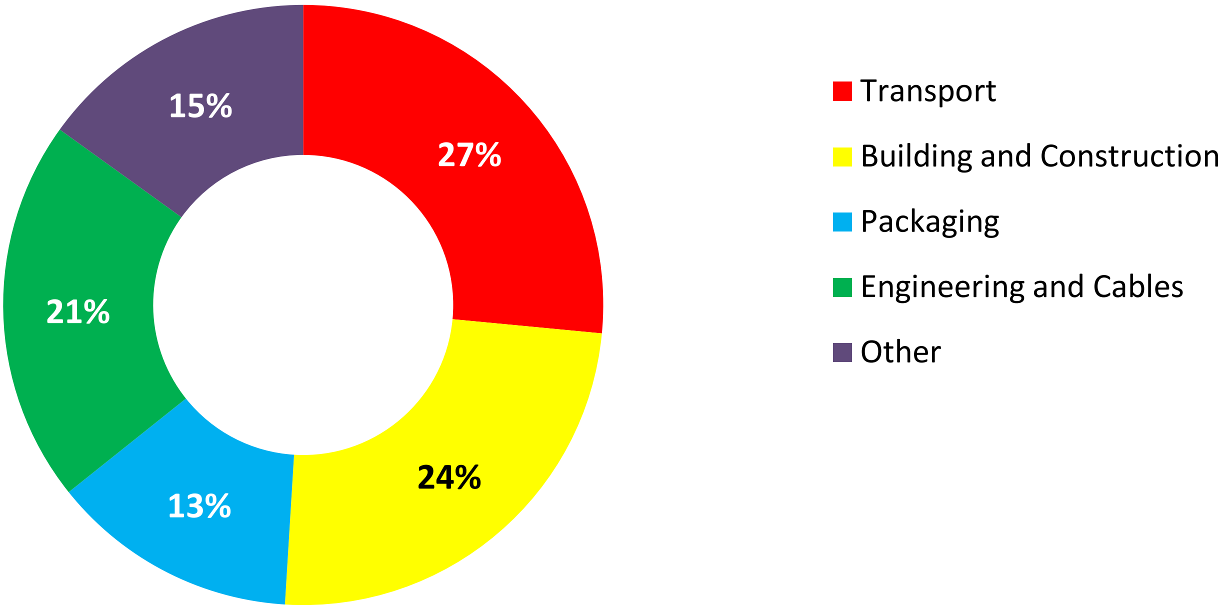


Figure 8: Global End-use Markets for Finished Aluminium Products, 2007

Global aluminium recycling rates are high, up to 90% for transport and construction applications and about 70% for beverage cans.

plastics, rubber, glass, textiles, high grade steel and nonferrous metals is obtained. This mixed fraction is intended for sink-float separation and eddy current separation and result in the extraction of aluminium scrap. Another process, developed to sort aluminium scrap metallurgically, utilises laser and spectroscopic technology.

Aluminium scrap collected using the various separation procedures is today mainly processed into aluminium casting alloys, which serve as pre-material for the production of castings. Typical applications include engines and gearboxes. Due to the increased use of aluminium wrought alloys in car bodies, a growing volume of wrought alloy scrap is anticipated. Hence, the separate collection of wrought alloys from cars will be economically viable in the future.

Aluminium used in other modes of transportation is collected separately at end-of-life, when commercial vehicles, aircraft, railway coaches, ships, etc. are dismantled. As the aluminium parts are often too large to be directly melted in the furnace, they must first be reduced to small pieces by processes such as shearing. A recent study by the University of Technology of Troyes on behalf of the European Aluminium Association demonstrated a recycling rate of 95% or higher for aluminium in trucks and trailers. Most aluminium-containing ships and railway coaches are still in use, though, because of aluminium's relatively recent history in these applications and its long-lasting performance.

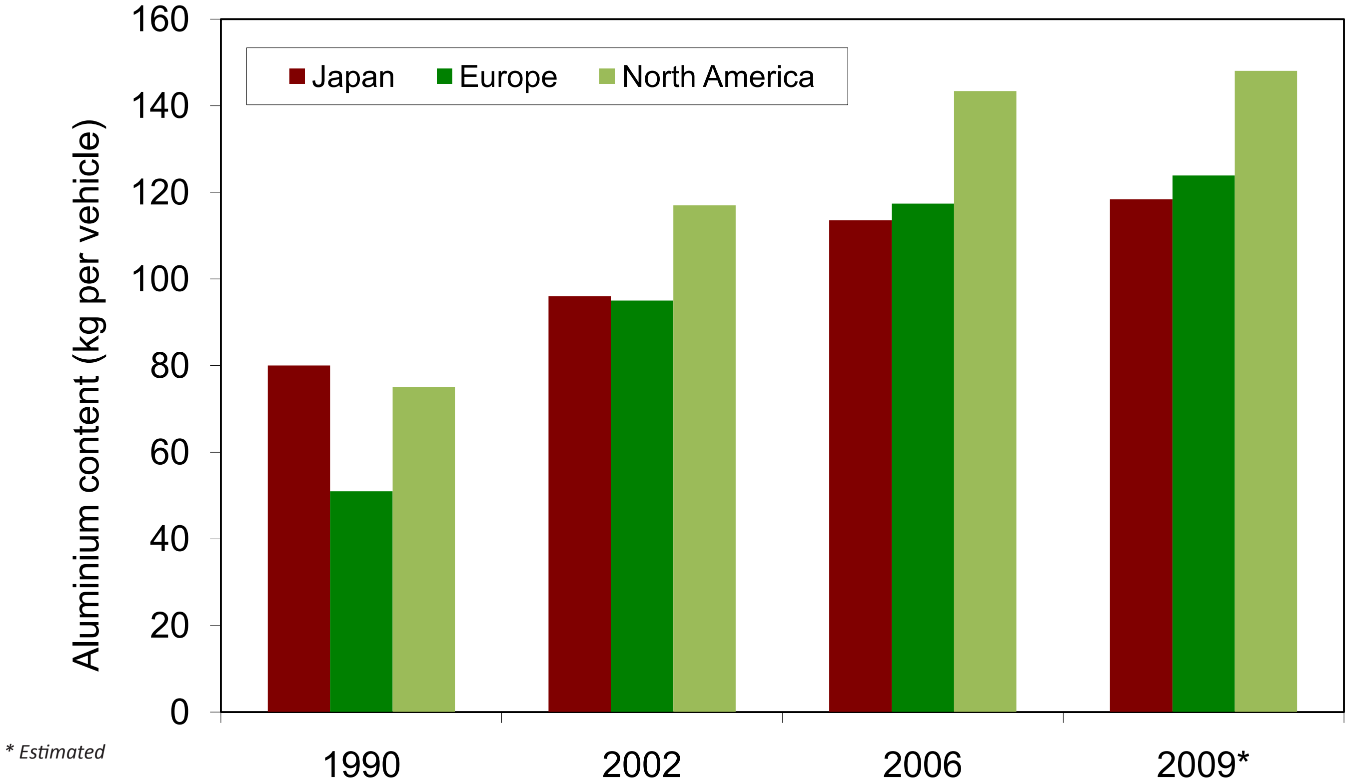


Figure 9: Average Aluminium Content in Vehicles for North America, Europe and Japan (source: Ducker Research)

Industry continues to recycle, without subsidy, all the aluminium collected from end-of-life products as well as from fabrication and manufacturing process scrap.

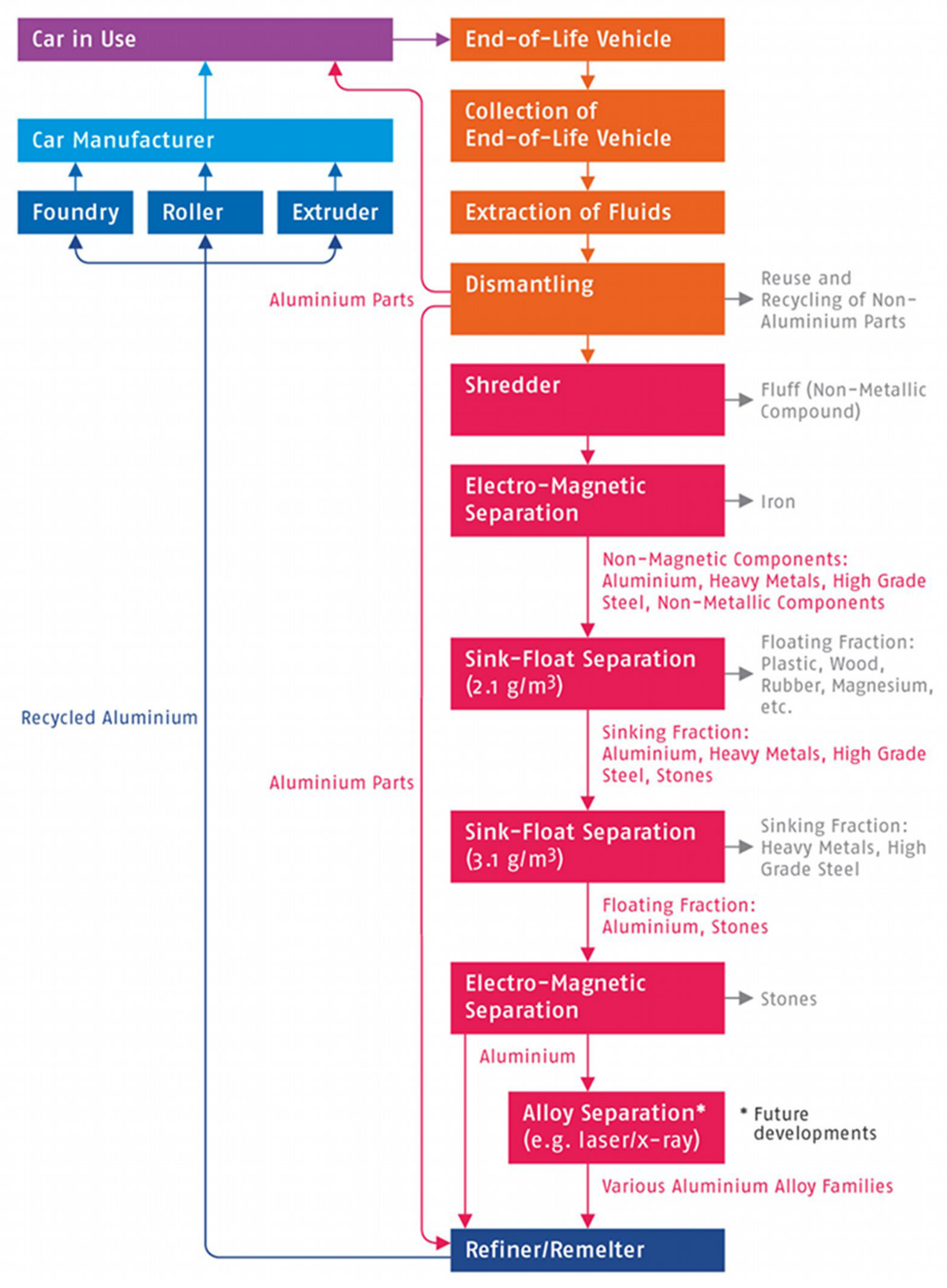


Figure 10: Modern End-of-Life Vehicle Dismantling and Aluminium Recycling Process

However, with a growing number of industry initiatives and the help of appropriate authorities, local communities and society as a whole, the amount of aluminium collected could be increased further.

Building

Architects have been aware of aluminium's unique qualities for over one hundred years. As well as being one of the most abundant metals in the world, aluminium's formability, high strength-to-weight ratio, corrosion resistance, and ease of recycling makes it the ideal material for a wide range of building applications. The main uses of aluminium are in the construction of windows, doors and facades, closely followed by roofs and walls. Other structural uses range from a glazed shop front to the superstructure of anything from a shopping centre to a stadium. Aluminium can also be found in door handles, window catches, staircases, roller shutters and sun-shading systems, heating and air-conditioning systems and more recently in the support structures for solar panels, solar collectors and light shelves.

Aluminium's excellent material properties provide the basis for intricate, stable and lightweight structures. These properties ensure that even thin structures do not warp. It also allows a high degree of prefabrication with a variety of finishes before components leave the factory. This reduces the work load at the construction site. Aluminium's resistance to corrosion is particularly important if a component is installed in an inaccessible area. Aluminium is a material that has given the architect the physical means to achieve creative innovations in design.

The life cycle analysis of buildings presents some very interesting challenges. Overall the building's design, along with the behaviour of the building's users will have a very large impact on its environmental and energy performance. The typical building will have four major parts to its life cycle; construction, use (mainly heating, lighting and air conditioning), maintenance and end-of-life management.

DEMOLITION DATA ON ALL BUILDINGS INVESTIGATED

Case study	Mass of building [tonnes]	Aluminium identified [kg]	Aluminium share [grammes per tonne]	Collection rate [%]
Pau – Elf Aquitaine office building (F)	10 659	6 826	640	92
Le Mans – apartment buildings (F)	9 243	165	18	31
Wuppertal – courthouse (D)	10 188	76 414	7 500	98
Frankfurt – department store (D)	12 000	21 000	1 750	98
Milan – Pirelli factory and offices (I)	142 753	61 384	430	94
Ridderkerk – apartment buildings (NL)	32 700	1 034	32	95
Eindhoven – terraced houses (NL)	37 500	1 853	49	95
Madrid – BNP Paribas bank (E)	23 000	92 000	4 000	95
London – Wembley Stadium (UK)	34 918	213 000	6 100	96
Average collection rate (%) for buildings investigated				95.7

Figure 11: Aluminium Collection Rates for European Buildings (source: TU Delft)

In a typical building the “use” phase of the life takes majority of the building’s energy requirements while the materials and construction account for a only a small fraction of the building’s energy requirements. Choosing the right material for the right application is therefore critical in reducing all the energy requirements over the life cycle of the building.
The final phase of a building’s life needs to also be considered when making material choices. Ideally the material will be recycled in an economically and environmentally sustainable way. Usually the least desirable option is landfill. A large amount of waste building materials goes to landfill sites at a cost to both the economy and the environment, others are recycled at cost to the community. In contrast, aluminium is recycled in a way that pays for itself and is sustainable.

The collection rate of aluminium in building can be determined by comparing of the mass of aluminium scrap dismantled from an end-of-life building with the mass aluminium identified in this building before starting to demolish it. In 2004 Delft University of Technology conducted a study into the aluminium content of, and collection rates from, demolished buildings in six European countries, which found that the average collection rate for aluminium was more than 95%. Globally, aluminium enjoys a high collection rate of 85% in the building industry. The global industry is keen to increase collection rates and is working with producers of building applications to enable more efficient collection of scrap from demolished buildings.

Today the global building market uses some 11 million tonnes of final aluminium products annually. Globally, it is estimated that buildings and their content comprise some 400 million tonnes of aluminium, which can be extracted and reused by future generations time after time.

Packaging

Aluminium possesses unique barrier and physical properties and is therefore used extensively for the packaging of food, beverages and pharmaceuticals. Even in its thinnest form, aluminium effectively protects contents against the quality-reducing effects of oxygen, light, moisture, micro-organisms and unwanted aromas.

Aluminium packaging fits every desired recycling and processing route. The amount of aluminium packaging effectively recycled depends greatly upon individual national circumstances and the efficiency of the collection schemes, and therefore rates vary from 25% to 85% across the globe. In Europe the collection rate of all aluminium packaging is about 50%.

Two different types of packaging can be distinguished, namely

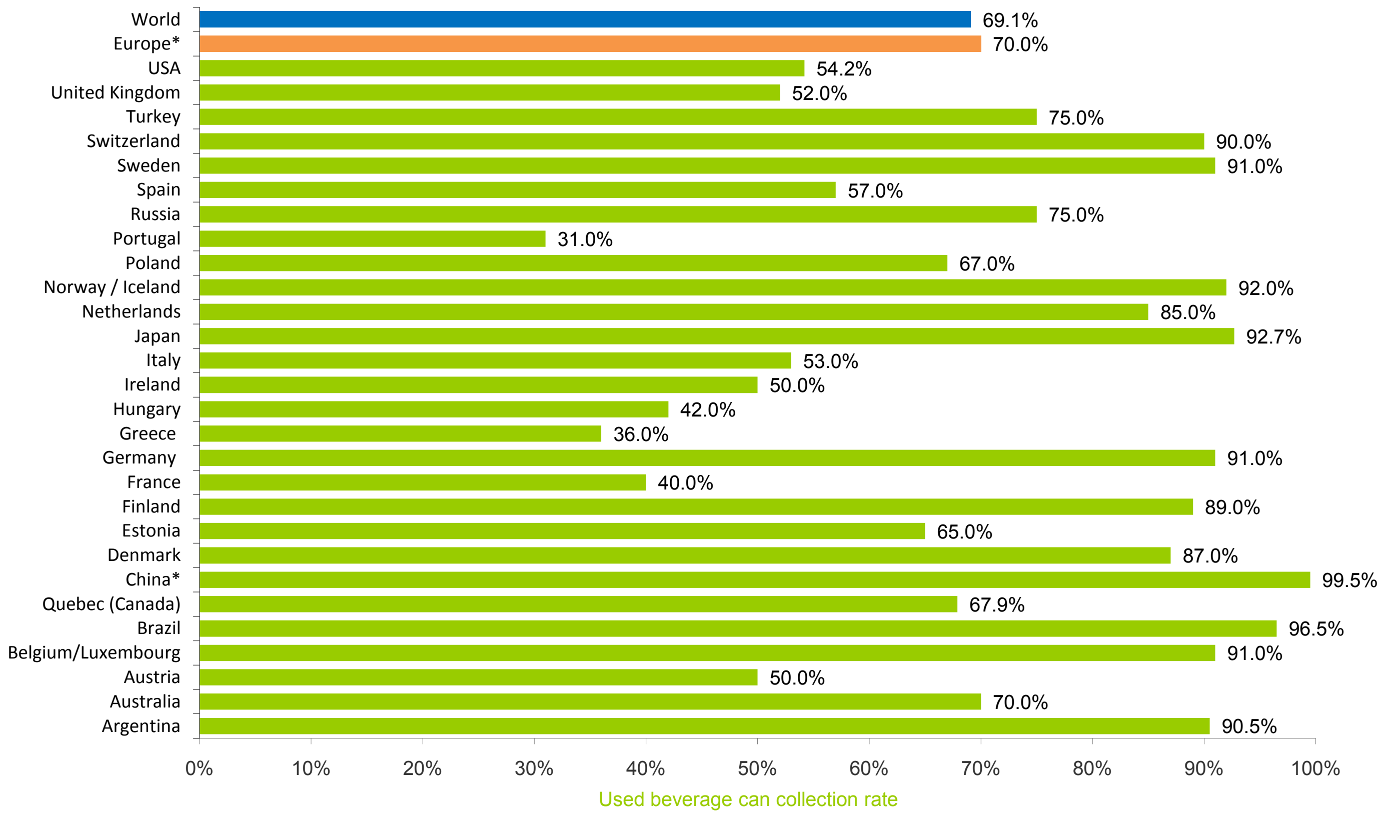
- rigid and semi-rigid packaging, i.e. food and beverage cans, aerosol cans, closures and menu trays which consist mainly of aluminium, and
- flexible packaging, i.e. packaging where a thin aluminium foil is laminated as a barrier material to plastics or cardboard.

For rigid and semi-rigid packaging, in which aluminium beverage cans are the most important representative product, aluminium remelters in particular have developed techniques to recycle old scrap into recycled aluminium ingots, from which wrought products (e.g. can stock) can be fabricated. Rigid and semi-rigid packaging scrap has a high aluminium content and therefore a high market value. The end-of-life route depends on the waste management policy of different countries. If for example a country decides not to separate such material but incinerate it as part of municipal waste, followed by sorting the incineration ash, the aluminium, because of its thickness and physical properties, can be separated and recycled.

The collection rates of used beverage cans vary from country to country from 30% to close to 100%, with a global average of close to 70% (includes unregistered collection & recycling in some areas). Sweden and Switzerland collect 91% and 90% of their aluminium beverage cans, respectively. Sweden's success lies in a deposit system whereas in Switzerland a voluntary prepaid recycling charge covers the costs of collection. Brazil is also one of the world leaders in can recycling, with a collection rate of 97%. Every region in Brazil has a recycling market which facilitates easy collection and transportation of end-of-life products. This has encouraged communities to collect and form co-operatives across the country. In Japan a collection rate for used beverage cans of 93% is achieved with a voluntary system. Collecting points include recycle boxes at supermarkets and major shopping centres, volunteer groups and municipality offices.

For flexible packaging, the aluminium barrier often has a low thickness down to 6 microns. This is typically laminated to paper and/or plastic layers that are the mayor components of the packaging. This means that flexible packaging waste has a very low content of aluminium. Nevertheless, aluminium can be extracted from laminates by pyrolysis and thermal plasma techniques. Alternatively, such a packaging is incinerated with a recovery of the combustion heat. Because of its low thickness, the aluminium barrier will be oxidized completely, and the combustion heat of aluminium can be recovered. The question of whether incineration or recycling is environmentally feasible can only be decided case-by-case, while comparing the specific alternatives by life cycle assessments, taking specific local circumstances and other aspects of sustainability into consideration.

Generally the energy required for the production of packaging is only a small percentage compared to the total energy used to produce and supply the final product. If the final product is spoiled due to inadequate packaging material much more energy is wasted than needed to produce the packaging. The aluminium barrier properties in flexible packaging is of special importance as it helps to prevent spoilage of food and pharmaceutical products, for instance, and therefore contributes to the food supply and health of the world's population.



** Includes unregistered collection*

Figure 12: Global Aluminium Beverage Can Collection Rate

6. Mass Flow Model: Tracking Aluminium Through its Life Cycle

There are some important regions where no recycling data have been collected and where little data are available on the amount of metal being lost annually to landfills or other material streams. Because of this, data collection has been complemented by the development of a resource flow model to help identify applications where aluminium is not yet being recycled to its full potential and to identify present and future recycling flows. The IAI's Global Aluminium Recycling Committee is investigating ways in which to promote better collection of these products in order to maximise recycling potential and thus minimise the energy use and green house gas emissions.

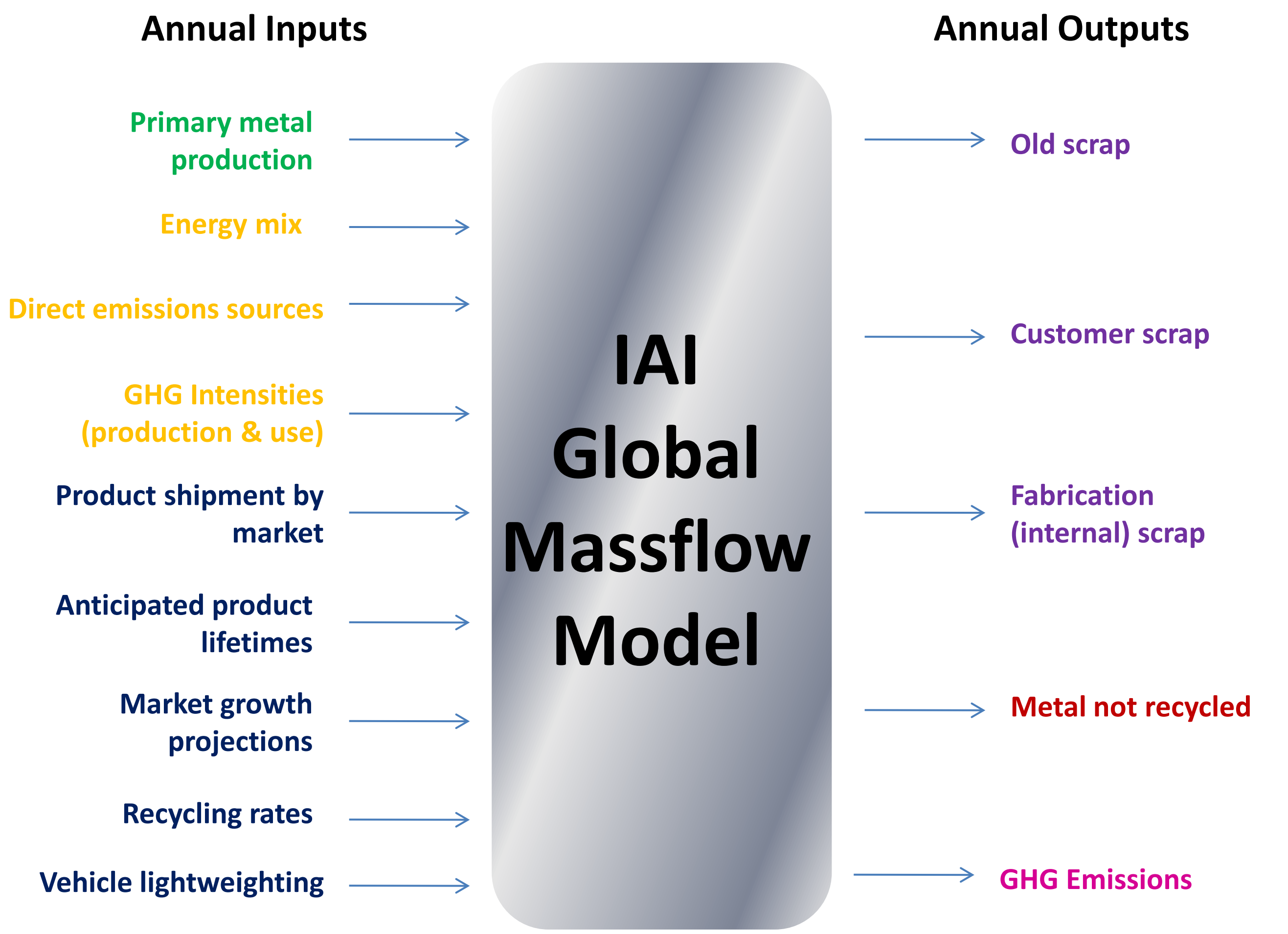
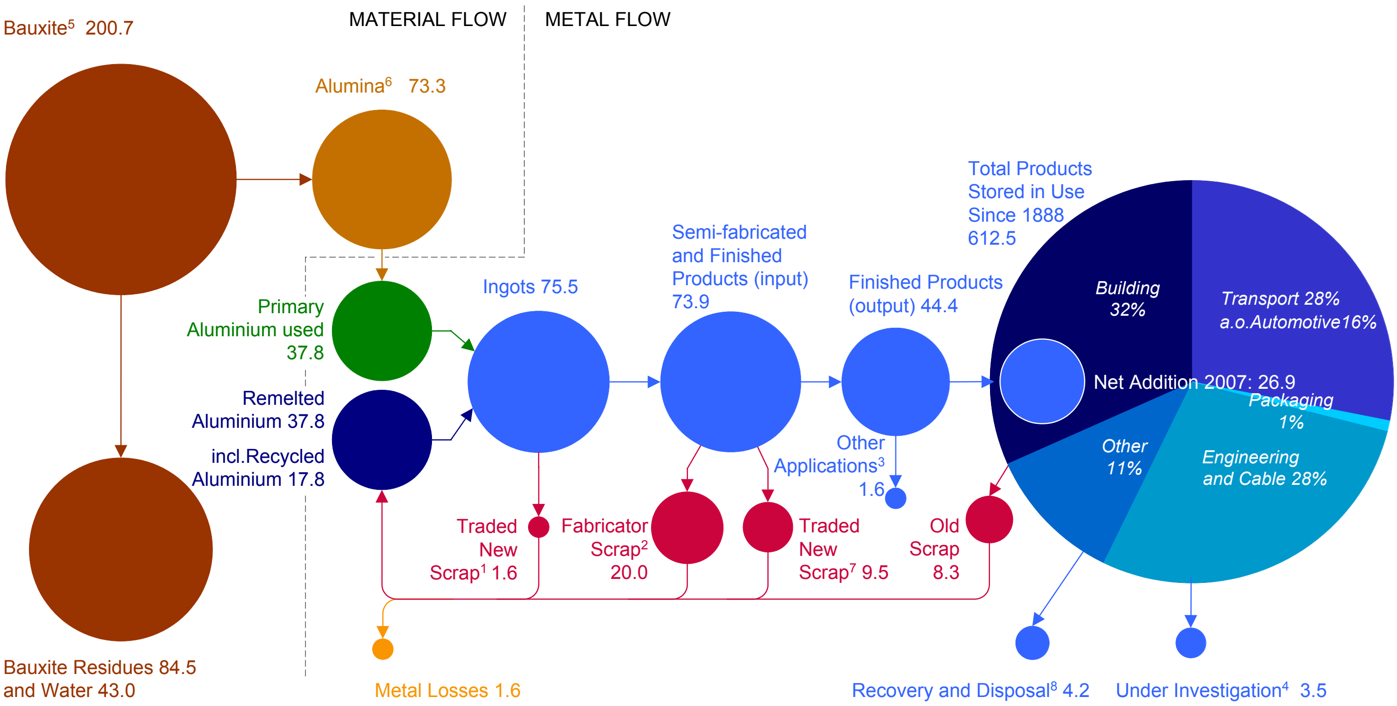


Figure 13: Functioning of Global Aluminium Flow Model with Data Inputs and Annual Outputs

The model traces the flow of aluminium from 1888 to the present along the complete value chain. Further, with historic information of more than 100 years it was possible to forecast the flow of aluminium to the year 2020. Eight major processes are investigated: bauxite mining, alumina refining, aluminium and aluminium ingot production, fabrication (rolling, extrusion and casting), manufacturing (production and assembly of finished products), use and recycling.



Values in millions of metric tonnes. Values might not add up due to rounding. Production stocks not shown
1 Aluminium in skimmings; 2 Scrap generated by foundries, rolling mills and extruders. Most is internal scrap and not taken into account in statistics; 3 Such as deoxidation aluminium (metal property is lost) 4 Area of current research to identify final aluminium destination (reuse, recycling, recovery or disposal); 5 Calculated based on IAI LCI report - update 2005. Includes, depending on the ore, between 30% and 50% alumina; 6 Calculated. Includes on a global average 52% aluminium; 7 Scrap generated during the production of finished products from semis; 8 Either incinerated with/without energy recovery, material recovery or disposal.

Figure 14: Global Aluminium Flow, 2007

The property of recyclability means that the world's increasing stock in use of aluminium acts like a resource bank, over time delivering more and more practical use and value from the energy embodied in the metal at the time of its production.

Of an estimated total of over 800 million tonnes of aluminium produced in the world since commercial manufacture began in the 1880s, about three quarters is still in productive use. About 32% is located in buildings in the form of facades, windows, doors etc., 28% as electrical cable and machinery and 28% within moving objects such as cars, commercial vehicles, trains, ships. Recycling the metal currently stored in use would equal up to 16 years' primary aluminium output.

The amount of aluminium produced from old scrap has been growing from one million tonnes in 1980 to 8 million tonnes in 2007. Since the 80s the transport sector has been the most important resource for recycled aluminium from end-of-life products. As aluminium building products often have lifetimes running into decades, only since 2000 is there an accountable amount recordable. Today recycled aluminium produced from old scrap originates from 42% transport, 28% packaging, 11% engineering and cables and only 8% from building applications due to its long life time.

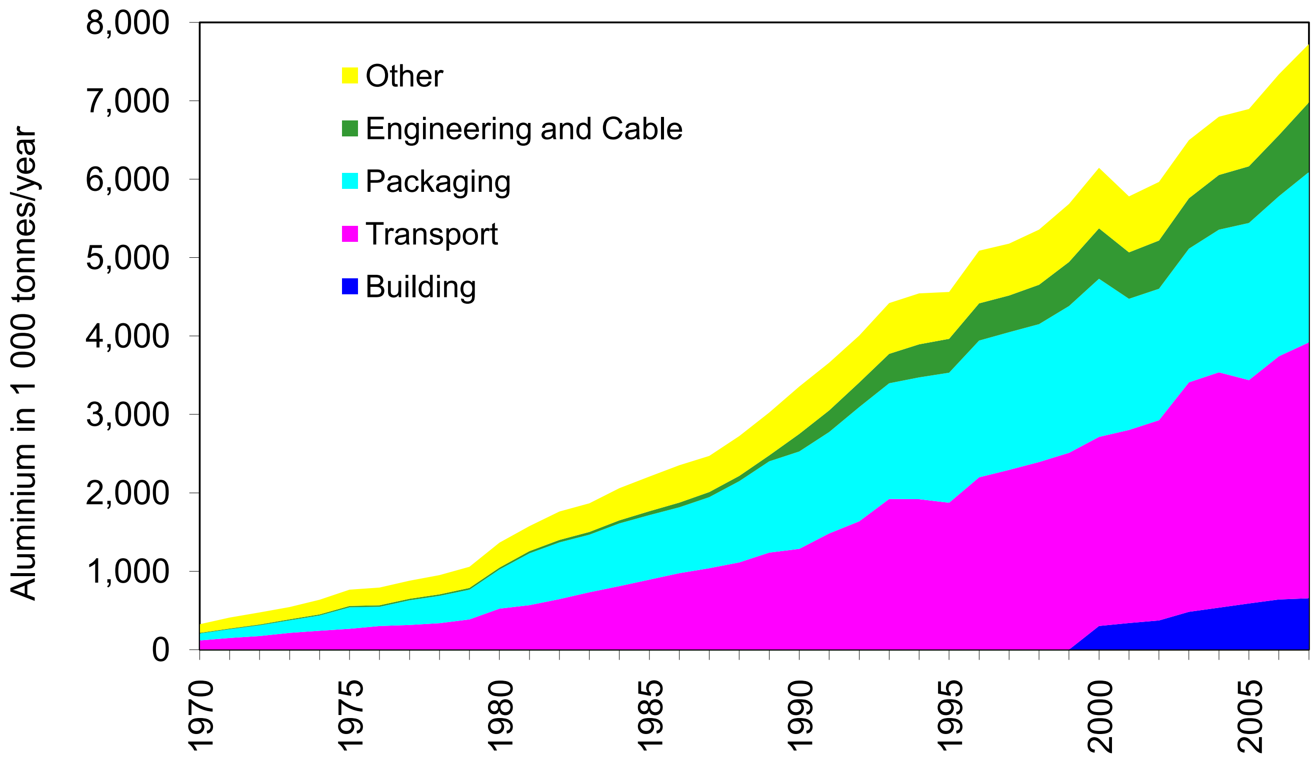


Figure 15: Global Old Scrap Recycled by Market

7. Energy: Global Stock and Savings Due to Recycling

Aluminium recycling benefits present and future generations by conserving energy and other natural resources. It saves up to 95% of the energy required for primary aluminium production, thereby avoiding corresponding emissions, including greenhouse gases.

38 million tonnes of primary aluminium and 38 million of remelted aluminium were produced in 2007. In the same year, 612 million tonnes of aluminium are stored in productive use.

The primary aluminium production in 2007 required 6 500 PJ of primary energy, as shown in Figure 16. However, these energy resources are not definitively lost, but transformed into material resources for use. Total primary energy stored in use amounts to close to 115 000 PJ. Through the use of only around 5% of the originally used energy, this metal can be made available not just once but repeatedly from these material resources for future generations. The 38 million tonnes of remelted aluminium only required 250 PJ gaining a product with the same primary energy content as primary alumium. Improving the overall recycling rate is an essential element in the pursuit of sustainable development.

Aluminium recycling benefits present and future generations by conserving energy and other natural resources. It saves up to 95% of the energy required for primary aluminium production, thereby avoiding corresponding emissions, including greenhouse gases.

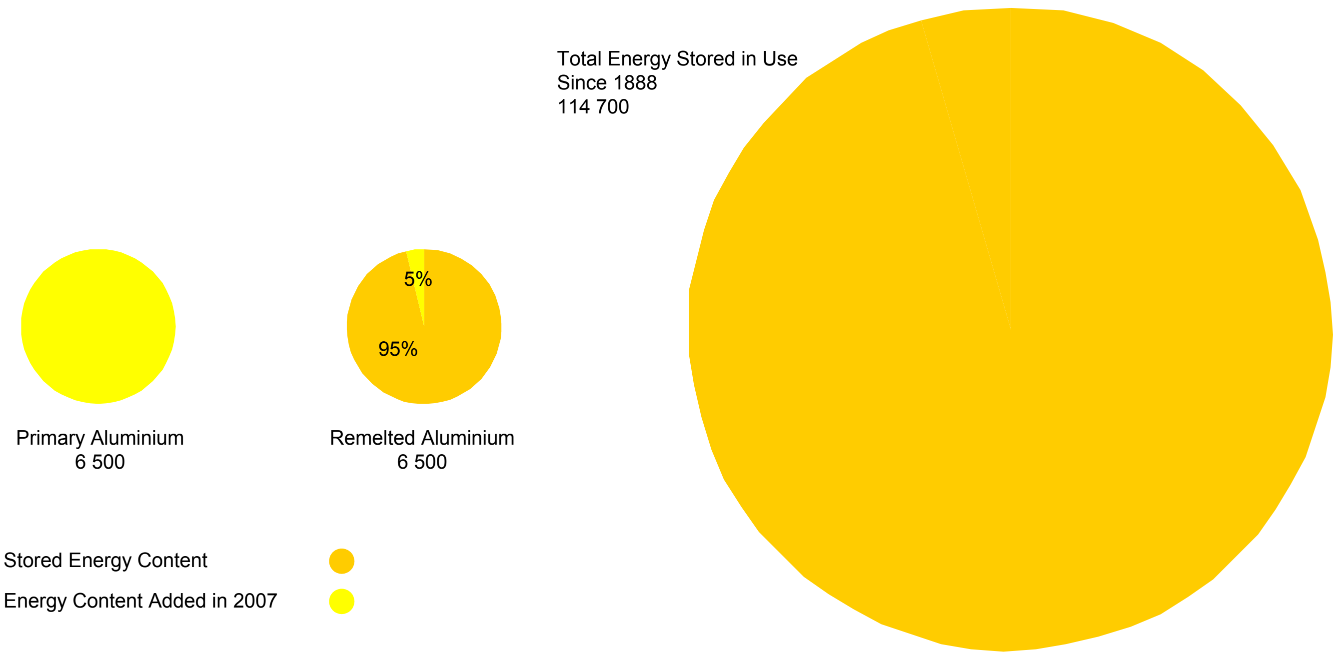
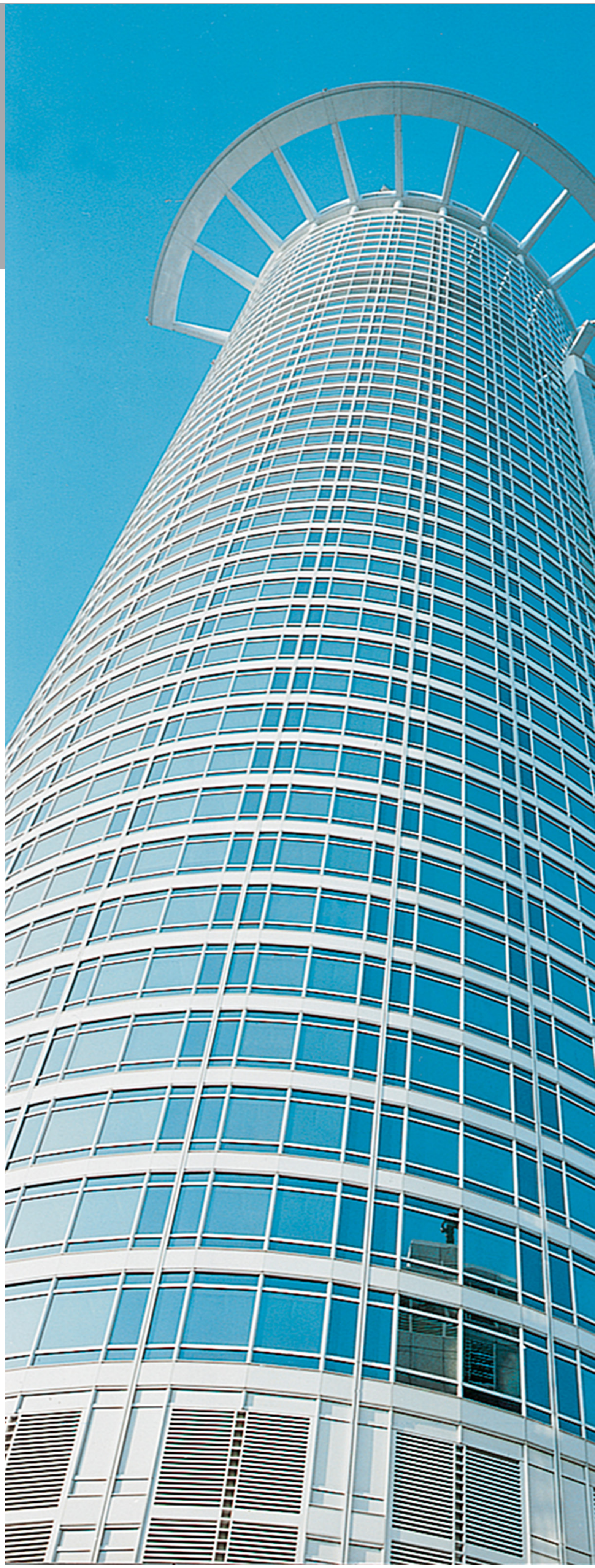


Figure 16: 2007 Primary Energy Content of Primary, Recycled and Aluminium Stored in Use in PJ (10^15 Joules)

8. The Future: Aluminium by 2020



The growing markets for aluminium are supplied by both primary and recycled metal sources. The increasing demand for aluminium and the long lifetime of many products mean that, for the foreseeable future, the overall volume of primary metal will continue to be substantially greater than the volume of recycled metal. The aluminium mass flow model enables the industry to calculate global recycling rates, including a recycling input rate 32% in 2007. Modelling predicts that this figure will stay constant in the future.

The global inventory of aluminium in use has grown from 90 million tonnes in 1970 to about 600 million tonnes today and is forecast to reach more than 1 billion tonnes in 2020. This is creating a vast material and energy storage bank for future recycling use. The building sector is forecasted to represent up to 35%, transport 28% and engineering plus cable 27% of the 2020 inventory in use.

The growing markets for aluminium are supplied by both primary and recycled metal sources. The increasing demand for aluminium and the long lifetime of many products mean

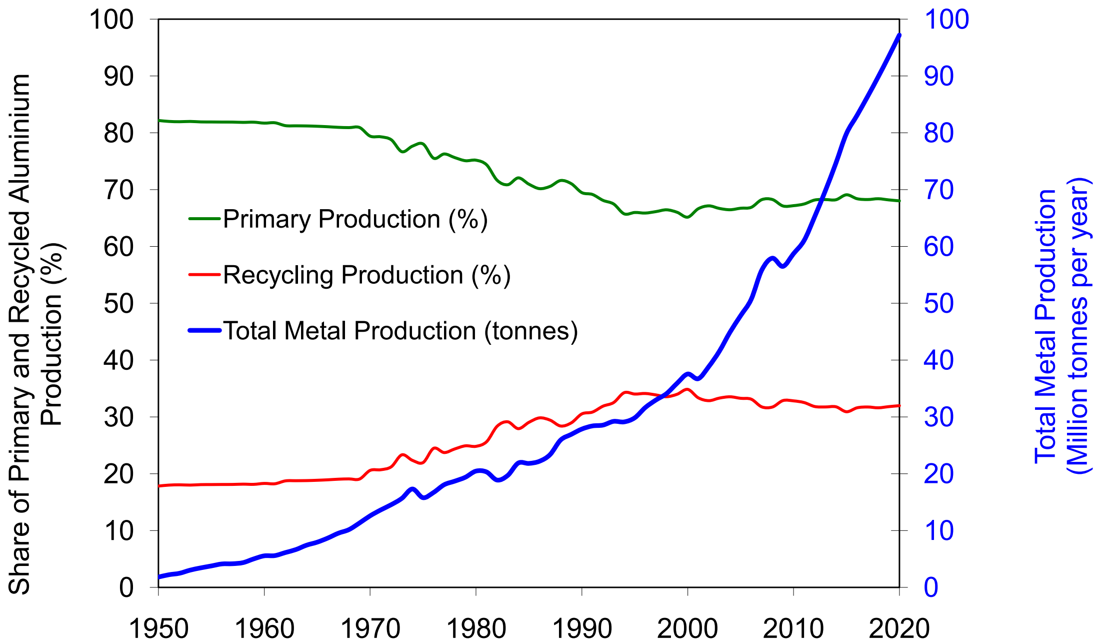


Figure 17: Forecast Share of Primary and Recycled Metal Production

The aluminium industry believes that improving the overall recycling rate is an essential element in the pursuit of sustainable development. Today, aluminium recycling now saves close to 170 million tonnes of greenhouse gas emissions per year.

The challenge is to address the continued rise in CO_2 emissions from power generation as well as the aluminium Industry's internal process emissions. This can be done partly by recycling, but it is also important to take account of the aluminium

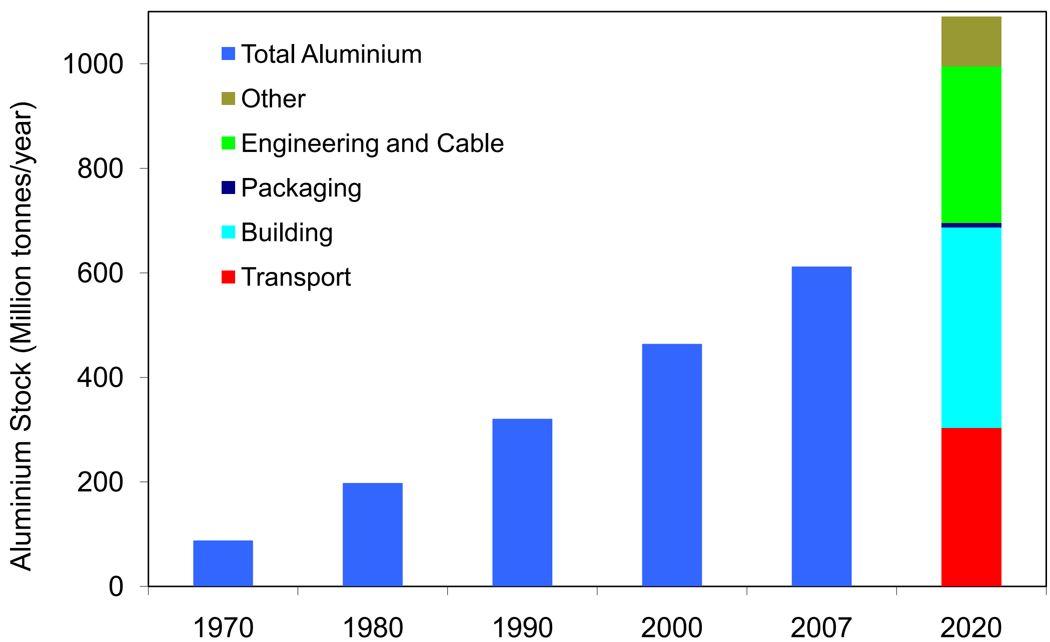


Figure 18: Build-up of Aluminium in Use by 2020

that, for the foreseeable future, the overall volume of primary metal will continue to be substantially greater than the volume of recycled metal.

products contribution to reducing GHG emissions. For instance, every kilogram of aluminium that is used in substitute for heavier materials in a car or light truck, has the potential to avoid the release of 20kg of CO_2 over the lifetime of the vehicle. Greenhouse gas emissions savings for transport other than passenger cars through lightweighting are even greater.

The objective for 2020 or beyond is for the aluminium industry to help in avoiding more greenhouse gas emissions than it creates directly and indirectly through its production by replacing traditional energy inefficient materials with aluminium, especially in transport applications.

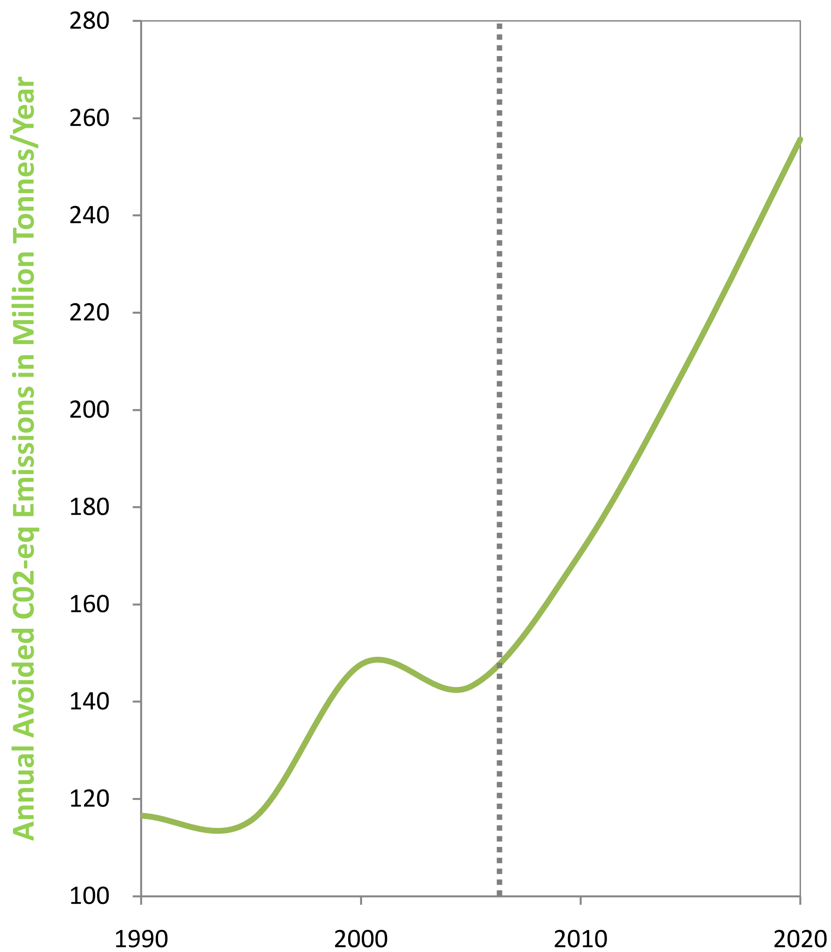


Figure 19: Annual Avoided Emission by Aluminium Recycling
Note: CO2 emission data for primary aluminium do not include China.

9. Glossary

Casting alloys
Aluminium alloys primarily used for the production of castings, i.e. products at or near their finished shape, formed by solidification of the metal in a mould or a die. Casting alloys typically have an alloy concentration of up to 20%, mostly silicon, magnesium and copper. Typical castings are cylinder heads, engine blocks and gearboxes in cars, components used in the mechanical and electrical engineering industries, components for household equipment and many other applications.

Deoxidation aluminium
Aluminium consisting of alloys with a high concentration of metallic aluminium (usually exceeding 95%) used to remove free oxygen from liquid steel.

Direct emissions
Emissions generated by the production process.

End-of-life aluminium
Aluminium that has been discarded by its end-user.

Foundry industry
Main customers of refiners. They produce a wide variety of castings which are mostly used in the transport sector.

GARC
Global Aluminium Recycling Committee. Joint committee of IAI and OEA

IAI
International Aluminium Institute

Indirect emissions
Emissions generated during the production and supply of electricity.

New scrap
Raw material mainly consisting of aluminium and/or aluminium alloys, resulting from the collection and/or treatment of metal that arises during the production, of aluminium products before the aluminium product is sold to the final user. Fabricator and internal scrap are included in the term new scrap.

OEA
Organisation of European Aluminium Refiners and Remelters. Represents the aluminium recycling industry in Europe and globally.

Old scrap
Raw material mainly consisting of aluminium and/or aluminium alloys, resulting from the collection and/or treatment of products after use.

Primary aluminium
Unalloyed aluminium produced from alumina, usually by electrolysis and typically with an aluminium content of 99.7%.

Recycled aluminium
Aluminium ingot obtained from scrap is now refereed to as recycled aluminium (formerly secondary aluminium). In this brochure the quantity of recycled aluminium refers to the production of aluminium from traded new and old scrap. Fabricator scrap is excluded.

Recycling
Aluminium collection and subsequent treatment and melting of scrap.

Recycling Rates
Performance indicators of global recycling performance are as follows:

Recycling input rate
Recycled aluminium produced from traded new scrap and old scrap as a percentage of total aluminium (primary and recycled sources) supplied to fabricators.

Overall recycling efficiency rate
Recycled aluminium produced from traded new scrap and old scrap as a percentage of aluminium available from new and old scrap sources.

End-of-life recycling efficiency rate
Recycled aluminium produced from old scrap as a percentage of aluminium available from old scrap sources.

The end-of-life collection rate
Aluminium collected from old scrap as a percentage of aluminium available for collection from old scrap sources.

The end-of-life processing rate
Recycled aluminium produced from old scrap as a percentage of aluminium collected from old scrap sources.

Refiner
Producer of casting alloys and deoxidation aluminium from scrap of varying composition. Refiners are able to add alloying elements and remove certain unwanted elements after the melting process.

Remelter
Producer of wrought alloys, usually in the form of extrusion billets and rolling ingots from mainly clean and sorted wrought alloy scrap.

Skimmings
Material composed of a mixture of aluminium, aluminium oxides and gas, which has been removed from the surface of the molten metal or from the bottom and walls of liquid metal containers, e.g. furnaces or transport ladles or transfer channels. This by-product is also termed “dross”.

Salt slag
Residue generated after remelting of aluminium scrap with fluxing salt, consisting of salt in which metallic and non-metallic particles are trapped in amounts that exhaust its fluxing properties. Fluxing salt is used mainly for refining in rotating furnaces in order to:

1. Cover the molten metal to prevent oxidation,
2. Increase the net metal yield,
3. Clean the metal from non-metallic inclusions and dissolved metallic impurities (e.g. calcium and magnesium), and
4. Enhance thermal efficiency in the furnace.

Wrought alloys
Aluminium alloys primarily used for wrought products by hot and/or cold working. Wrought alloys typically have an alloy concentration of up to 10%, mostly manganese, magnesium, silicon, copper and zinc. Typical wrought products are sheet, foil, extruded profiles or forgings.

10. Further Reading

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The Global Recycling Messages

Aluminium can be recycled over and over again without loss of properties. The high value of aluminium scrap is a key incentive and major economic impetus for recycling.

The growing markets for aluminium are supplied by both primary and recycled metal sources. The increasing demand for aluminium and the long lifetime of many products mean that, for the foreseeable future, the overall volume of primary metal will continue to be substantially greater than the volume of recycled metal.

Aluminium recycling benefits present and future generations by conserving energy and other natural resources. It saves up to 95% of the energy required for primary aluminium production, thereby avoiding corresponding emissions, including greenhouse gases.

Industry continues to recycle, without subsidy, all the aluminium collected from end-of-life products as well as from fabrication and manufacturing process scrap. However, with a growing number of industry initiatives and the help of appropriate authorities, local communities and society as a whole, the amount of aluminium collected could be increased further.

Global aluminium recycling rates are high, up to 90% for transport and construction applications and about 70% for beverage cans.