Aluminium Recycling in Europe

The Road to High Quality Products

european
aluminium associatio

Organisation of
European Aluminium Refiners
and Remelters

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Contents

Preface

This brochure is the product of years of close collaboration between the European Aluminium Association (EAA) and the Organisation of European Aluminium Refiners and Remelters (OEA). The scope of activities of this unique co-operation is very broad, covering all manner of production- and product-related aspects. This includes consolidating the position of the European aluminium industry with respect to existing recycling performance, and improving awareness of recycling rates, scrap flow, and scrap statistics. It also extends to the management of research and development projects linked to recycling, as well as consultation and support of recycling-related activities within end-use markets.

1. Recycling: a Cornerstone of Aluminium Sustainability

Recycling is a major consideration in continued aluminium use, representing one of the key attributes of this ubiquitous metal, with far-reaching economic, ecological and social implications. More than half of all the aluminium currently produced in the European Union (EU-25) originates from recycled raw materials and that trend is on the increase. In view of growing end-use demand and a lack of sufficient domestic primary aluminium production in this part of the world, Europe has a huge stake in maximising the collection of all available aluminium, and developing the most resource-efficient scrap treatments and melting processes. The importance of efficient aluminium recycling will even further increase in the future because of rising energy constraints in this region.

The high intrinsic value of aluminium scrap has always been the main impetus for recycling, independent of any legislative or political initiative. But in addition to this obvious economic dimension, growing environmental concerns and heightened social responsibility, especially during this last decade, have served to boost the recycling activity, since recycling requires as little as 5% of the energy needed for primary aluminium production.

The aluminium economy is a cycle 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 processed appropriately, the recycled aluminium can be utilised for almost all aluminium applications, thereby preserving raw materials and making considerable energy savings.

Key Players in Recycling

The aluminium recycling industry, including both refiners and remelters, treats and transforms aluminium scrap into standardised aluminium. Refiners and remelters play integral roles in aluminium recycling but they, in turn, depend on other crucial links in the chain. Indeed, without the collectors, dismantlers, metal merchants and scrap processors who deal with the collection and treatment of scrap, they would not be able to fulfil their roles. The metal merchants are also responsible for handling most of the foreign trade in aluminium scrap.

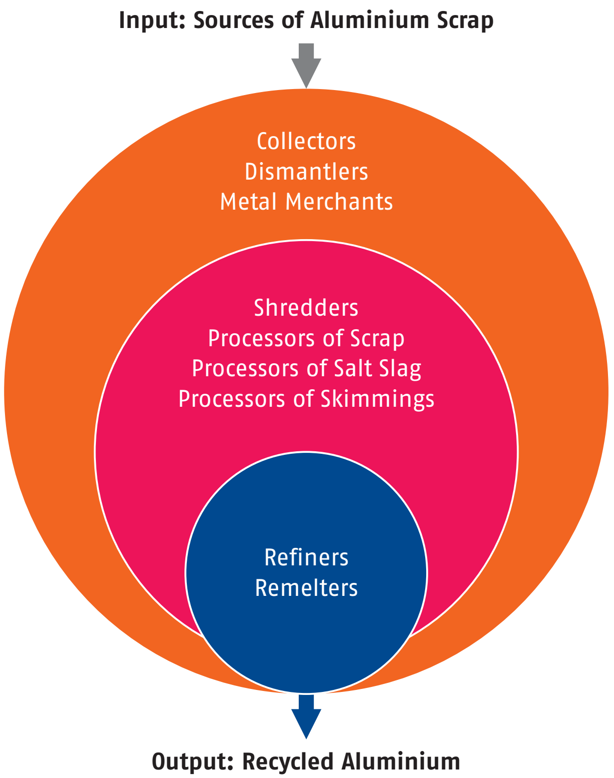
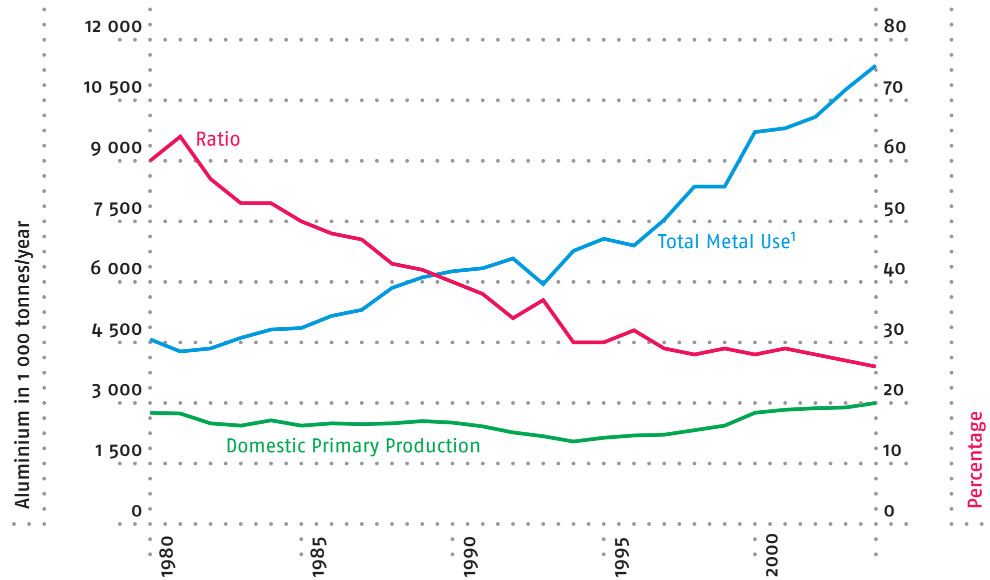


Figure 1: Structure of the Aluminium Recycling Industry

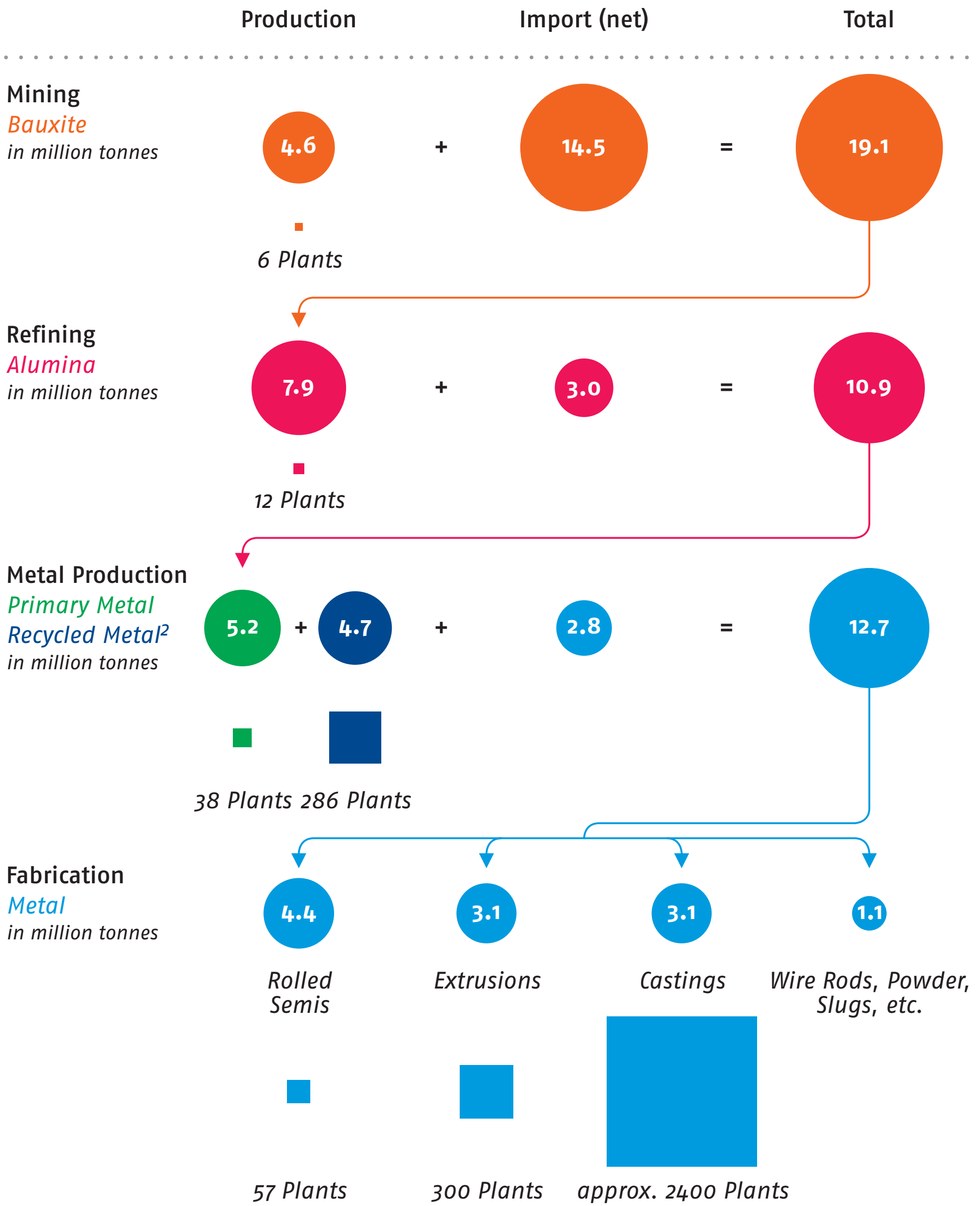
Recycled Aluminium: an Important Raw Material for the EU-25

In 2004, approximately 11.4 million tonnes of aluminium were used for the production of fabricated goods in the EU. Primary aluminium production in the EU currently amounts to just 3 million tonnes. This in fact means that, without aluminium recycling, the EU would have to import about 8.4 million tonnes of primary and recycled aluminium to meet requirements. Primary aluminium production in the rest of Europe yields a further 2.2 million tonnes so, even if this figure were added to the equation, the EU would still depend considerably on aluminium imports. This dependence is substantially alleviated, however, by the recycling of aluminium. In 2004, the EU produced 4.5 million tonnes of ingots for aluminium castings, wrought aluminium (rolling ingots and extrusion billets) and deoxidation aluminium from aluminium scrap.



1 Includes domestic metal production (primary and recycled) and net-metal imports.
2 1980 to 1999: EU-15; since 2000: EU-25

Figure 2: Ratio: Primary Production / Total Use in the EU[2]



Note: Since data on each production step are based on independent statistics and stockists are not taken into account, quantities may not add up.
1 Western and Central Europe (former CIS excluded, except Baltic States)
2 Produced from tolled and purchased scrap

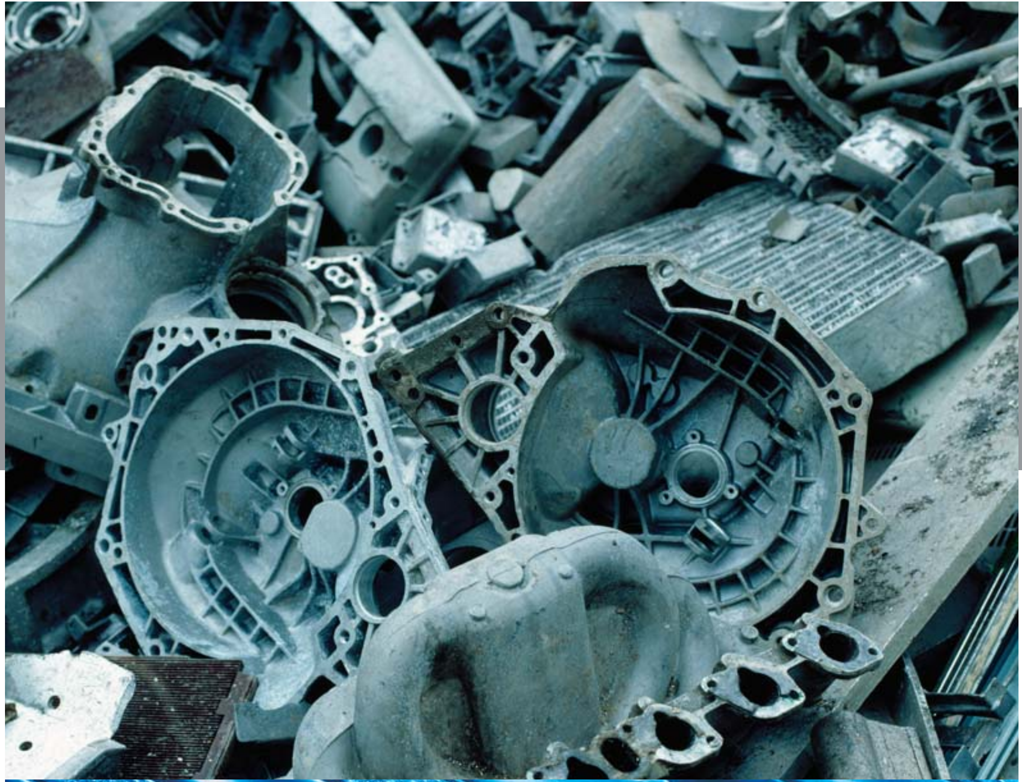
Figure 3: Aluminium Sector in Europe[1] (2004)

	Europe	EU-25
Bauxite		
in million tonnes		
Production	4.6	3.3
Number of Plants	6	4
Net Import	14.5	12.8
Total	19.1	16.1
Alumina		
in million tonnes		
Production	7.9	6.6
Number of Plants	12	7
Net Import	3.0	-0.3
Total	10.9	6.3
Metal Production		
in million tonnes		
Primary Metal	5.2	3.0
Number of Plants	38	24
Recycled Metal[1]	4.7	4.5
Number of Plants	286	263
Net Import	2.8	3.9
Total	12.7	11.4
Fabrication		
in million tonnes		
Rolled Semis	4.4	4.0
Number of Plants	57	50
Extrusions	3.1	2.8
Number of Plants	300	223
Castings	3.1	2.9
Number of Plants	2400	2200
Wire Rods, Powder, Slugs, etc	1.1	0.8

Note: refer to figure 3
1 Produced from tolled and purchased scrap

Figure 4: Comparison – EU-25 and Europe (2004)

2. Economy: the Main Impetus for Aluminium Recycling



Aluminium Recycling: a Profitable Business Activity

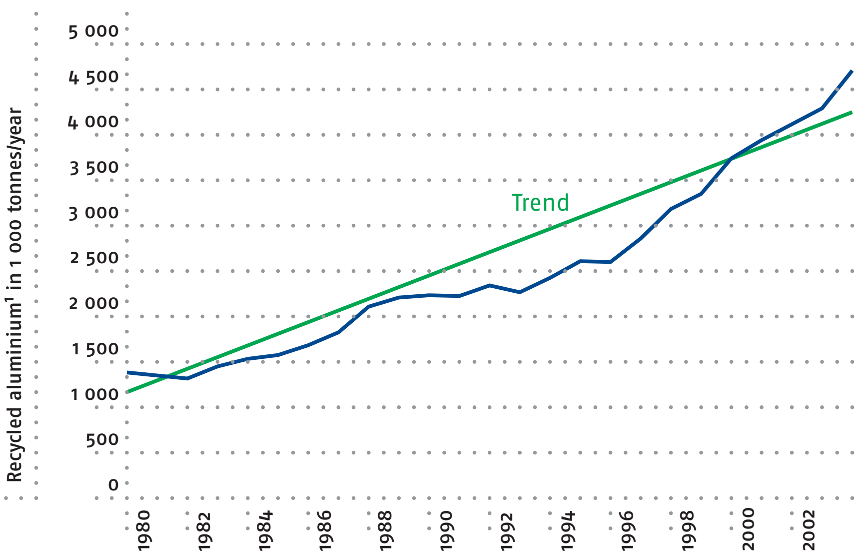
Aluminium scrap has considerable market value because the energy needed for primary production is stored, to a large extent, in the metal itself and, consequently, in the scrap too. Therefore, the energy needed to melt aluminium scrap is only a fraction of that required for primary aluminium production. Furthermore, it can be recycled again and again without loss of its inherent properties since its atomic structure is not altered during melting.

The economic importance of aluminium recycling in Europe cannot be overstated in an aluminium recycling industry that effectively tripled its output from about 1.4 million tonnes in 1980 to approximately 4.7 million tonnes in 2004. The refining sector has grown by 53% and the recycling activity of remelters by a massive 95%. During the same time primary metal production has grown by 17%.

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.

From an environmental point of view, aluminium recycling is ecologically advantageous if the environmental impact of the collection, separation and melting of scrap is lower than that of primary aluminium production. The aim of the aluminium recycling industry is to recycle all sources of aluminium scrap, whenever it is technically feasible, economically viable and ecological desireable. Material recycling is deemed economically viable if the added value exceeds the recycling costs. In specific cases, for instance for very thin aluminium foil laminated to paper, plastics foils, etc., thermal incineration and energy recovery is often preferable to the recovery of the minute amount of aluminium metal.

In recent years, a trend towards greater plant capacity has been observed within



1 *Aluminium produced from tolled and purchased scrap*

Figure 5: Evolution of Recycled Aluminium in Europe

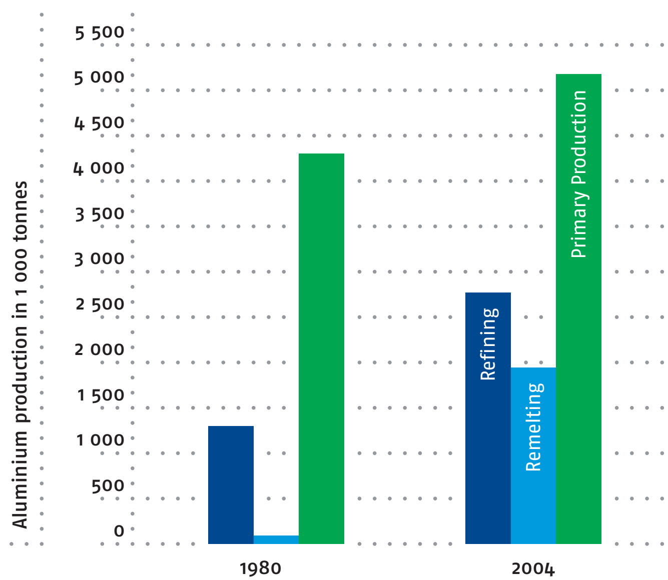


Figure 6: Production – 1980 and 2004 – Europe

the refining industry. This evolution has contributed, above all, to improvements in melting and emission reduction technologies, research and development activities, and economic efficiency.

Aluminium Scrap Standards to Ensure Efficient Recycling

Various types of scrap and other aluminium-containing reclaimed materials are used in aluminium recycling. Since 2003, the European Standard EN 13920 (parts 1–16) on aluminium and aluminium scrap, which covers all scrap types, has been considered the norm for scrap classification. In addition, further classifications at national and international level have been developed on the basis of bilateral agreements, for example, between associations of metal merchants and aluminium recycling smelters. These standards and classifications are the result of quality control developments, which have been ongoing for decades.

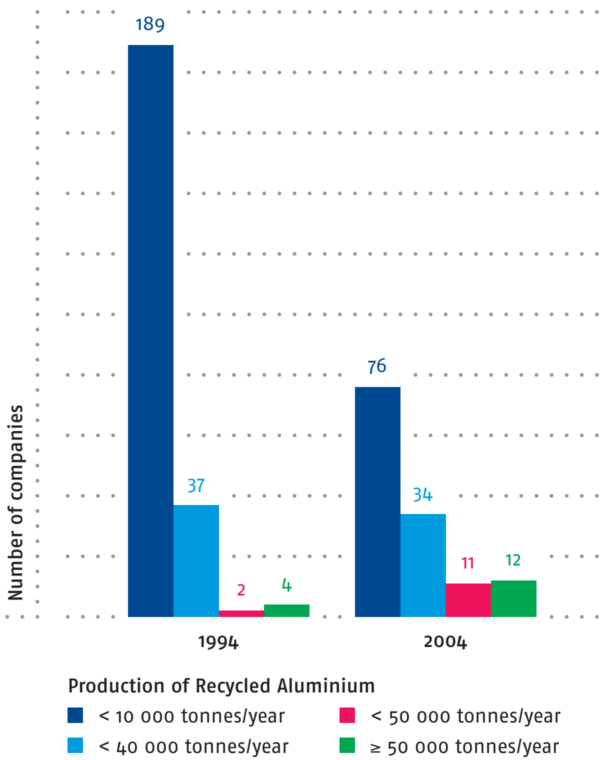


Figure 7: Growing Capacity within the Aluminium Refining Industry

Aluminium Scrap Availability

For decades, aluminium recycling was a regional concern. Recycling was traditionally concentrated in the regions with high aluminium demand and a well organised aluminium recycling industry. Today aluminium scrap is a global raw material commodity. Because its supply is finite, the balance between supply and demand is fundamentally unstable. Trade in scrap, predominantly within Europe, has always been of vital importance to the industry. Because of the variability in the chemical composition and price of scrap, both refiners and remelters have become increasingly specialised over the years. These specialists now apply scrap-specific treatment processes and melting, and operate in facilities implementing strict pollution control practices. If a particular type of scrap is not available in the area where a plant is located, as is often the case, importing the scrap may be the best solution.

Customers of the Aluminium Recycling Industry

There is a well-established market for recycled aluminium with firmly defined distribution chains. Hence, the refiners supply the foundries with casting alloys and the remelters supply the rolling mills and extruders with wrought alloys, where the processing of alloy-specific pieces can ensue. Aluminium alloys are supplied according to European standards and/or customer specifications. Typical products made from recycled aluminium include castings like 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 user of recycled aluminium is the steel industry which utilises aluminium for deoxidation purposes.

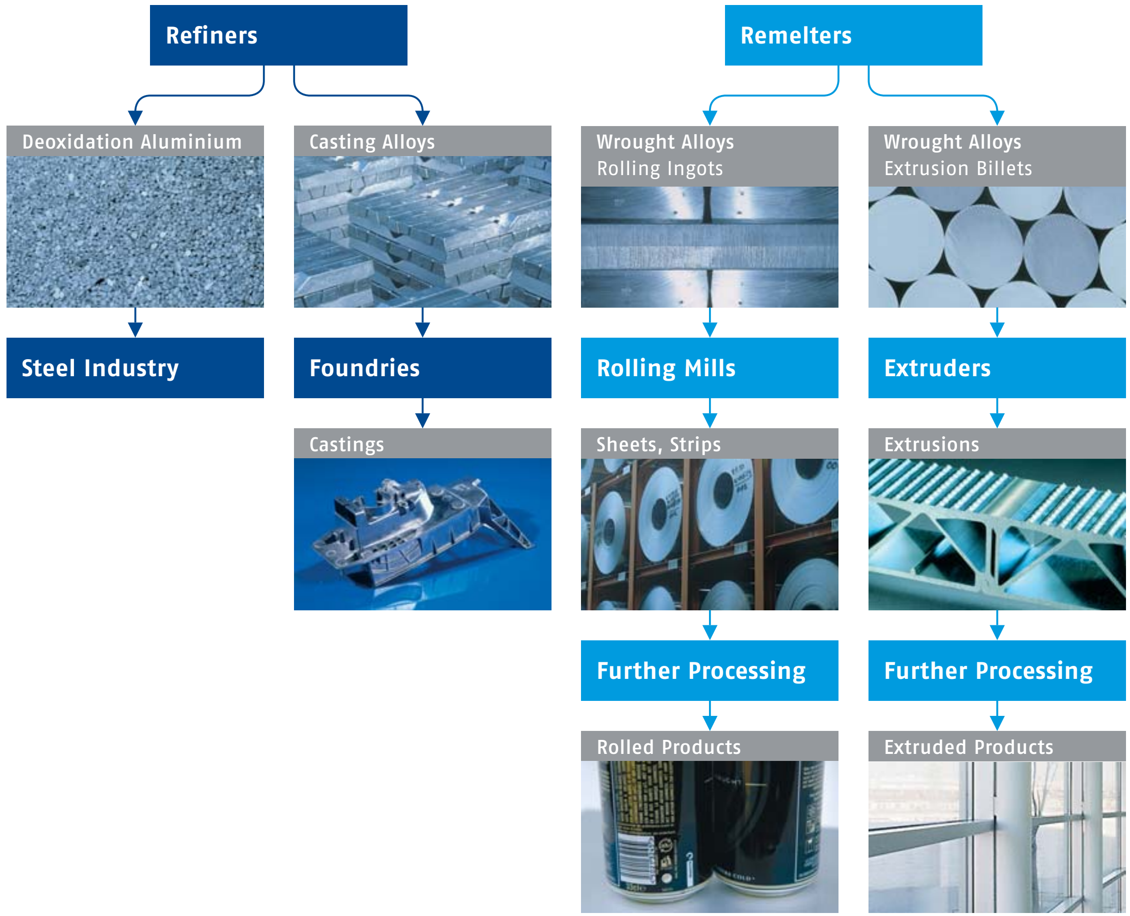


Figure 8: Customers of the Aluminium Recycling Industry

3. Environment: the Commitment of the Aluminium Industry

The aluminium industry fully supports optimal use of energy and materials with minimal waste and emissions during the entire life cycle of the metal: an integrated model of environmentally sustainable industrial activity. The aluminium industry considers recycling an integral and essential part of the raw material supply, underlining the industry's commitment to the sustainable use of resources.

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

Recycling Minimises...

...Energy Needs

Energy savings of up to 95% are achieved per tonne of aluminium produced from scrap compared to primary aluminium.

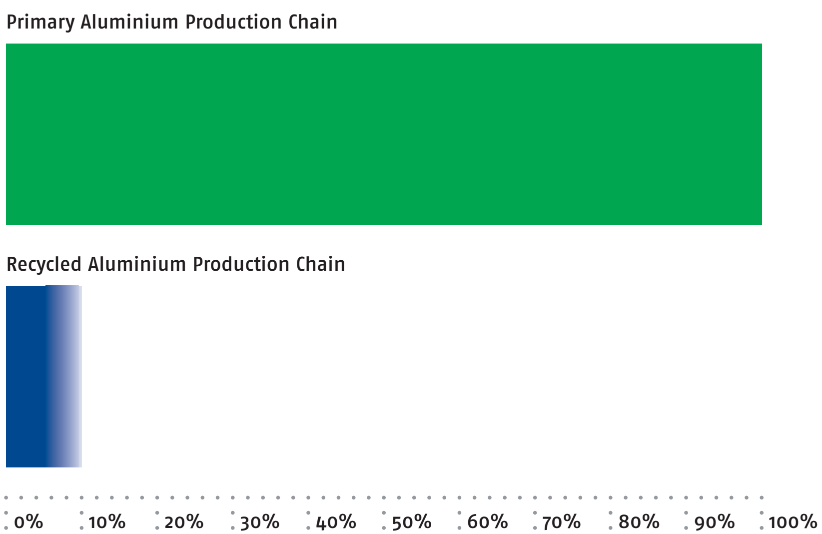


Figure 9: Energy Needs for Primary and Recycled Aluminium

...Use of Natural Resources

In 2004, approximately 19 million tonnes of bauxite, 11 million tonnes of coal, 1 million tonne of natural gas and 6 million tonnes of crude oil were conserved globally as a result of aluminium recycling in Europe alone[1)].

Almost all aluminium used commercially contains one or more alloying elements to enhance its strength or other properties. Aluminium recycling therefore contributes to the sustainable use of copper, iron, magnesium, manganese, silicon, zinc and other elements. This effectively means that, at today's recycled metal production of 4.7 million tonnes, 230 000 tonnes of alloying elements are simultaneously conserved by the aluminium industry in Europe every year.

...Land Use

Aluminium scrap is a recyclable, non-hazardous and valuable raw material, which is not landfilled. In highly urbanised regions, landfill space is dwindling and the construction of new landfill areas is very costly or not even an option because of the lack of potential sites. If aluminium would be non-recyclable material and if the industry would not care about recycling, Europe would have landfilled 4.7 million tonnes more in 2004, which is equal to about 2 million m^3 of landfill volume. Hence, as less ground is used for land-filling, fewer communities need to live beside landfill sites, fewer ecosystems are destroyed and less money is required for site maintenance.

Bauxite deposits are generally extracted by open cast mining. In most cases the topsoil is removed and stored. Since between 4 and 5 tonnes of bauxite are required to produce 1 tonne of primary aluminium and for each tonne of bauxite up to 1 m^2 of land is disturbed, the land use for mining is reduced by recycling. Nevertheless, the impact of bauxite mining is greatly lessened by the industry's sustainable post-mining rehabilitation measures. In 2002, about 83% of the total mined area was rehabilitated, of which 80% was returned to native forests, 10% to tropical forests, 4% to commercial forests, 2% to native pasture and the remaining 4% was predominantly used for urban and industrial development, housing and recreational purposes[2].

...Waste and Pollution

The aluminium industry has always been proactive in its efforts to minimise waste, landscape disruption and emissions during primary aluminium production, while at the same time striving to increase the use of recycled aluminium. Industry monitoring[1] of environmental aspects in Europe demonstrates the following approximate savings made when producing one tonne of recycled aluminium by refiners versus primary aluminium (including both direct and indirect emissions):

- 1 370 kg bauxite residues
- 9 800 kg CO_2 equivalent
- 64 kg SO_2 emissions

Environmental Impact of Recycling

European refiners and remelters are equipped with state-of-the-art technology (see reference document on Best Available Techniques in the Non-Ferrous Metal Industries by the European Commission) to clean exhaust gases of dust, acidic compounds (HCl, HF, SO_2), volatile organic carbon, dioxins and furans. Residues are recycled wherever possible or treated and disposed of according to the latest available technologies and procedures. Aluminium salt slag (~260 kg/tonne aluminium[3]) that is generated during melting of scrap under a salt layer is processed to reusable salt, aluminium

metal for future use, and aluminium oxide. The aluminium oxide is then used in a variety of applications, such as the production of cement. Filter dust (~8 kg/tonne aluminium[3]) is recycled or discarded into specially designed facilities. Skimmings (~120kg/tonne aluminium[3]) and, in some cases, furnace lining (~2 kg/tonne aluminium[3]) are recycled within the aluminium recycling industry.

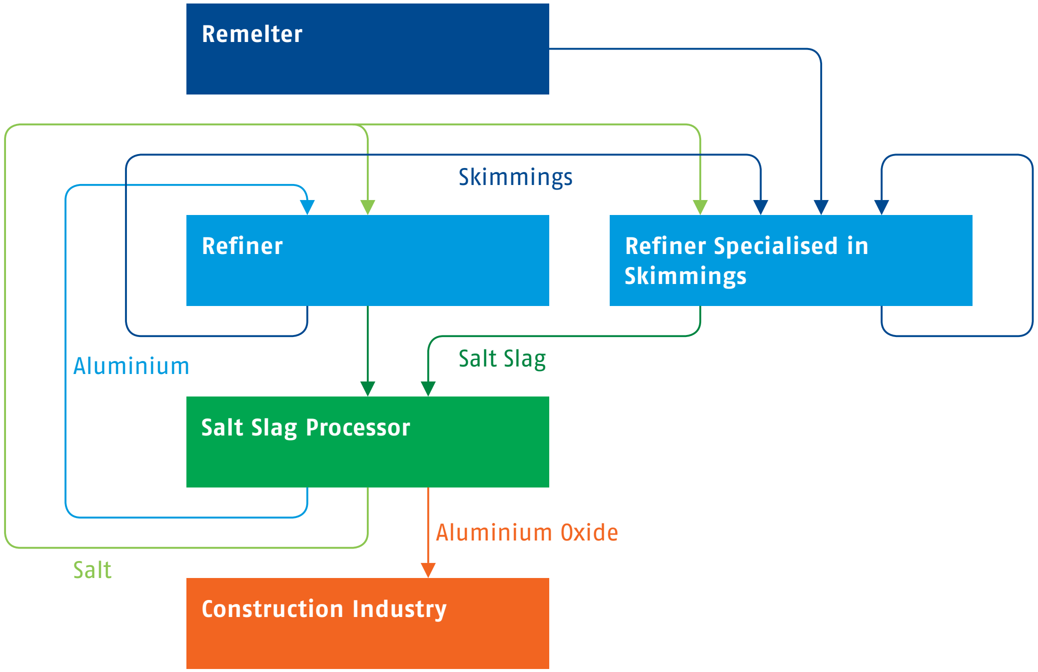


Figure 10: Internal Recycling Flow

Measuring the Recycling Performance of the Aluminium Industry

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 frequently ask questions).

The recycling performance of the aluminium industry is determined first of all by how much aluminium metal is lost within the industry. 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, *The growing markets for aluminium are supplied by both primary and recycled metal sources. Increasing demand for aluminium and the long lifetime of many products mean that, for the foreseeable future, the overall volume of primary metal produced from bauxite will continue to be substantially greater than the volume of available recycled metal.*

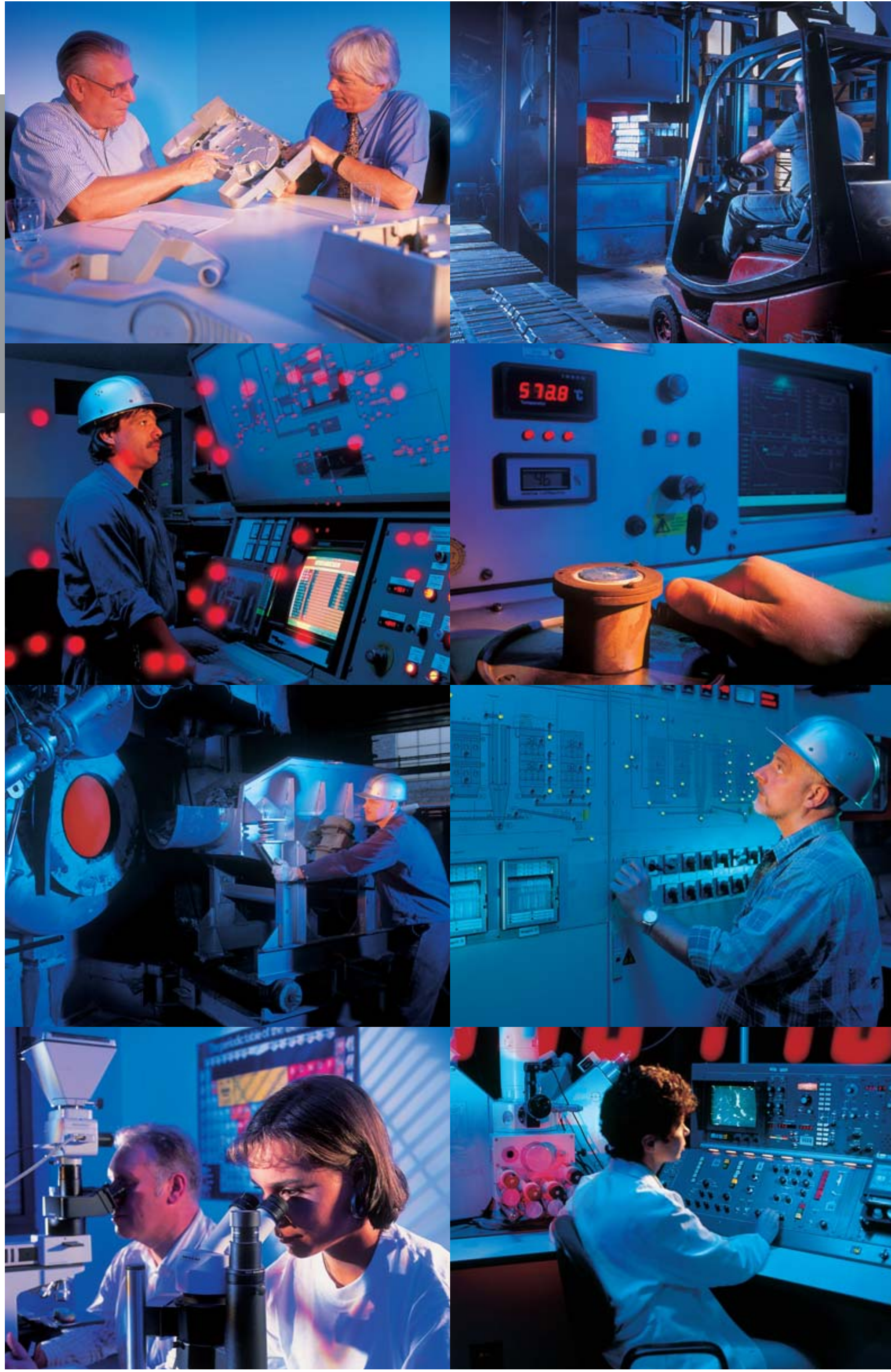
plastic, lubricants, etc), at the input side of the scrap and aluminium recycling from skimmings and salt slag. The study[3] has shown that the real metal loss for all scrap melted in the EU-15 is usually less than 2%, i.e. the net metal yield is above 98%. For old scrap, the metal loss is between 1 and 5% depending on the scrap type and the furnace technology used.

Secondly, when looking at a broader picture of aluminium use and resource conservation, one needs to compare the amount of recycled metal used in relation to the availability of scrap sources keeping in mind the technological and ecological borders of recycling. For aluminium products heavier than around 100 grams, 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 building products or overhead cables. However, we are living in the world of "dematerialisation" and multi-material 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, machines, electrical and electronic equipment get smaller and more complex. From a sustainability standpoint this is altogether a positive development, but requires additional efforts for the collection and recovery of aluminium from end-of-life products.

Legislators, politicians and aluminium users often refer to the ratio of recycled material to total material used as an indicator of recycling efficiency. 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.

Many of the alloying elements do, however, limit the usability of recycled aluminium in the production of fabricated goods, like extrusion billets or rolling ingots. Therefore, aluminium scrap with an alloy composition corresponding to that of wrought alloys is separated whenever possible.

1) *EAA, 2004. Environmental Profile Report – reference year 2002.*
2) *IAI, 2004. Third Bauxite Mine Rehabilitation Survey. http://www.world-aluminium.org*
3) *Boin U.M.J. and Bertram M., 2005. Melting Standardized Aluminium Scrap: A Mass Balance Model for Europe. JOM 57 (8), pp. 26–33.*



4. Social Aspects: the Small to Medium-Size Business Structure of the Aluminium Recycling Industry

Although the number of integrated aluminium companies (i.e. companies involved in all stages of aluminium production) producing recycled aluminium is on the rise, most existing recycling companies are non-integrated, privately owned and of medium size. In 2004, the European aluminium recycling industry numbered 160 refining and 126 remelting plants. This industry, comprising all areas of collection, processing, refining and remelting, currently provides more than 10 000 direct and indirect jobs over all Europe.

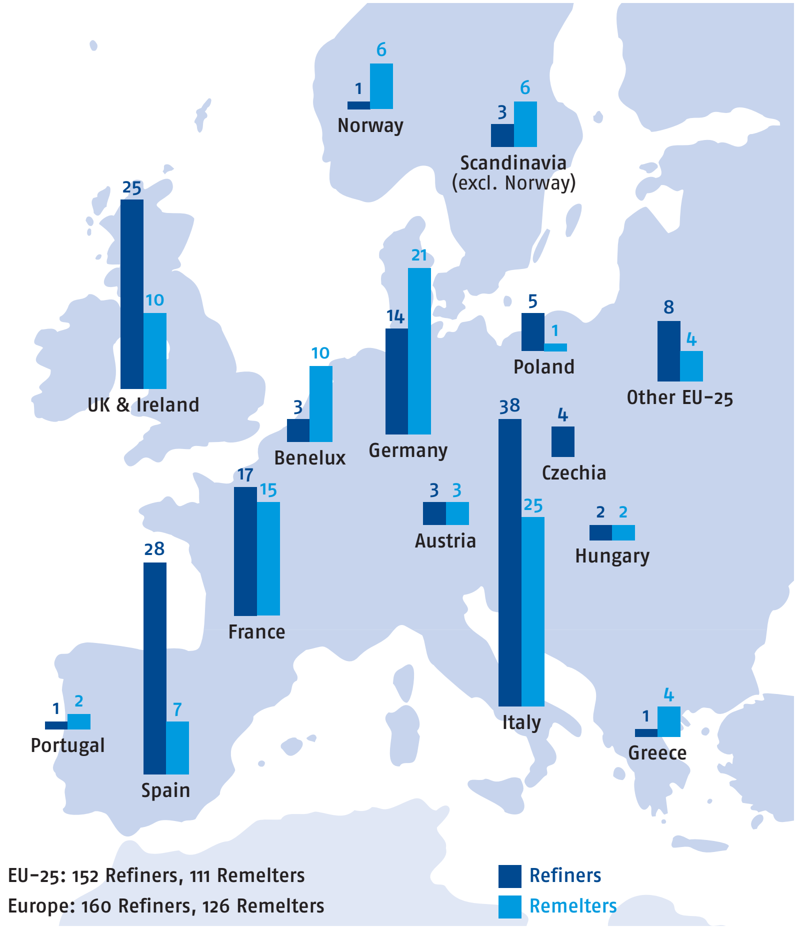
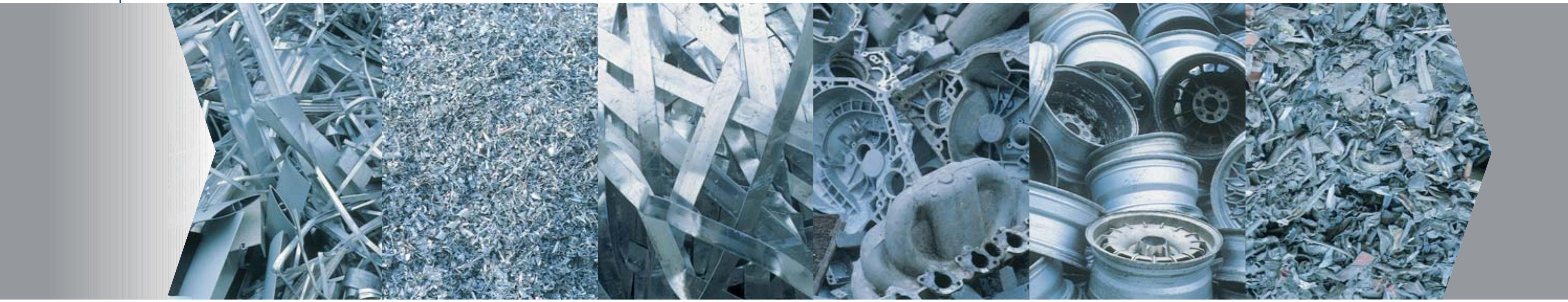


Figure 11: Number of Plants in the European Aluminium Recycling Industry

European refiners and remelters play vital roles as material suppliers, having produced 4.7 million tonnes of aluminium from scrap in 2004. They contribute in no small measure to safeguarding the continued existence of the aluminium fabrication and manufacturing industry in Europe.

5. Closing the Cycle: the Aluminium Recycling Process

As the final link in the recycling chain, the refiners and remelters contribute significantly to the protection of our environment. It is they who ensure the production of a material that can be reabsorbed into the aluminium life cycle. Both refiners and remelters treat and melt scrap. The refiners then supply the foundries with casting alloys, and the remelters provide the rolling mills and extruders with wrought alloys. Refiners use scrap, almost exclusively, as a raw material, while remelters use both aluminium scrap and primary metal. For this reason, the size of the remelting industry is measured by the extent of its scrap intake rather than by production volumes of extrusion billets or rolling ingots.

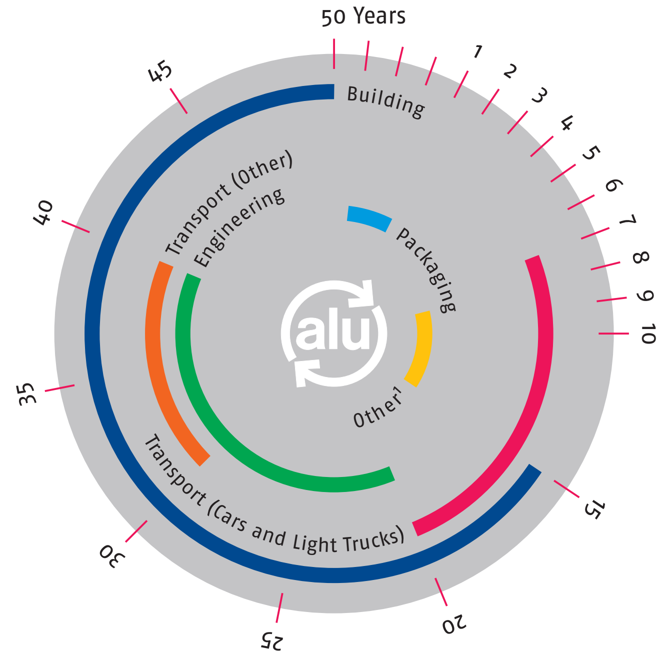


Raw Materials

To obtain a finished aluminium product from raw materials, the aluminium undergoes a variety of processes from bauxite mining, alumina refining and aluminium smelting to fabrication and manufacture. Some of these processes generate aluminium by-products: skimmings during melting and casting; edge trimmings and billet ends during rolling and extruding; turnings, millings and borings during various machining processes; off-cuts during stamping and punching processes, as well as defective goods at all production stages. This material is termed "new scrap" because it is generated during the initial processing and production stages, not having yet reached the use phase. A large quantity of new scrap in Europe is generated and recycled in the same company or company group. It is then referred to as internal scrap and is not covered in statistics.

Once aluminium is turned into a final product, it is purchased by the consumer and used for a certain lifetime. The lifetime of aluminium products ranges from a few weeks for packaging items like cans, to decades for permanent fixtures like window frames and building façades. However, lifetime averages can be distorted by products going into "hibernation", that is to say, they are not discarded but rather stored in households. Furthermore, a proportion of products that have reached the end of their intended life may be reused as replacement parts, a common practice with vehicles. Sooner or later, aluminium products are discarded and find their way into the recycling loop. After collection, this material is termed "old scrap" because it has been used.

Both new and old scrap are equally precious raw materials for recycling.



1 Including consumer durables

Figure 12: Average Lifetime Ranges for Aluminium Products in Years

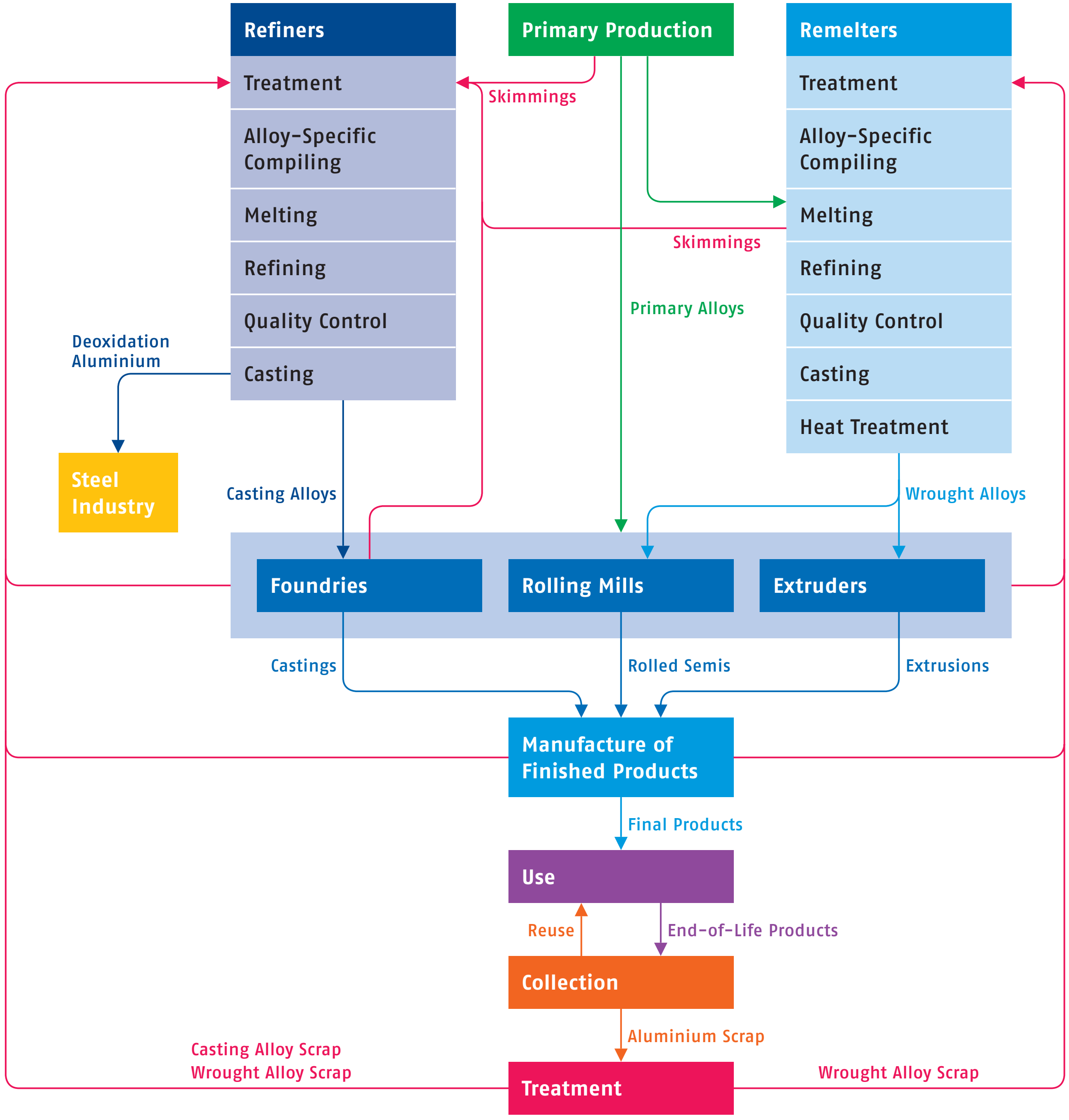
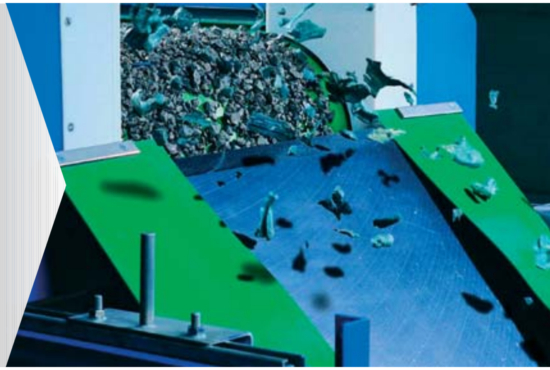


Figure 13: General Aluminium Flow Chart



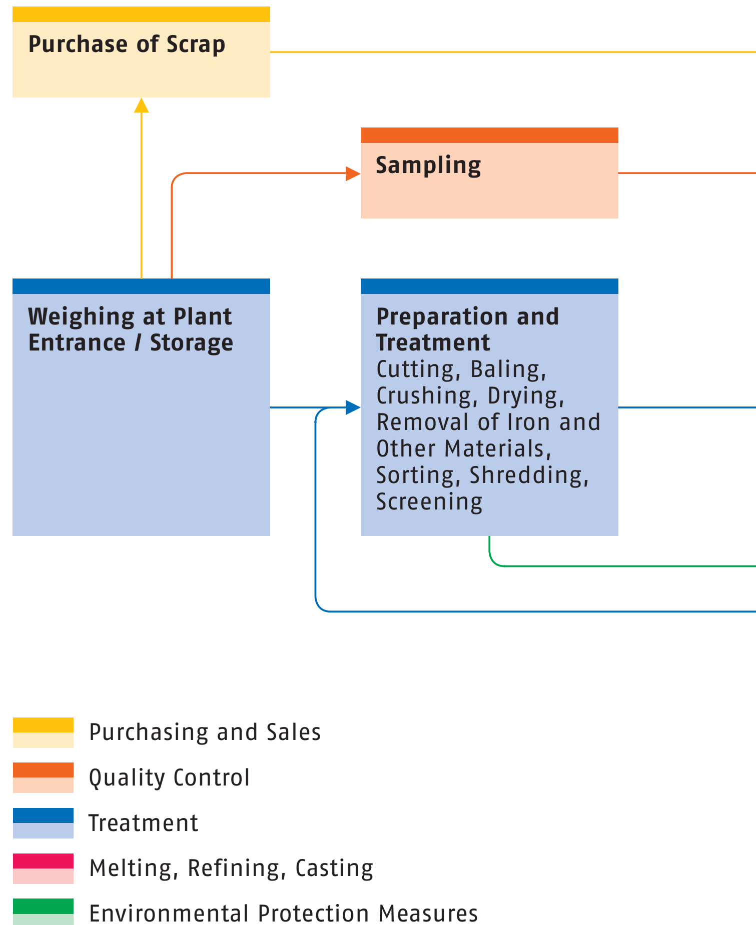
Collection

The aluminium recycling industry recycles all the aluminium scrap it can obtain from end-of-life products and aluminium by-products. New scrap is collected in its entirety, as collection is in the hands of the aluminium industry. The collection of aluminium at end-of-life depends, however, on consumer initiative to collect aluminium for recycling, as well as the co-operation of industry, legislators and local communities to set up efficient collection systems.

Treatment

Scrap must be of appropriate quality before it can be melted down. To obtain this level of quality, all adherent materials must be removed. Depending on scrap type, aluminium losses of about 2% to 10% may be incurred during separation of aluminium from other materials. A certain degree of material loss is inevitable with industrial processes but, because of aluminium's high intrinsic value, all efforts are directed at minimising losses. For example end-of-life products are often not mechanically separable into single material output fractions. A dilution of foreign materials within each output is the result. The treatment of scrap is a joint undertaking by the aluminium recycling industry and specialised scrap processors.

Clean scrap may be shredded or baled to assist subsequent handling. Turnings are treated in special processing facilities, where they are freed of all adherents, degreased, dried and separated from any iron particles using a magnetic separator.



Industry continues to recycle, without subsidy, all the aluminium collected from used products, as well as fabrication and manufacturing processes. However, with the help of appropriate authorities, local communities and society as a whole, the amount of aluminium collected could be increased further.

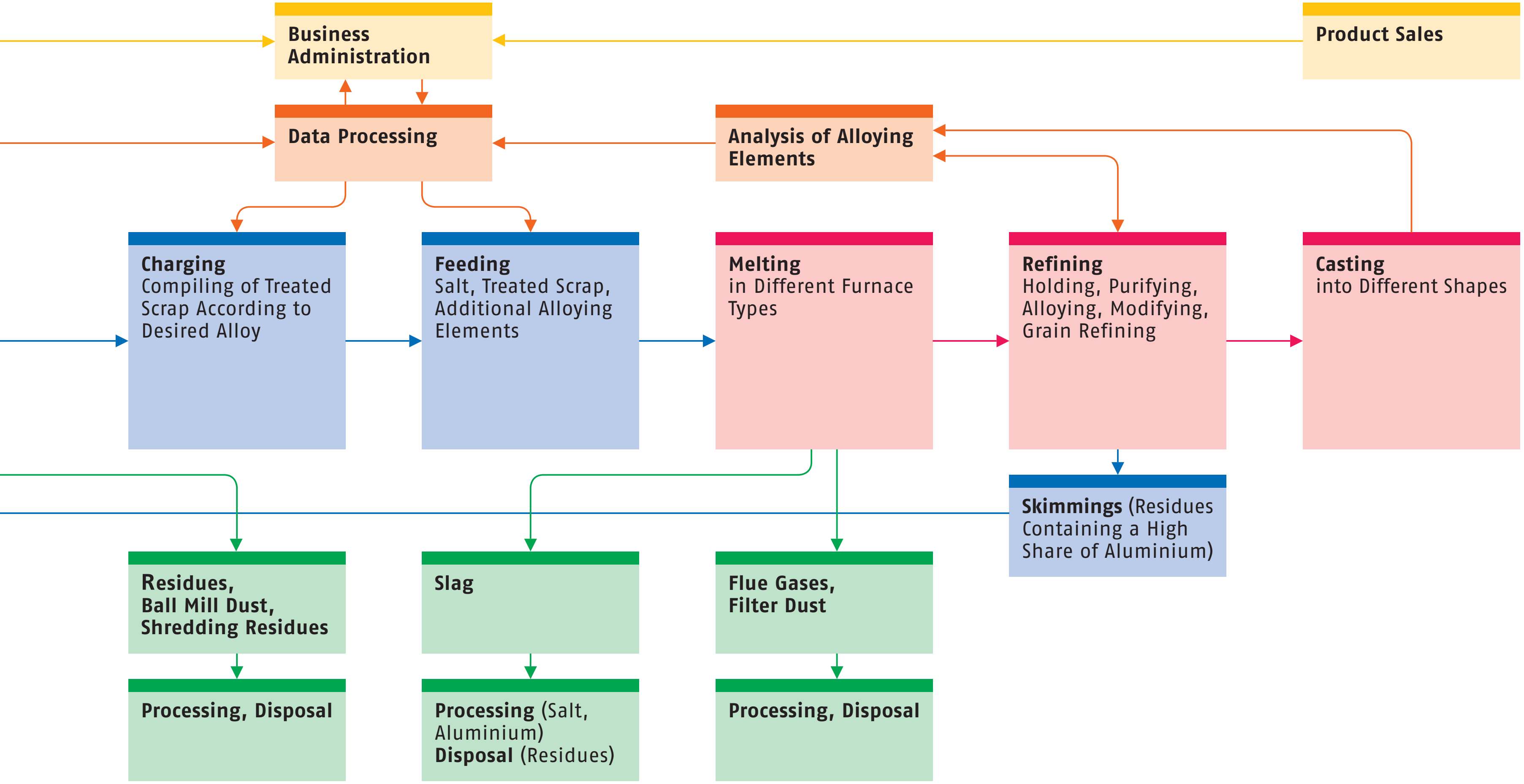


Figure 14: Information and Material Flow within the Aluminium Recycling Industry

Large scrap pieces (e.g. engine blocks) are fragmentised in order to separate foreign iron from the aluminium. If it is difficult to separate unwanted iron mechanically or manually from aluminium scrap, the scrap is fed into a special furnace that separates the iron thermally. Usually, it is more difficult to separate other non-ferrous metals from aluminium. For this purpose, heavy media separation is used, where scrap can be separated from impurities by density.

For the separation of aluminium from non-metallic pieces eddy current installations are used which separate materials with different electrical conductivity. For example, eddy current machines can be used to separate aluminium from shredded computers.

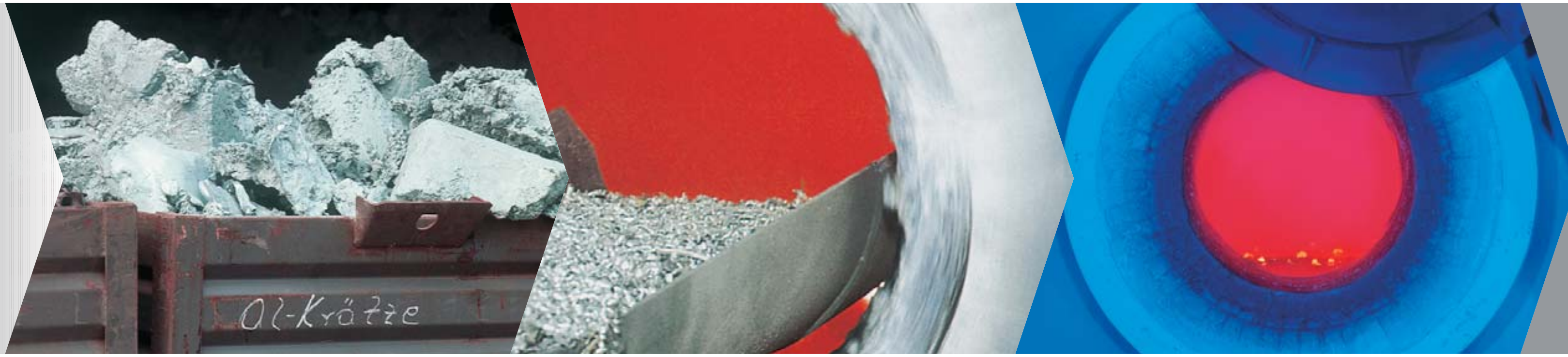
Aluminium cans, lacquered and laminated scrap are often cleaned to remove coatings and residues to minimise metal losses during remelting. The industry uses three principal de-coating technologies: Rotary kiln, belt and fluidized bed de-coater.

Aluminium contained in multi-material packaging (e.g. beverage cartons) can be separated by pyrolysis. In this case, the non-metallic components are removed from the aluminium by evaporation.
A newer technology is the thermal plasma process here all three components – aluminium, plastic and paper – are separated into distinct fractions.

Before entering the furnace, aluminium skimmings are usually broken up or milled and separated by density, while aluminium oxides are separated by sieving.

The chemical composition of wrought alloys are generally characterised, among others things, by their low tolerance for certain alloying elements. Remelters select the appropriate quantity and quality of scrap to correlate with the chemical composition of the wrought alloy to be produced. Hence, great care must be taken to choose the right scrap. New scrap, for which the alloy composition is known, is predominantly used by remelters but old wrought alloy scrap of known chemical composition is also increasingly employed. Two good examples are used beverage cans, which are utilised to produce new can stock material, and window frames which, after being in use for decades, are treated and melted down for the production of new wrought alloy products.

In order to build lighter vehicles, greater quantities of aluminium, especially wrought alloys, will be used in the future. When these vehicles return for recycling it might be needed to separate the wrought alloys from the casting alloys, a technology not applied nor needed at present, as little of the aluminium contained in today's vehicles is in the form of wrought alloys. Thus, the implementation of separation procedures does not make economic sense at present, but new technology in the form of laser and x-ray sorting is under development for future application.



Alloy-Specific Compiling of Scrap

Before being loaded into the furnace, it is standard practice for alloy-specific scrap batches to be combined in order to ensure a precise alloy composition in the final product. This type of computer-assisted optimisation of selection and mixing of scrap types enables the aluminium recycling industry to work as economically as possible. It also serves to minimise environmental impact, since limited alloy corrections need to be made after melting.

Melting

Refiners melt mixed casting and wrought alloy scrap, while remelters use mainly clean and sorted wrought alloy scrap, as well as some primary metal.

Selection of the most appropriate furnace type is determined by the oxide content, type and content of foreign material (e.g. organic content), geometry of the scrap (mass to surface ratio), frequency of change in alloy composition and operating conditions. Scrap is melted in dry hearth, closed-well, electric induction, rotary or tilting rotary furnaces. Refiners most commonly use the rotary furnace, which melts aluminium scrap under a salt layer, while remelters favour the hearth furnace.

As a result of contact with the oxygen in air, aluminium is covered with a thin layer of aluminium oxides. This chemical reaction occurs particularly at high temperatures during melting, be it primary melting, foundry casting or recycling. This is the reason why molten aluminium is protected from further oxidation in the furnace. The generated fine mixture of oxide skins, metal (in equal amounts) and gas on the surface of the melt in the furnace is termed skimmings or aluminium dross. These skimmings have to be removed before the metal is cast. This by-product is collected and recycled into aluminium alloys and aluminium oxides (used in the cement industry) in special refineries. Using salt during the melting process reduces the amount of oxides generated and removes impurities from the liquid metal.

Refining

Alloy production in the melting furnace is followed by a refining process. The molten metal is transferred to a holding furnace, where the chemical composition is adjusted and the metal purified by the addition of refining agents or with the use of filters. For example, the introduction of fine bubbles of chlorine, argon and nitrogen removes unwanted elements, such as calcium and magnesium, and degasses the molten metal. Different grain refiners and modifiers are added in order to guarantee the desired metallurgical structure of the resulting product.

Quality Control

Casting and wrought alloys are subject to the most stringent controls with regard to chemical composition, cleanliness and consistency, in line with European standards. However, special alloys can be produced according to specific customer demand. Most casting alloys are produced exclusively by the aluminium recycling industry, as the primary industry is often unable to produce the diversity of alloys required by the foundry industry.

During melting, samples are regularly taken and analysed using the latest computer-controlled technology, before it is awarded the necessary certification. Even the smallest discrepancy with the specified alloy composition, down to the parts-per-million range, can be detected and adjusted. Documentation systems ensure future traceability of every step of the process, from the initial scrap load to the final alloy.

Casting

As a final step, molten aluminium casting alloys are cast into ingots (4 kg to 25 kg) or directly transported to the foundry as molten metal. Indeed, refiners often deliver aluminium in its molten state to be turned into castings immediately upon arrival at the foundry. In the right circumstances this saves money and reduces environmental impact. Sometimes aluminium oxides trapped within the metal are filtered out during the casting process.

Molten aluminium wrought alloys are cast into extrusion billets and rolling ingots, which may need to undergo heat treatment for various metallurgical reasons before hot working.

Aluminium is used in the steel industry to eliminate unwanted oxygen because of its high affinity for oxygen. Special aluminium alloys are thus cast into small ingots or other specific shapes for deoxidation purposes to produce high quality steel.

Product Range

At the end of the material cycle, the final aluminium product is obtained. This may be the same as the original product (e.g. window frame recycled back into a window frame) but is more often a completely different product (cylinder head recycled into a gearbox).

Foundries are the main customers of refiners. They produce a wide variety of castings which are principally used in the transport sector. More than 70% of castings are used in the transport sector. Examples of castings produced from recycled alloys include cylinder heads of engines, engine blocks, pistons, gearboxes, auxiliary equipment and seats. Other prominent users of aluminium casting alloys are the mechanical and electrical engineering sectors, producers of consumer durables and the construction industry. Commonplace castings in everyday use include parts of washing machines, escalator steps and electronic equipment, to name but a few.

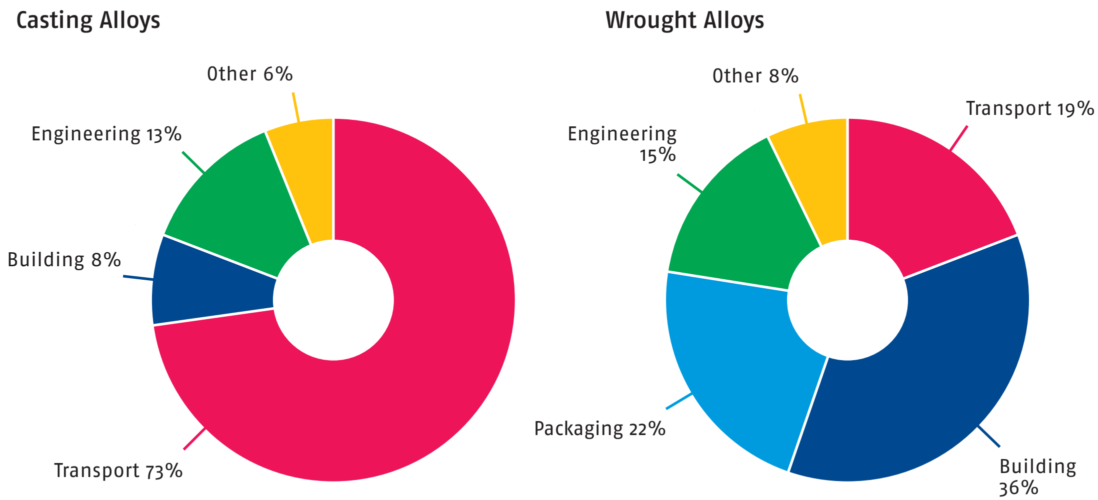


Figure 15: End Uses of Casting Alloys and Wrought Alloys in Western Europe

Wrought alloy products such as sheets, foil and extrusion profiles can be found in roofs and curtain walls of buildings, food and pharmaceutical packaging, beverage cans, windows, doors, truck trailers, trains and, increasingly, car bodies.

6. End-of-Life Product Recycling: the Route to High Quality at Low Cost

Estimated end-of-life recycling rates for aluminium used in the transport and building sectors are very high (90 to 95%). These represent 63% of fabricated goods shipped to the European aluminium market in 2004. Packaging recycling rates in Europe range from 25 to 75%, depending on the country.

Global aluminium recycling rates are high, approximately 90% for transport and construction applications and about 60% for beverage cans.

Transport

Transportation is the most important field of application for aluminium in Europe. In 2004, approximately 3.6 million tonnes of wrought and casting alloys were used for the production of cars, commercial vehicles, aeroplanes, trains, ships, etc., and that figure is steadily rising. Consequently, the transport sector is also a major source of aluminium at the end of a vehicle's lifetime. The precise end of a vehicle's lifetime is, however, difficult to define. In Germany, for example, cars are used for an average period of 12 years, at the end of which they can enter the recycling loop. But their lifetime is often extended by export to less developed parts of the world, where their useful life may continue for many more years to come. Compared to other materials, aluminium scrap has a very high material value, which provides sufficient economic incentive for it to be recycled. For this reason, 90 to

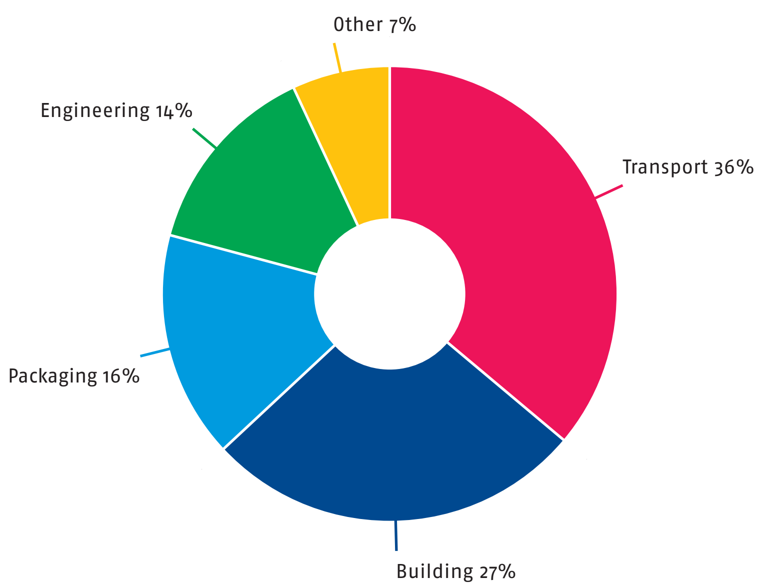


Figure 16: Aluminium End-use Markets in Western Europe

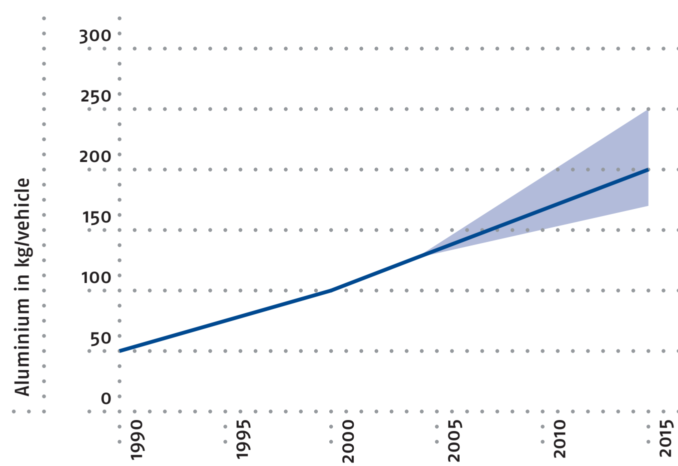


Figure 17: Aluminium Content in European Vehicles

95% of the aluminium used in cars is collected and reused as automotive parts, or introduced into the recycling loop. Other modes of transport have similarly high recycling or reuse rates.

A number of efficient processes are used to collect and separate aluminium from vehicles. Figure 18 shows a modern process used in order 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 plastics, rubber, glass, textiles and non-ferrous metals is obtained. This mixed fraction constitutes merchandise subject to the European Standard EN 13290-8 and is intended for further sorting processes by the user.

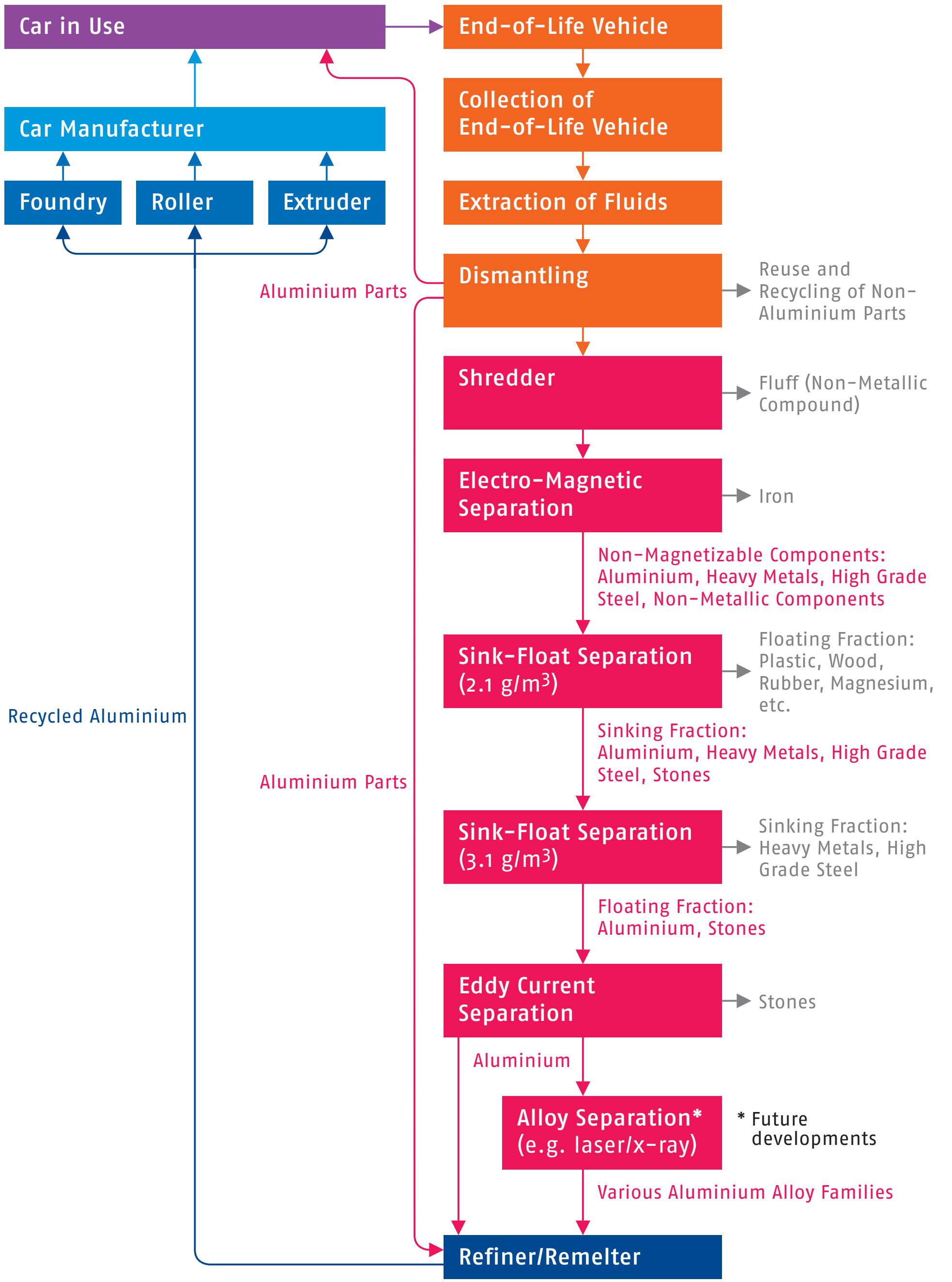
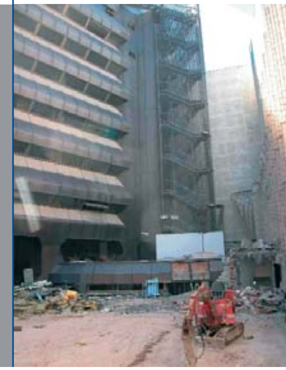


Figure 18: Modern End-of-Life Vehicle Dismantling and Aluminium Recycling Process



These processes include sink-float and eddy current separation and result in an aluminium fraction covered by EN 13290-9. A new process being developed to sort aluminium scrap metallurgically utilises laser and spectroscopic technology. This technology, is now at an advanced stage of development, looks very promising.

Aluminium scrap collected using the various separation procedures is 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 as of 2015/2020. From then on, the separate collection of wrought alloys from cars will be economically viable.

Aluminium used in other modes of transport is collected separately at end-of-life, when commercial vehicles, aeroplanes, railway coaches, ships, etc. are dismantled. As the aluminium parts are often too large to be immediately melted in the furnace, they must first be reduced to small pieces by processes such as shearing. Aluminium-intensive trailers often spend their entire life in the same region, where they are eventually dismantled and subsequently melted by refiners or remelters. Most aluminium-containing ships and railway coaches are still in use due to aluminium's relatively recent history in these applications and its long-lasting performance.

Building

In order to raise people's awareness of the excellent recycling properties of aluminium and the extent of its scrap potential in the building sector, the EAA commissioned Delft University of Technology to conduct a scientific study investigating aluminium content and collection rates in European buildings. The demolition of a significant number of buildings in six European countries was closely monitored and comprehensive data were gathered. The collection rates of aluminium in this sector were found to vary between 92 and 98%, demonstrating aluminium's pivotal role in the pursuit of full sustainability. Although it was revealed that the average aluminium inventory per building is currently less than 1% of the overall mass, the quantities of aluminium recovered from demolition sites often yield a substantial profit for the contractor.




Today, the European building market uses some 2.7 million tonnes of aluminium semis annually. As aluminium building products often have lifetimes running into decades, a vast material (close to 50 million tonnes of aluminium) storage bank is being created for future recycling use.

Packaging

Aluminium packaging fits every desired recycling and processing route. The amount of aluminium packaging effectively recycled greatly depends upon individual national requirements and the efficiency of the collection schemes, therefore rates vary from 25 to 75% across Europe. However, in all cases the value of the collected scrap covers most if not all of the related recycling costs.

Most European countries have nationwide aluminium packaging recycling schemes in place. These can be grouped into three main routes:

1. Separate collection of used beverage cans, either in designated deposit systems (Scandinavian countries and Germany), voluntary take back systems (Switzerland and Poland) or incentive based projects (UK, Ireland, Hungary and Greece) such as charity events. Moreover aluminium containers are included in separate collection schemes in the UK and Switzerland; the later covers aluminium packaging tubes as well.

2. Multi-material packaging collection systems, where aluminium containing packaging is part of the “light packaging flow” containing plastics, tinplate, beverage cartons and sometimes paper packaging, newspapers and magazines. Here, aluminium is separated during the final step of sorting at the plant (e.g. Italy, Spain, Germany, Portugal, France, Belgium, Austria).

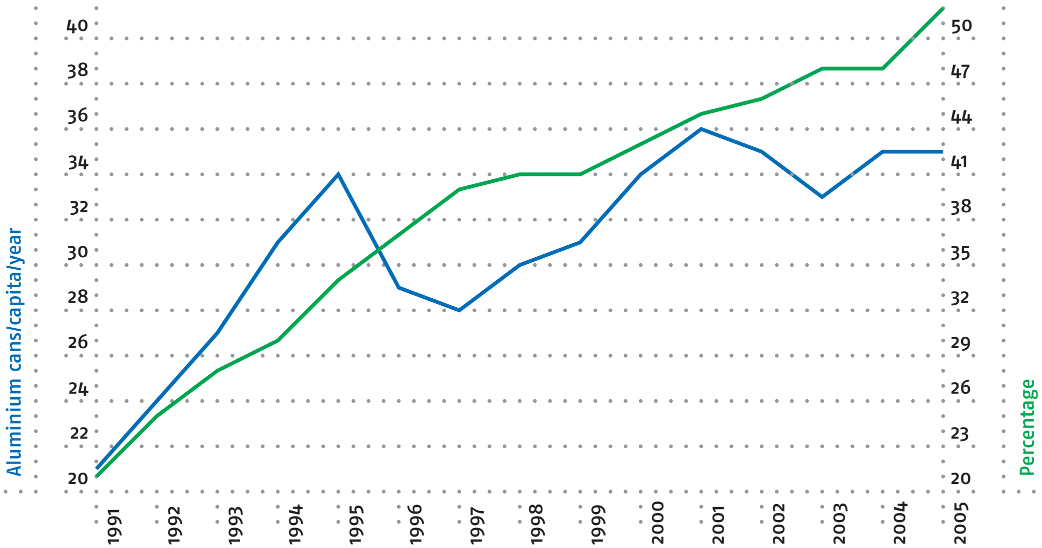
3. Extraction from the bottom ashes of municipal solid waste incinerators as aluminium nodules (Netherlands, France, Belgium and Denmark, in particular)

In many European countries municipal solid waste is entirely or partly incinerated, in this case the contained thin gauge aluminium foil is oxidised and delivers energy while thicker gauges can be extracted from the bottom ash.

In line with national requirements (e.g. Germany), aluminium can be extracted from laminates by pyrolysis and thermal plasma techniques.

As aluminium from collected packaging is just as easy to melt as other types of aluminium scrap, the aluminium industry, together with the equipment manufacturers, has focused its efforts on developing various aluminium sorting techniques. Eddy current machines and detection-ejection systems are implemented to extract aluminium from mixed materials flows as well as from incinerator bottom ashes where it is highly diluted.

For used beverage cans alone the collection rates are as high as 80 to 93% in some European countries (Benelux, Scandinavian countries and Switzerland). The mean collection rate of aluminium beverage cans in Western Europe, which has been monitored since 1991, has more than doubled from 21% in 1991 to 52% in 2005.

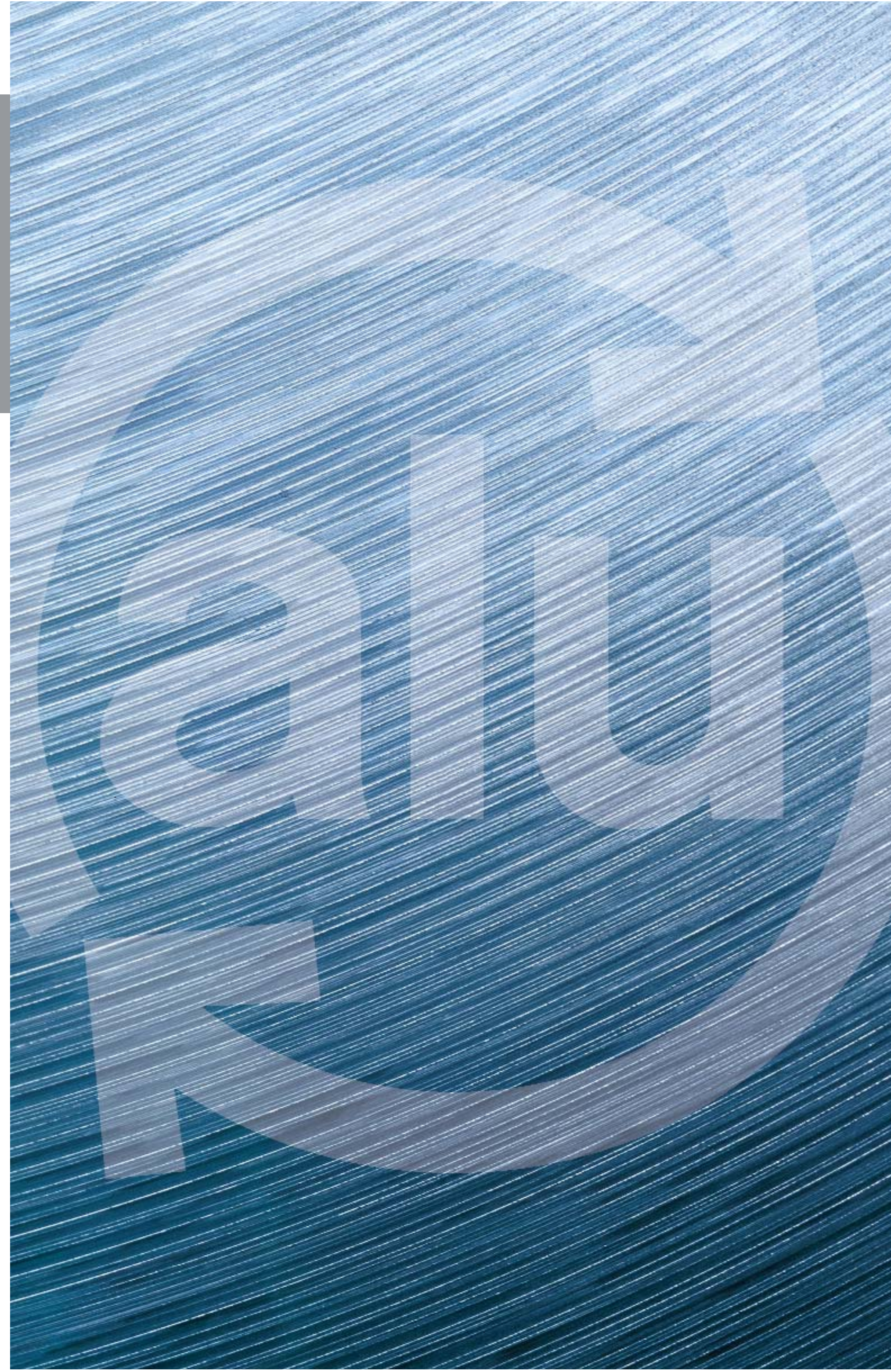


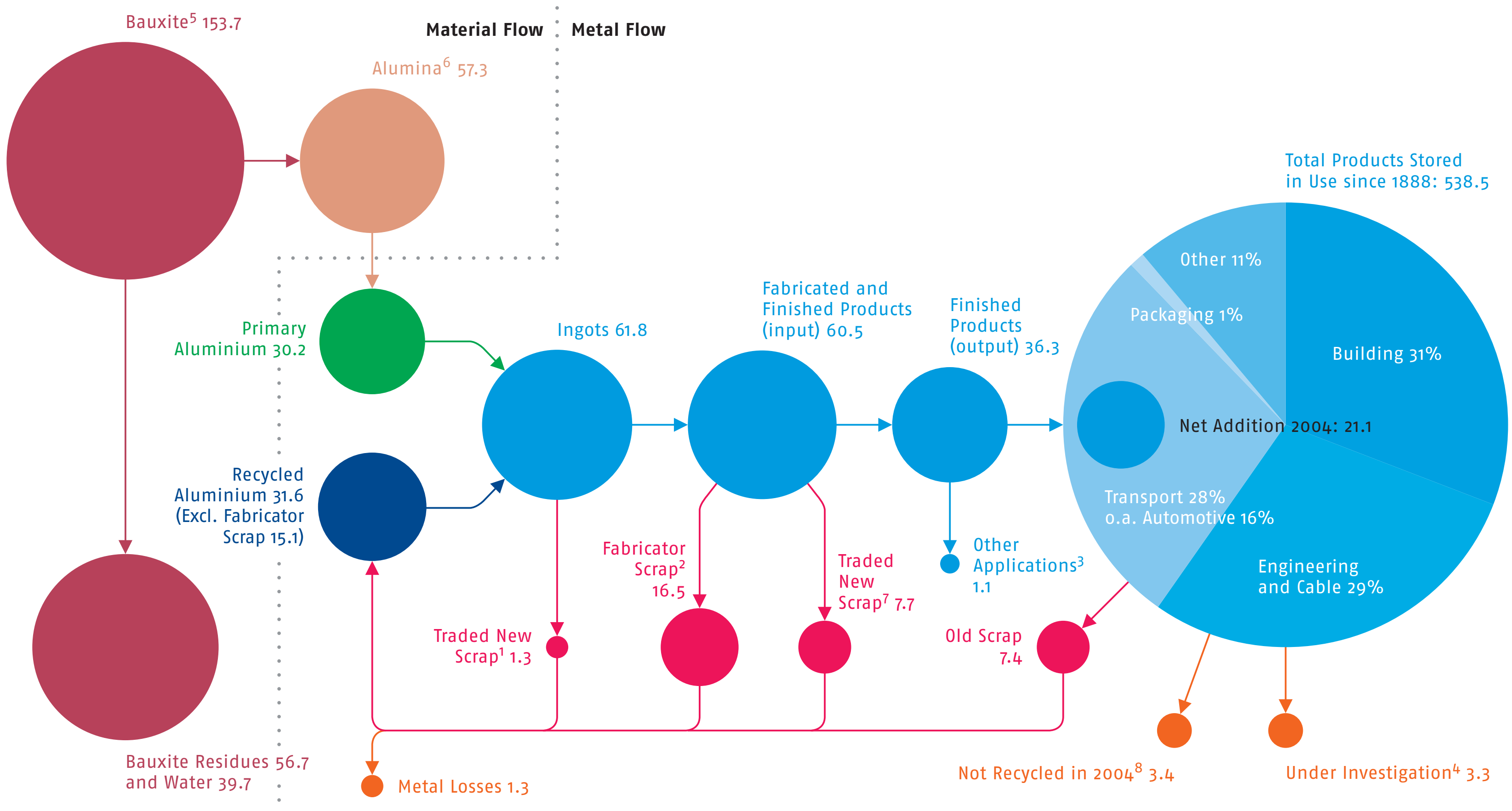
1 *Term collection used here refers to recycling in the directive for packaging and packaging waste.*

Figure 19: Aluminium Beverage Can Usage and Collection Rate[1] in Western Europe

7. The Aluminium Life Cycle: the Never-Ending Story

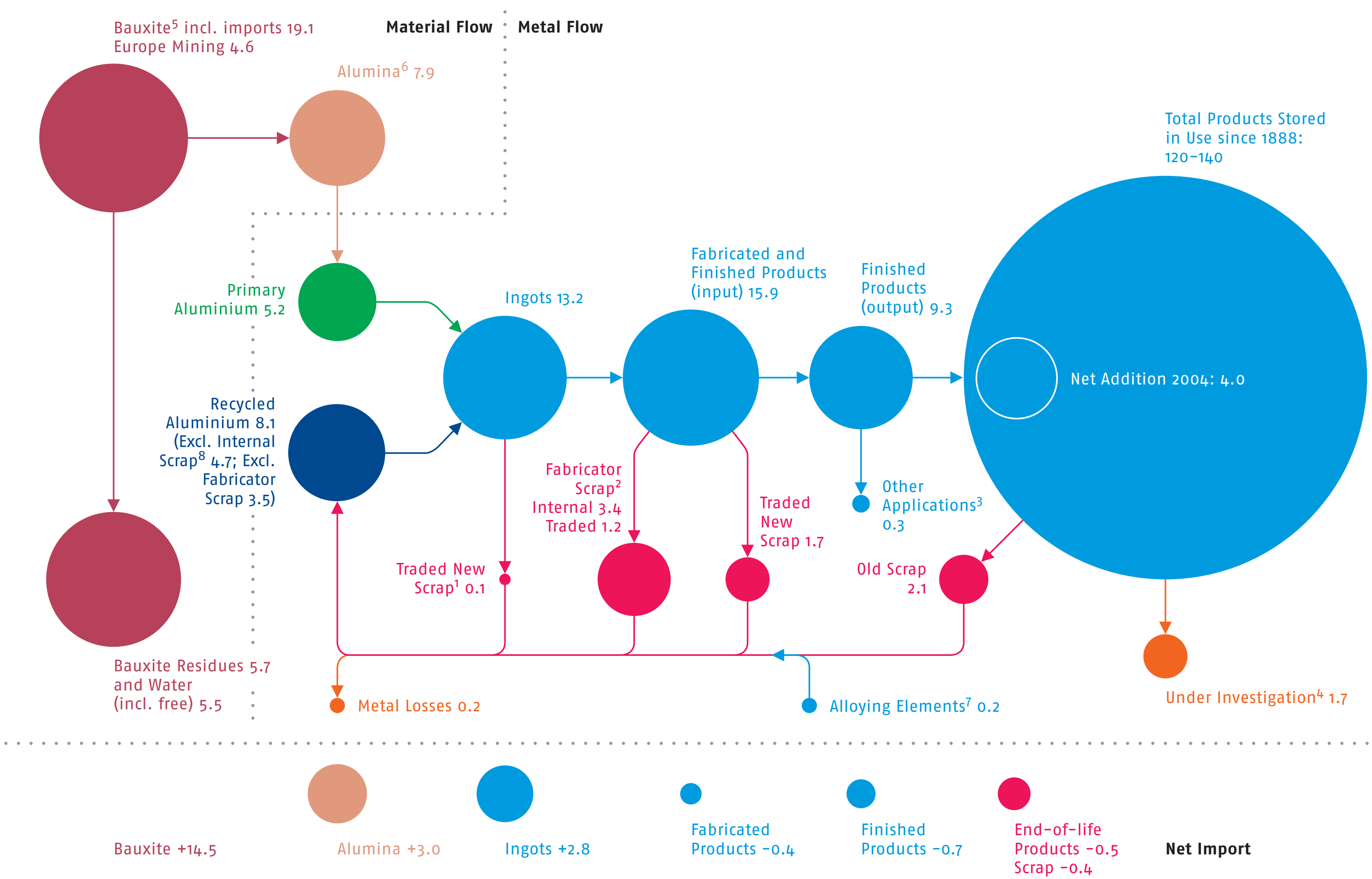
In the past, much was known about the primary aluminium production chain but comparatively little about recycled aluminium. The EAA and the OEA, in the course of their ongoing close co-operation, have thus sought to improve understanding of the multitude of processes needed to produce recycled aluminium.





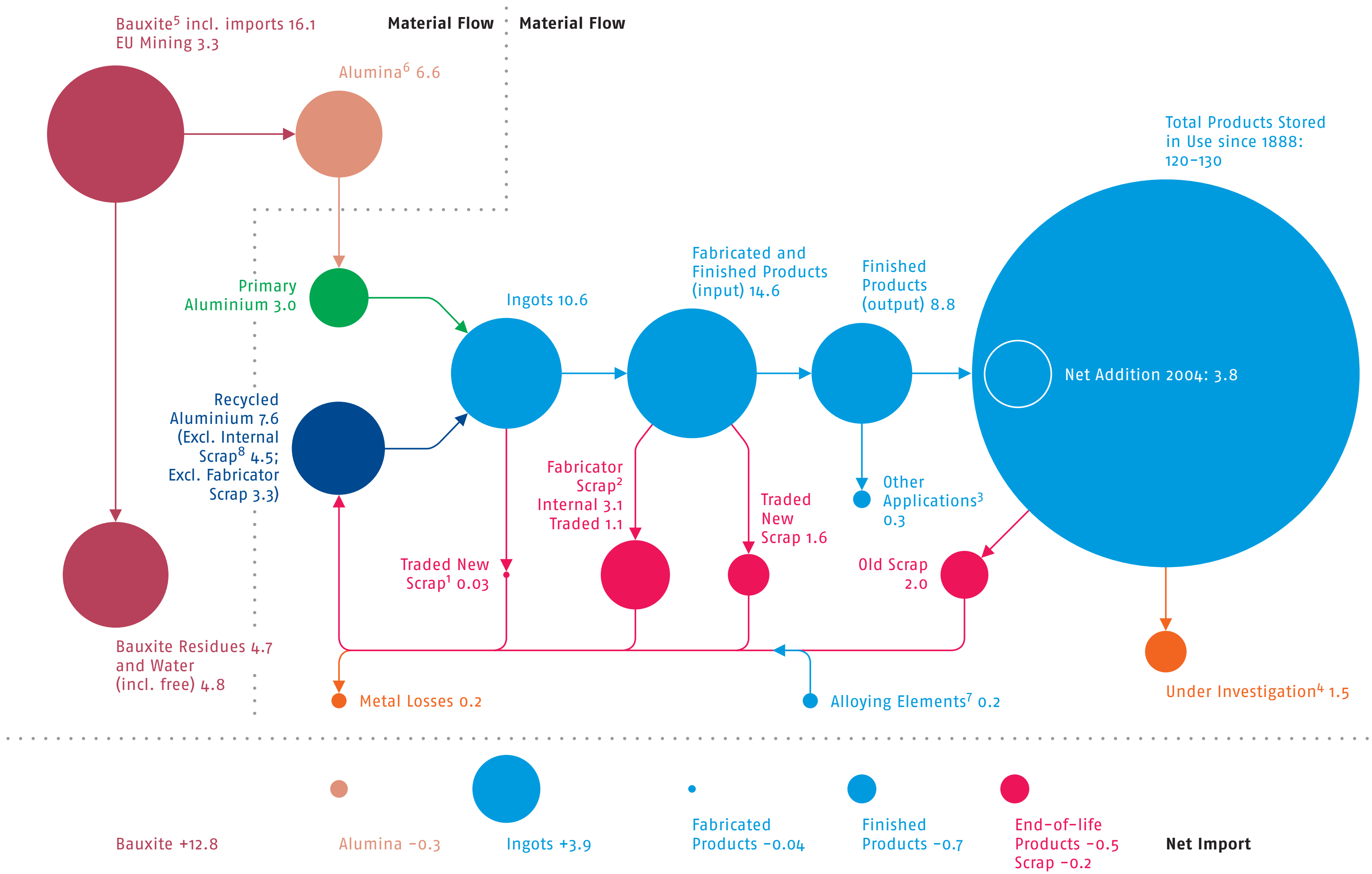
Values in millions of metric tonnes. Values might not add up due to rounding. Production stocks not shown.
1 Aluminium in skimmings; 2 Scrap generated by foundries, rolling mills and extruders. Most is internal scrap and not taken into accounts in statistics;
3 Such as powder, paste and deoxidation aluminium (metal property is lost); 4 Area of current research to identify final aluminium destination (reuse, recycling or landfilling);
5 Calculated. 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 Landfilled, dissipated into other recycling streams, incinerated or incinerated with energy recovery.

Figure 20: Global Aluminium Flow, 2004



Values in millions of metric tonnes. Values might not add up due to rounding. Production stocks not shown.
1 Aluminium in skimmings from primary production only; 2 Scrap generated by foundries, rolling mills and extruders. Internal scrap is not taken into account in statistics; 3 Such as powder, paste and deoxidation aluminium (metal property is lost); 4 Area of current research to identify final aluminium destination (reuse, recycling or landfilling); 5 Based on statistics. Includes, depending on the ore, between 30% and 50% alumina; 6 Based on statistics. Includes on a global average 52% aluminium. Includes non-metallic uses; 7 alloying elements are only shown for recycling; 8 Based on statistics; 9 West and Central Europe (Former CIS excluded, except Baltic states)

Figure 21: European[9] Aluminium Flow, 2004



Values in millions of metric tonnes. Values might not add up due to rounding. Production stocks not shown.
1 Aluminium in skimmings from primary production only; 2 Scrap generated by foundries, rolling mills and extruders. Internal scrap is not taken into account in statistics; 3 Such as powder, paste and deoxidation aluminium (metal property is lost); 4 Area of current research to identify final aluminium destination (reuse, recycling or landfilling); 5 Based on statistics. Includes, depending on the ore, between 30% and 50% alumina; 6 Based on statistics. Includes on a global average 52% aluminium. Includes non-metallic uses; 7 alloying elements are only shown for recycling; 8 Based on statistics

Figure 22: EU-25 Aluminium Flow, 2004

The aluminium industry, in collaboration with various universities, is currently designing a model to track aluminium throughout its life cycle from mining to use to recycling. More than 90 processes (including sub-processes) and 300 aluminium flows will be investigated in Europe. The main objective of the study is to quantify the aluminium collection rate, as well as the metal losses incurred during the treatment and melting of scrap. This will help the industry to understand more fully, and continue to improve, the diversity of processes required for recycled aluminium production.

The model is not static but is regularly updated to ensure that technological, market and legislative changes are incorporated as they arise. This represents yet another significant step by the aluminium industry in its drive for, and commitment to, continued progress.

Figures 20 to 22 illustrate the model. Global and European, primary and recycled aluminium flows are shown.

8. Frequently Asked Questions

How is the recycling rate defined and calculated?

For aluminium, three recycling rates apply:

1. The recycling input rate (recycled aluminium/total aluminium supplied to fabricators)
2. The end-of-life recycling efficiency rate (aluminium recycled from old scrap/ aluminium available for collection after use)
3. The overall recycling efficiency rate (recycled aluminium/aluminium available for collection at production, fabrication and manufacturing and after use)

The recycling input rate does not reflect the recycling activity of the aluminium industry. It purely takes into account the origin of the metal, i.e. primary or recycled. The amount of recycled aluminium is based on statistics pertaining to the remelters' production from tolled and purchased scrap and the refiners' production. Furthermore, the recycling input rate is significantly influenced by import and export activities at all life cycle stages. Thus a healthy fabrication industry which is able to export its products "destroys" the recycling input rate per definition.

The end-of-life and the overall efficiency rate is obtained by multiplying the collection rate (aluminium collected/ aluminium available for collection) by the treatment efficiency rate (aluminium treated/aluminium collected) by the melting efficiency rate, also termed net metal yield (aluminium recycled/ aluminium treated).

The recycled aluminium referred to in the recycling efficiency rates is therefore not determined on the basis of statistics, but calculated by means of a material flow model. Collection rates differ greatly, however. New scrap has a collection rate of almost 100% and aluminium from buildings approximately 96%. The collection rate of aluminium beverage cans has reached 52% in 2005 and this figure continues to rise. But aluminium utilised in powder, paste and for deoxidation purposes is defined as impossible to recycle after use, because it loses its metallic properties. Aluminium metal losses incurred during separation treatment range from 0% (no treatment necessary) to 10%.

Melting losses are defined as the proportion of metal in the scrap lost during melting, which therefore excludes all aluminium oxides found on the surface of scrap prior to melting. Delft University of Technology and the OEA determined in a joint research project how resource-conservative the industry is when melting aluminium scrap and found that melting oxidation losses are on average 2%.

The end-of-life recycling efficiency rate can also be used to provide product-specific definitions for life cycle analysis purposes. Here, the recycling rate of one specific product, such as end-of-life vehicles, is calculated.

How much energy is saved by aluminium recycling compared to primary aluminium production?

The energy required to produce one tonne of recycled aluminium ingots from clean scrap can be as little as 5% of the energy needed to produce one tonne of primary aluminium.

However, aluminium scrap is frequently mixed with other materials and additional energy may be required to separate the aluminium and protect the environment from the impact of these materials. Further energy needs relating to both the primary and recycled aluminium production chain are dependent on the technology applied and the geographical location, and therefore on local energy mix and efficiency as well as transportation distances.

Hence, it is only possible to calculate overall magnitude of a universal value for energy savings.

Is it possible to recycle aluminium without loss of properties?

Yes, recycled aluminium can have the same properties as primary aluminium. However, in the course of multiple recycling, more and more alloying elements are introduced into the metal cycle. This effect is put to good use in the production of casting alloys, which generally need these elements to attain the desired alloy properties. For instance, in the composition of alloy EN-AC 46000 (Al Si9Cu3 (Fe), containing about 9% silicon and 3% copper), which is widely used for automotive applications like cylinder heads and gearboxes, the need for alloying elements is manifestly clear. Approximately 26% of aluminium in Europe is used for castings, where aluminium scrap is especially chosen for its valuable alloy content. Thus, aluminium recycling contributes not only to the sustainable use of aluminium but also, to some extent, its alloying elements, making it both economical and ecological!

Many of these alloying elements do, however, limit the usability of recycled aluminium in the production of fabricated goods, like extrusion billets or rolling ingots. Therefore, aluminium scrap with an alloy composition corresponding to that of wrought alloys is separated whenever possible.

Is there an oversupply of high-alloyed scrap?

Absolutely not! As long as there is a growing demand for aluminium castings worldwide, a shortage of high-alloyed scrap is closer to the truth. The supply situation may become even worse, since the automotive revolution is just in its starting phase in many developing countries.

Is the recycled aluminium content of products an indicator of recycling efficiency?

“Recycled content” is a phrase with a certain ecological appeal. But, what does it actually mean in the context of the aluminium industry?

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.

If all aluminium applications were grouped together, the average global recycled content (excluding fabricator scrap) would stand at around 33% overall. But, in reality, recycled content varies substantially from one product to another. With the continued growth of the aluminium market and the fact that most aluminium products have a fairly long lifespan (in the case of buildings, potentially more than 100 years), it is not possible to achieve high recycled content in all new aluminium products, simply because the available quantity of end-of-life aluminium falls considerably short of total demand.

Furthermore, recycled aluminium is used where it is deemed most efficient in both economic and ecological terms. Directing the scrap flow towards designated products in order to obtain high recycled content in those products would inevitably mean lower recycled content in other products. It would also certainly result in inefficiency in the global optimisation of the scrap market, as well as wasting transportation energy. Calls to increase recycled content in specific categories of aluminium products make no ecological sense at all.

Even though the recycled content of a particular product or product part may range from 0% to 100%, all collected aluminium is recycled . Aluminium that cannot be collected includes that used in powder, paste and for deoxidation purposes as, after use, it loses its metallic properties.

What are the European sources of aluminium scrap?

Recycled aluminium is produced from both new and old scrap. New scrap is surplus material that arises during the production, fabrication and manufacture of aluminium products up to the point where they are sold to the final consumer. The production route of new scrap from collection to recycled metal is thus controlled by the aluminium industry. Old scrap is aluminium material that is treated and melted down after an existing aluminium product has been used, discarded and collected. Based on statistics and existing knowledge of the European aluminium scrap flow (excluding internal scrap), approximately 40% of recycled aluminium originates from old scrap, and the rest is new scrap.

Why does the industry not recycle 100% of all available aluminium?

The industry continues to recycle all the aluminium collected from end-of-life goods and by-products. However, the collection of aluminium-containing end-of-life products from municipal waste streams (e.g. household waste) depends largely on national waste schemes. The amount collected could be increased with the help of appropriate authorities, local communities and heightened awareness by society as a whole. The environmental feasibility of whether to recycle or incinerate flexible packaging waste, such as aluminium laminated to paper and/or plastic layers, which has a very low aluminium content can only be decided case-by-case by 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 spoilt due to inadequate packaging material, much more energy is wasted than needed to produce the packaging itself.

During all industrial processes involving treatment and melting, a certain degree of material loss is inevitable. Aluminium losses during such processes are therefore unavoidable, and this holds true for all other materials. But a recycling rate of almost 100% can be achieved with new scrap, such as aluminium sheets, because the route from collection to melting is entirely in the hands of the aluminium recycling industry.

Certain applications are not available for recycling as they loose their metallic properties by their very nature. For example, in order to produce one tonne of steel in a basic oxygen furnace, around 1.8 kg of aluminium is needed for deoxidation purposes. Other examples of metal loss include use as aluminium powder or as an additive to metallic lacquers.

Is aluminium metal lost during the recycling process?

Due to its high affinity for oxygen, aluminium always forms an oxide layer, one of the reasons why it has such excellent corrosion resistance qualities. This results, however, in loss of metal during use and melting.

In addition finished or end-of-life products exported out of a country or region are no longer available for recycling to the industry located in this area.

Aluminium which has been collected at the end of its useful life has to undergo various sorting and treatment processes before it can be melted down again. Along the way, some metal is lost. Due to the complexity of these processes and the great variety of scrap types, it is still not possible to quantify these losses exactly, but they range between 0 and 10%. Metal loss in case of clean, clearly identifiable aluminium scrap, which can be used directly for melting, can be practically none, while scrap containing foreign materials that needs to undergo several processing steps may lose some metal on its way to the furnace. During melting, the EU-15 aluminium recycling industry was able to achieve a metal recovery rate of 98%.

Typical metal losses during scrap melting including the recycling of skimmings and salt slag range from 1 to 5% depending on the application and the furnace technology.

Should a window frame be recycled back into a window frame?

From a technical and ecological point of view, whether a window frame is made of what was previously a window frame or a door is totally irrelevant. In the context of the global aluminium market, it is pointless to track end-of-life aluminium to the next aluminium product. Recycling within the same product group or not is simply a question of end-of-life aluminium availability, collection and sorting logistics, and the economics of recycling, as the ultimate objective is to obtain optimal added value for the metal.

What happens to the emissions generated during the melting of scrap?

The most significant emissions resulting from the aluminium recycling process are emissions released into the air. These include dust and smoke, metal compounds, organic materials, nitrogen oxides, sulphur dioxides and chlorides. State-of-the-art technology is used to extract fumes and other emissions and to reduce fugitive emissions. Emission limits, stipulated in the reference document on Best Available Techniques in the Non-Ferrous Metal Industries, which forms part of the broader Integrated Pollution Prevention and Control measures, are EU-wide benchmarks.

In addition, there are regional regulations, like the new TA Luft in Germany, that provide a standard for other countries and are even more stringent. The limits for dioxin emissions are very strict, in the range of <0.1–1 ng/Nm^3.

European refiners and remelters are equipped with state-of-the-art air filter equipment to clean exhaust gases of dust, acidic gases (HCl, HF, SO_2), volatile organic carbon, dioxins, and furans.

What happens to the salt slag and other residues generated during the recycling process?

Aluminium salt slag is a mixture of salts, aluminium oxide, metallic aluminium and impurities, extracted from aluminium scrap during melting. It is the typical residue left behind when aluminium scrap is melted in a rotary furnace. Rotary furnaces are commonly employed for aluminium scrap containing foreign materials. Depending on the kind of rotary furnace used and the type of scrap being melted, anything up to 500 kg of salt slag can be generated in the production of one tonne of aluminium metal. Salt slag, which used to be land filled, is now recycled. The salt that is applied during melting can be completely recovered and used again for the same purpose by the refiner. The metallic aluminium is also recovered and utilised to produce aluminium alloys.

The remaining residues, mainly aluminium oxide and impurities, are rendered inert and subsequently used by the cement industry or, if this is not possible, land filled.

Filter dust, which arises during the cleaning and de-acidification of gaseous combustion products, is deemed to be hazardous waste and is partly land filled or recycled. Skimmings and, in some cases, furnace linings are recycled within the aluminium recycling industry.

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.
Note 1: In general, these aluminium alloys have an alloy concentration of up to 20%, mostly silicon, magnesium and copper.
Note 2: 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.

EAA

European Aluminium Association. Represents the aluminium industry in Europe.

End-of-life aluminium

Aluminium that has been discarded by its end-user.

Europe

Includes EU-25, Bosnia-Herzegovina, Croatia, Iceland, Norway, Romania, Serbia-Montenegro, Switzerland and Turkey.

Foundry industry

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

Internal scrap

Scrap that is melted in the same company or company group in which it was generated.
Note: Internal scrap is also known as turnaround, in-house or home scrap.

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.
Note: 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, typically with an aluminium content of 99.7%.

Recycled aluminium

Aluminium ingot obtained by recycling of scrap.
Note 1: Recycled aluminium has replaced the term secondary aluminium.
Note 2: In this brochure the quantity of recycled aluminium is based on statistics and includes aluminium produced from tolled and purchased scrap.

Recycling

Aluminium collection and subsequent treatment and melting of scrap.

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 intimately mixed aluminium, aluminium oxides and gases, 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.
Note: Skimmings are also known as dross.

Salt slag

Residue generated after remelting of aluminium scrap with fluxing salt, consisting of salt in which metallic and non-metallic particles are entrapped in amounts that exhaust its fluxing properties
Note: 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.

Treatment

Mechanical and thermal processing of scrap, including the separation of aluminium scrap from other materials and the pre-processing of scrap before it enters the furnace.

Western Europe

EU-25 and EFTA plus Turkey.

Wrought alloys

Aluminium alloys primarily used for wrought products by hot and/or cold working.
Note 1: In general, these aluminium alloys have an alloy concentration of up to 10%, mostly manganese, magnesium, silicon, copper and zinc.
Note 2: 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.

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

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

Industry continues to recycle, without subsidy, all the aluminium collected from used products, as well as fabrication and manufacturing processes. However, with 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, approximately 90% for transport and construction applications and about 60% for beverage cans.

Aluminium for Future Generations alu