RM INSIGHT

RENEWABLE MATTER

INTERNATIONAL MAGAZINE
ON THE BIOECONOMY
AND THE CIRCULAR ECONOMY

Issue 06-07 Supplement
November 2015
Edizioni Ambiente

URBAN MINES OF ALUMINIUM

- **The Circular Economy Race: Aluminium in Pole Position**
- **The Role of Design in New Matter Scenarios**
- **Zero Waste Disposal, 100% Recovery**

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Cover
Photo by Giovanni Diffidenti

Editorial

The Circular Economy Race: ALUMINIUM in Pole Position

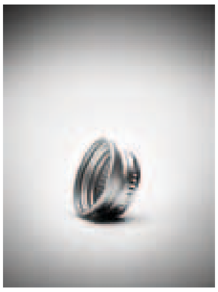
Using recycled instead of virgin aluminium saves 95% of energy. Besides, it is a resistant and versatile material that can be recycled* ad infinitum*: 2 cans are enough to produce a pen, 70 a pot, 800 a bicycle.

by **Antonio Cianciullo**

In all sports there are natural talents, champions with innate abilities. In the *circular economy* race, aluminium features amongst the favourites at the starting grid, with all the right stuff for a great performance. It is an advantage stemming from a basic characteristic: the difference between the production costs of the virgin raw material and those of recycling.

Indeed, the problem with aluminium is not the availability of raw material, because in nature there is an abundance of the resource: bauxite, the main source of aluminium, is one of the most common elements. The critical issue is represented by the processing costs because the price to produce a kilo of aluminium is very high, especially in energy terms (13 kWh). However, using recycled instead of virgin material can guarantee 95% energy saving, thus avoiding 9 tonnes of carbon dioxide per tonne of recycled material. For instance, in Italy, in 2014, thanks to the recycling of 47,100 tonnes of aluminium packaging, CO_2 emissions were reduced by 402,000 tonnes, with an energy saving of 173,000 tonnes of oil equivalent (TOE). It is thus imperative that, for economic and environmental reasons, the recovery of aluminium be a priority. What's more, with regard to reusing, aluminium proved particularly versatile: 2 cans are enough to produce a pen, 3 cans a pair of sunglasses, 37 cans a coffee maker, 70 a pot, 130 a push scooter, 640 a rim for vehicles and 800 a bicycle.

These are all interesting and useful examples because they allow to grasp in an intuitive way the link between everyday actions (separate waste) and a benefit of our everyday life (drinking coffee using a coffee maker boasting lower costs with the same performance). This constant reference to ecology as a consumption and life style has been necessary to involve millions of people. But today a perception leap is necessary: there is a need for focussing on the overall dimension of the *circular economy* challenge, in order to make the necessary economic decisions to revamp a production modality which will act as a common ground where countries and economic blocks will put their competitive abilities to the test.
From this perspective, aluminium is interesting for a number of reasons. Because it can be

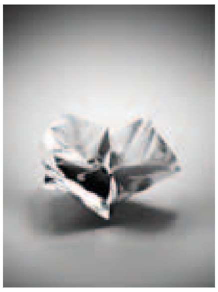


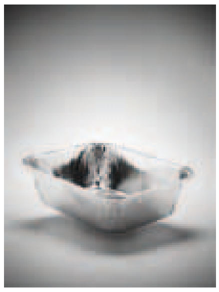
This issue's black
and white *still-life*
photographs
by Sergio Tornaghi

100% recycled many times without losing its initial characteristics. Because Italy has a special interest in this recovery, in that it does not have any bauxite mines. Because of its lightness and resistance to corrosion, aluminium plays an increasingly important role in a sector with a high impact on the environment such as transport (if in the 50's and 60's a car contained an average of 40 kilos of aluminium, today that amount is almost double).
Aluminium can thus become a test to measure the scope of the circular economy relaunch, which is only just beginning. Although still a fledgling economy, the trends show the need for a quality leap. According to a study by Ellen MacArthur Foundation, in 2010, 65 billion tonnes of materials have been extracted from nature and they will rise to 82 billion in 2020. Of the 2.7 billion tonnes of waste generated in Europe in 2010 only 40% was reused, recycled or composted. In total, according to UNEP, there was a loss of 52 billion for failing to recover copper, 34 billion for gold, 15 for aluminium and 7 for silver.
While, by developing the circular economy in the EU's manufacturing sectors – following the Ellen MacArthur Foundation's line of reasoning – there would be a saving of $380 billion during the transition and 520-630 in an advanced scenario: 3-3.9% of the EU's GDP for 2010. In practical terms, thanks to the savings of raw materials alone, the circular economy can produce a global revenue of $700 billion.

Is it a realistic scenario or just a dream? The signs are moving in the direction of the circular economy both at present and in future market projections. Price volatility in the first decade of the 21st century was higher than the previous century. And by 2030, three billion members of the new global middle class will be present on the planet, double compared to the current numbers.
After all, the need for a turning point had been in the pipeline for a long time. Already at the start of the century, the *State of the World 2004* revealed in advance this issue, not just by outlining the theoretical profile of the new production model, but making a list of successful innovations both from an economic and ecological point of view. The examples of recycling potential included the 32 billion cans disposed of in 2002 by US citizens as a mine large enough to build a commercial global airline fleet 1.5 times bigger than the current one. ●

Worldwatch Institute, *State of the World 2004: Special Focus: The Consumer Society* (www.worldwatch.org/node/1043)



Zero Waste Disposal, 100% RECOVERY

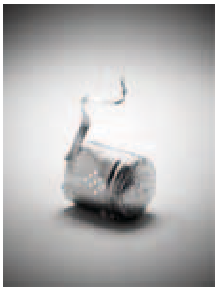
by Gino Schiona,
CiAL, General Manager

The excellent results that have been achieved in recent years in the packaging sector take up a new meaning, much more important than the evidence linked to matter and energy recovery. In reality, it is a result showing the catching on and the spreading of a lifestyle and consumption awareness and a culture consistent with truly sustainable growth.

In any of its uses, aluminium in particular fully represents and expresses the values and the principles of a system embracing the so-called circular economy, even anticipating the challenges and opportunities proposed by the European Commission within the efficient use of resources framework.

The strengthening of the Consortium's role in all the national territory and of the relation network with Municipalities and operators, a cooperation that so far has guaranteed impressive results, now nearly represents the beginning of a new era. We are ready to tackle the challenges coming our way at European level and to grab the opportunities offered by Italy's regulatory compliance.

An ever increasing domestic capacity to scrap in order to reduce even further the dependence on foreign imports is the goal pursued by the Consortium favouring the Italian aluminium sector that has proved to be a global leader both for the quantity and quality of its production,

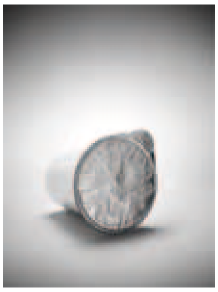
deriving almost completely from pre and post consumer recycling.
It is not a coincidence that while renewing the ANCI-CONAI Framework Agreement, amongst the changes, we introduced a maximum threshold of homogeneous goods fraction that can be disposed of together with packaging. This means facilitating and promoting the recycling of everyday aluminium objects and products, often small items, that have reached their end of life and that until not long ago ended up in the residual waste flow. Today these objects can feed the efficient and well-established aluminium packaging managing flow, becoming a new resource, also in economic terms, for all Italian Municipalities and at the end of the day for citizens as well.

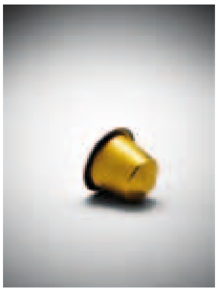
The EU is setting ever increasingly ambitious recycling goals, with the need to adopt increasingly advanced and reliable technologies to guarantee the maximization of any kind of recyclable fraction cutting even further the final waste disposal. These goals seem to reflect the strategy adopted by CiAl over ten years ago. That is “Zero waste disposal, 100% recovery”.
In a true circular economy spirit, whose principles are very much akin to aluminium values, the metal to metal loop guarantees that energy and matter in any aluminium product last over time, without compromising its chemical and physical performance by being reused and thus preserved endlessly in any further use.
From this stems the idea of permanent material, associated to those metals that, thanks to these specific characteristics, cannot be included in materials deriving from renewable resources but they can neither belong to the non-renewable category.
In order to offer an up-to-date panorama and overview of the entire productive and recycling sectors of different kind of products and uses, associated to an analysis of the Italian but also of the European and global context, we asked Ambiente Italia to write a report able to confirm aluminium performances and economic, energy, environmental and social benefits. As well as the potential and possible development areas where the exploitation of “urban aluminium mines” can be further increased.

Thus, the study offers a snapshot of the current situation and shows clearly the interesting opportunities and contributions that the aluminium sector will be able to guarantee in the future, as a leading figure, in a sector that is already deeply based on the principles of the circular economy and that is a real asset to the Italian economy. ●

Aluminium Packaging Consortium, www.cial.it

Ambiente Italia, www.ambienteitalia.it





Marco Ferreri

The Role of DESIGN in New Matter Scenarios

Interview with Marco Ferreri

edited by **Marco Moro** and **Mauro Panzeri**

The catalogue of economic ideas evolves rapidly but this is not the case for economic practices, which are still linked to operating models that have clearly shown their limitations. The circular economy and the bioeconomy represent the most promising development trajectories for their ability to provide answers to the various crises underway. Over the last decades, when engaging with sustainability issues, recycling, reusing, recovery, as well as the fourth "R", for reduction, are words that have been widely employed. Nevertheless, figures, with due exceptions (as is the case with aluminium), reveal that we are far from an across-the-board adoption of such practices.

Equally, as we have heard it many times before, design plays a crucial role in transforming the way products – from the simplest to the more complex – are conceived. A specific EU directive is devoted to ecodesign, thus identifying it as one of the key strategies to achieve the 2020 energy efficiency target.

Such "ecologic" efficiency concept must necessarily be extended to the use of materials, a scenario where the industrial culture seems to have grasped, before politics, the urgency of a change.

We talk about this with Marco Ferrari, an architect, designer and artist, who has lived side by side with generations of great masters of Italian design. He is also one of the most gifted contemporary interpreters.

Aluminium is a ubiquitous material in the "everyday material scenario", as suggested by the *still-life* image portfolio, enriching this publication, as well as other sectors. In your opinion, what is the role of aluminium in the construction of our material imagery?

"Thanks to its lightness and resistance, aluminium is a material for modernity. Inconceivable results have been achieved thanks to this: suffice it to think of the development of the aviation industry, which was born with materials such as wood and canvas.

Then, the fantastic thing about aluminium – as the images show – is how research is always looking for best performance. Already light weights, thanks to the thinning of matter, become almost impalpable, always in search of the minimum filter between user and content. The first printed cans, for example, had a certain weight: over the last twenty years, such weight has been reduced by almost 20%, down to the current 12.5 grams.

The portfolio photographs are fascinating because they omit graphic design, thus letting the object identity speak and not that of a brand, which in reality overwhelms the image of the material. In these iconic figures, therefore, their essence as minimalistic objects emerge, which is a focal point in my research. In this gallery of images, aluminium shows its ability to be exempt from any contamination of luxury ideas, with a tendency towards ornate, extravagant and expensive styles.

Aluminium luxury is democratic, it means hygiene for all (think for example of packaging and containers). Such characteristics are intrinsic to the material. The energy necessary for its production is also a luxury, this is why it is important to educate people to recycling, for example, screw caps on wine bottles, normally not considered suitable for recycling.

If I had to describe the role of aluminium in our material landscape, I would highlight

Marco Ferreri was born on 26th February 1958 in Imperia and graduated in Architecture in 1981 at Polytechnic University in Milan, where he currently works. His research spans from industrial to graphic design, from architecture to exhibition installations. His creations were awarded prizes and shown in prestigious design collections, including the "Permanent Design Collection" of the Museum of Modern Art in New York, the permanent design exhibition at the Israel Museum in Jerusalem, the National Contemporary Art Collection Fund in Paris and in a number of private collections. His works have been shown in several international exhibitions in 2010, Triennale di Milano devoted a monographic exhibition to him. He has also taught in Italian as well as foreign universities.

Marco Moro is editor in chief at Edizioni Ambiente.

Mauro Panzeri is art director and publishing graphic designer.

its versatility and the associated research in using less and less material. As if efficiency were a characteristic of aluminium, a distinctive feature that sets it apart from other materials and metals. In other words, it is a material with a natural high performance that technology and human know-how – since it is also a material that does not lend itself well to DIY compared to other materials – develop and create ageless and functional objects. This is its greatest intrinsic asset. If I had to make a staircase I would use iron, because it can be found everywhere and does not require specific knowledge for welding, for example. Well, aluminium is noble in this as well: it demands knowledge.
This is all the more fitting in our contemporary era, it is the right challenge: doing and saying things because we know them.
We should bear in mind that the project – and this is a typically Italian characteristic of design – is something that combines technological and humanistic cultures."

What is the role of design in this scenario?
"Design can play a crucial role, if it understands the challenge. One of my teachers was Elio Cenci, who, 40 years ago, published the magazine *Design* whose subheading was 'a means to improve the quality of life'. In this, we already have the manifesto of design. Just to make things clear, the solution is not in the chair you design but in the suggestions you can make through that design. Today is really the best time to rethink the meaning of this profession. Due to a lack of real criticism, this represents a huge problem, we live in a treacle of information in which we are all happily driving into a ravine like Thelma and Louise."

You have always worked on everyday objects, simple objects such as brooms and dustpans for instance...
"Yes, that's true, projects that try to understand how the relation between people and the objects they use can change. A relation that inevitably changes, because our ways of socialising change. Your project must take into account the evolution of society, it is the evolution of society that dictates new needs. For instance, as for living, you should no longer concentrate on objects, but on the new types of community, increasingly diversified. Do we all sleep in the same way? Do we all cook in the same way?
Design's greatest challenge is to be able to find the lowest common denominator. Objects can be enriched, changed by users.
When designing things, we must bear in mind that then people make them theirs changing them. At the moment, I'm dealing with agriculture and I can see that tractors are all the same when they come out of the factory, but once farmers get hold of them they are changed and modified in order to make their use more effective and add a personal touch. Design must carry on taking care of this."

Tell us more about this "farmer's design".
"It was my way of going back to designing for the real world. If you think about it, today's agriculture, if carried out to the highest level it can become a scientist's job, has always more than one parameter that must be taken into consideration: time (necessary for a crop to grow) and seasonality; and then you have other variables, such as climate, that make the whole process very similar to gambling. Despite all these uncertainties, you can be certain that if you do your job well, in the end you will achieve a result. Well, in my job, these aspects have nearly disappeared, that is why I felt an almost physical urge to deal not with clients who don't know what to ask but with the real world."

In your working career, you have had the opportunity to work with some masters of Italian design such as Angelo Mangiarotti, Bruno Munari and Marco Zanuso. Designers working within a culture in which the variety of materials they used to express their designing creativity seemed endless, in the 1980s there was even a so-called "hyperchoice of materials". How has the design culture changed in a context where the material limits of our actions are becoming increasingly defined with each passing day?
"Some of these top designers made beautiful things, but sometimes with limited awareness of technical aspects. This means that there was an industrial fabric (even if in certain contexts 'industrial' is too big a word) that chose designers, believed in them completely making available to them all the resources they need to realize their dreams.
It is true that nowadays we are confronted with increasing 'material' limitations, but it is also true that we are able to imbue the materials at our disposal with the characteristics and functions we need. Obviously, this can create recycling problems, but our knowledge of things and of what they can do has improved tremendously. This is why designers can no longer work in isolation as problem solvers, but they must integrate their knowledge with other fields of expertise.
All this clashes with products still and too often conceived to become obsolete in no time, in net contrast with the value embedded in them. If your computer's case is made of aluminium, its potential life is extraordinary. What's the point in using such material to clad a product destined to 'expire' probably within a year?
Companies must change their attitude. I wonder whether they are, but also if consumers are, ready to take the leap. As I said before, there is a basic education problem."●

Urban Mines of Aluminium

Economic and Material Analysis of Recycled Aluminium in Italy’s Industrial Supply Chain

Report written for CiAl
By Duccio Bianchi
Ambiente Italia Srl, Milan

Photo by Alberto Bernasconi

Global Context

Global Aluminium Flows

75% of aluminium produced over the last 125 years is still in use. 52% of aluminium comes from recycling, 26% from post-consumer matter.

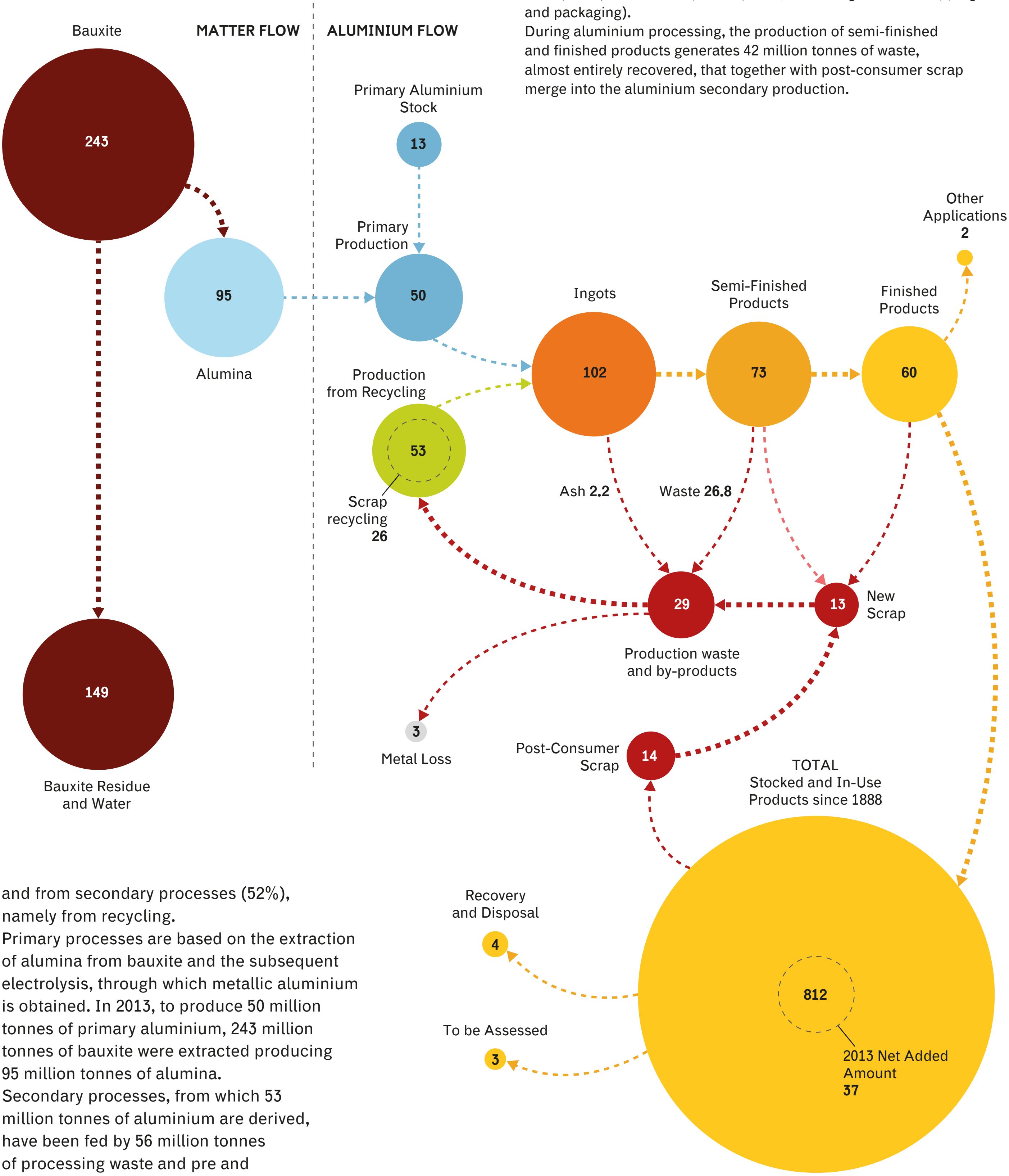
Endless recyclability, versatility, lightness and high conductivity are some of aluminium’s peculiarities, a material present in nearly all aspects of our everyday lives and in many industrial sectors.
There are aluminium components in many everyday objects: bicycles, cars, aircrafts and trains, doors and windows. We are also surrounded by aluminium in our houses: cans, aerosols, tubes, trays and rolls, pots, cutlery, coffee makers and various accessories, let alone packaging.
Suffice it to say that, in 2013, the world production of aluminium exceeded 100 million tonnes, of which 60 million were finished products.

Besides being a material with a wealth of excellent features, aluminium boasts a high recycling rate. As a matter of fact, nowadays, 1/3 of all finished products in use are substitutes and 2/3 are new. Aluminium products have indeed a long life cycle: about 75% of primary aluminium produced over the last 125 years is still in use.

There are two production methods to obtain aluminium: from primary processes (48%)

2013 Global Aluminium Flow (Millions of Tonnes)

The flow model shows the origins of primary and secondary aluminium, processing, marketing and recycling. The net added entry is the difference between finished products for non-destructive uses (58 Mt) and total disposals (21 Mt, consisting of both scrapping and packaging).
During aluminium processing, the production of semi-finished and finished products generates 42 million tonnes of waste, almost entirely recovered, that together with post-consumer scrap merge into the aluminium secondary production.



and from secondary processes (52%), namely from recycling.
Primary processes are based on the extraction of alumina from bauxite and the subsequent electrolysis, through which metallic aluminium is obtained. In 2013, to produce 50 million tonnes of primary aluminium, 243 million tonnes of bauxite were extracted producing 95 million tonnes of alumina.
Secondary processes, from which 53 million tonnes of aluminium are derived, have been fed by 56 million tonnes of processing waste and pre and post-consumer scrap. In particular, 2/3 of post-consumer aluminium waste are directly recycled, generating 26% of secondary production. ▶

Source: International Aluminium Institute, 2014: Global Mass Flow Model.

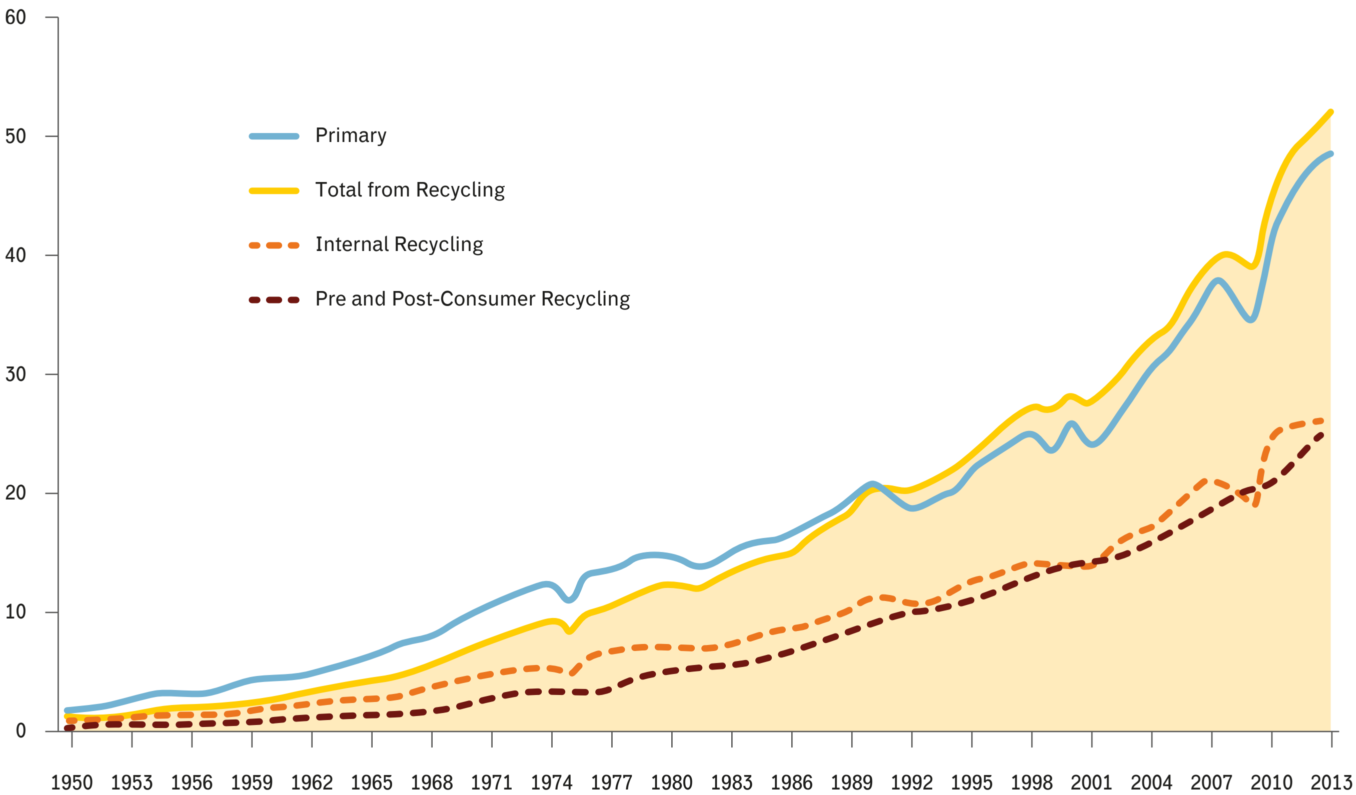
Photo by Alberto Bernasconi

Aluminium Production

Strong production growth, above all of secondary and recycled aluminium.

Over the last 50 years, the production of **primary aluminium** has increased tenfold and has grown by 60% in the last 10. Currently, it is concentrated in China (over 50%), while in Europe it is dwindling (15%).
Moreover, the production of **secondary aluminium from internal recycling**, based on remelting of internal processing and production waste (unmarketed) of semi-finished products, has also skyrocketed over the last fifty years, reaching 27 million tonnes.
Also, the production of **secondary aluminium from pre and post-consumer recycling,** based on refining and remelting both of pre-consumer processing and production scrap (commercial) of finished products and post-consumer waste must be taken into account: it amounts to about 26 million

World Production of Primary and Recycled Aluminium (Millions of Tonnes)



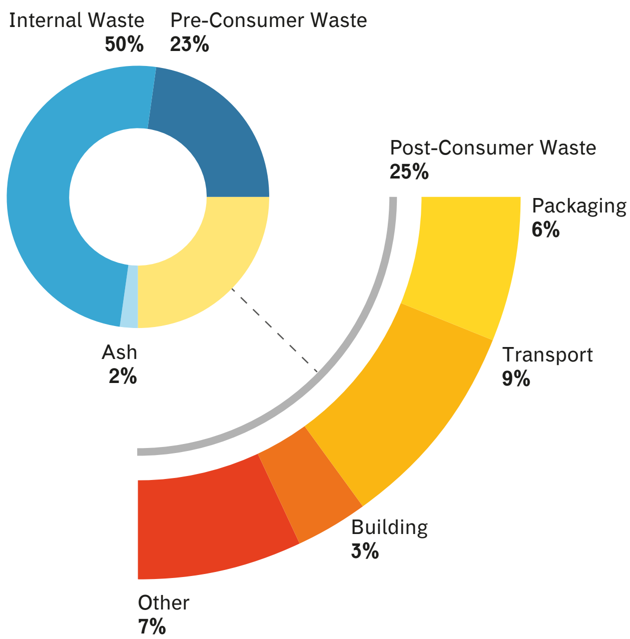
tonnes, of which about half from post-consumer activities. It is the fastest growing production segment, which increased twenty times over the last 50 years and over 60% in the last ten. In China, the production from recycling is low, while that from post-consumer materials is concentrated mainly in Europe and Japan.
Recycled post-consumer materials mainly derive from car and means of transport scrapping and packaging collection.

End Uses of Aluminium

The variety of uses: transport, building, packaging, electric sector, consumer goods.

Aluminium has a plethora of uses, but on a global scale it is mainly used for means of transport (mainly cars and trains) and in the construction industry.
Other important areas of use are the electric sector (mainly cables), packaging production, mechanical manufacturing ▶

Origin of Aluminium from Recycling



End Uses of Aluminium Products (World 2012)

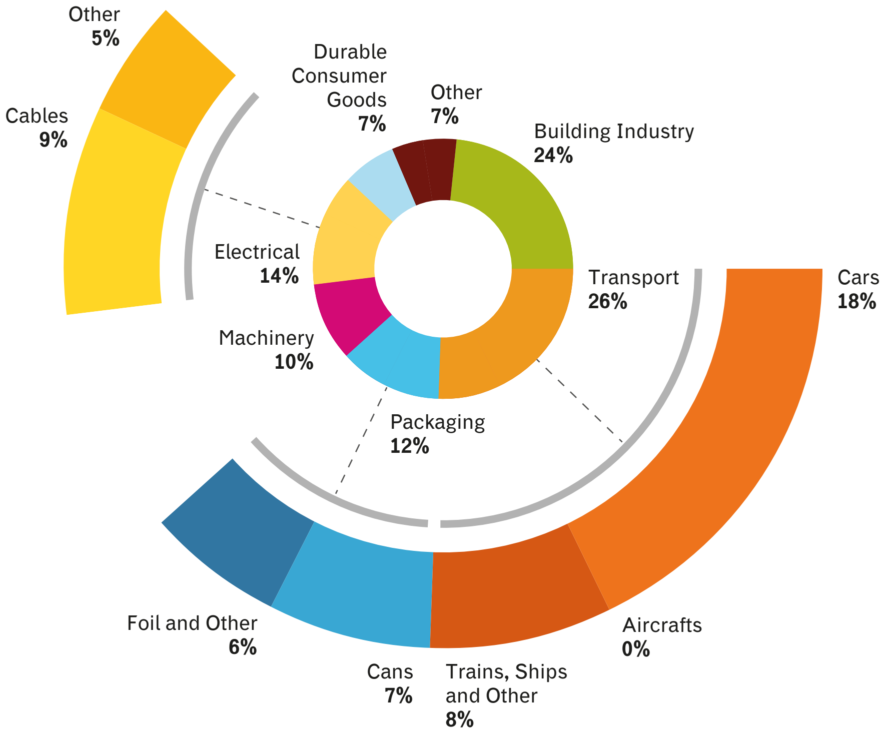


Photo by Giovanni Diffidenti

and durable goods (from pots and pans to furniture).
All these sectors have expanded their production volume, with regional differences. In China, for example, the construction and electric industries have experienced an increase in aluminium use, whilst in Europe aluminium use has soared in the transport business, despite the car market crisis, while the production for the building sector has stabilized.

Durability of Aluminium

65% of aluminium products marketed since 1950 is still in use. 75% of the aluminium produced is still employed.

About 65% of all aluminium products marketed since 1950 is still in use today. This is the effect of the products' long ▶

Average LIfe of Aluminium Products

As mentioned before, most aluminium products, in particular those for the construction and mechanical industries, have a long life expectancy. Calculated on the 2013 production, the average life is 27 years. This means that, except for packaging, the availability of scrap enjoys a long time gap compared to production.

Source: Elaboration on International Aluminium Institute Data.

Photo by Alberto Bernasconi

Service Life of Aluminium Products

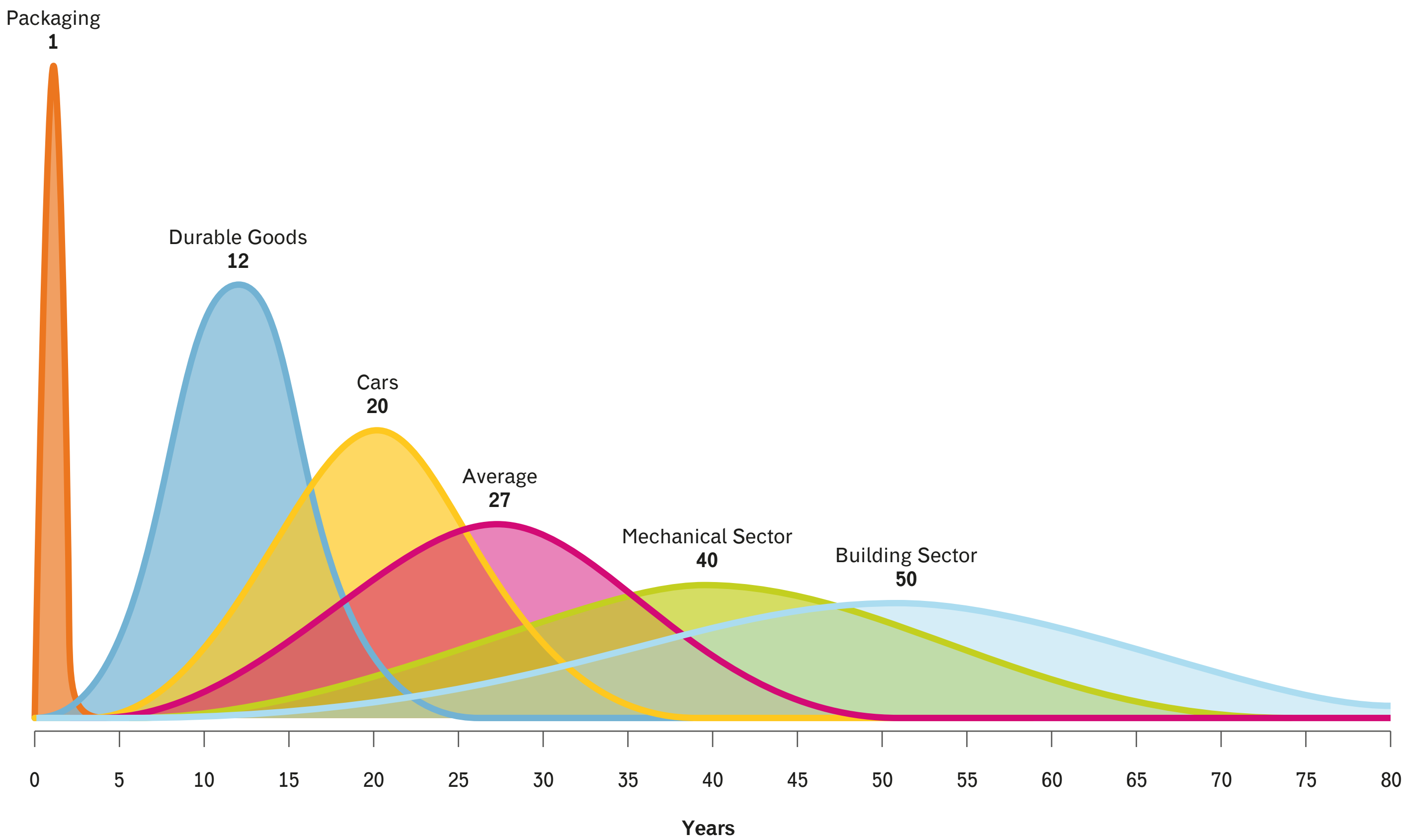
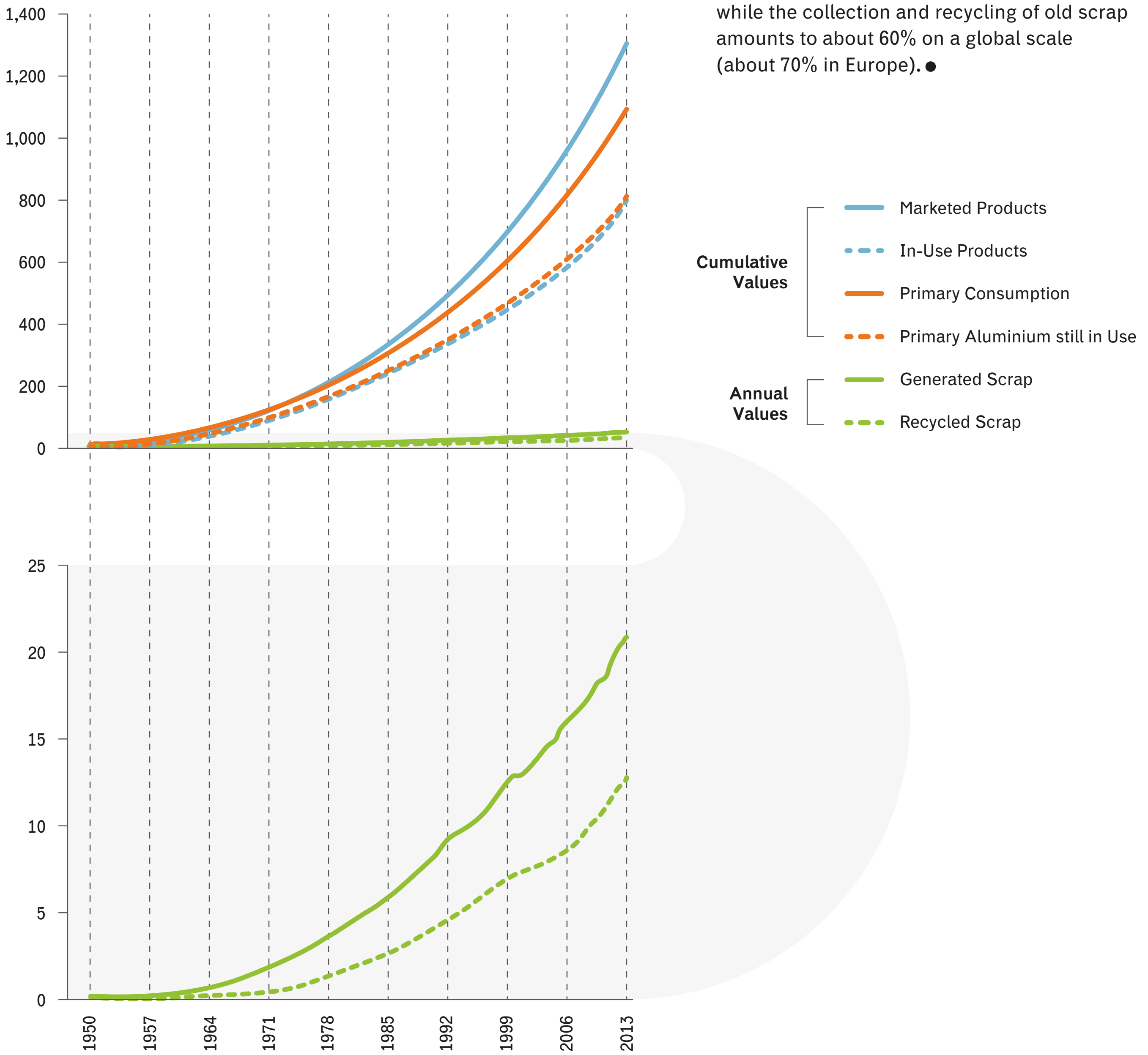


Photo by Alberto Bernasconi

Primary Aluminium; Introduced and in-Use Products; Generated and Recycled Scrap (Millions of Tonnes)



service life. But consumption has also soared considerably: little less than 40% of all aluminium products after World War II has been introduced just over the last ten years.
Products' longevity, together with a high recycling rate, has determined a strong persistence of primary aluminium produced since 1950 (over a total of 1.4), about 75% is still used – directly or after recycling – in products which are still in use.
Taking into consideration all products placed on the market, the share of aluminium from recycling amounts to about 23%.
But, despite the high value of aluminium and its recyclability, a significant share of aluminium is still wasted. According to some figures, since 1950 to date, about 50% of scrap, theoretically generated, is not recycled.
Currently, the collection and recycling rate of manufacturing waste exceeds 90%, while the collection and recycling of old scrap amounts to about 60% on a global scale (about 70% in Europe). ●

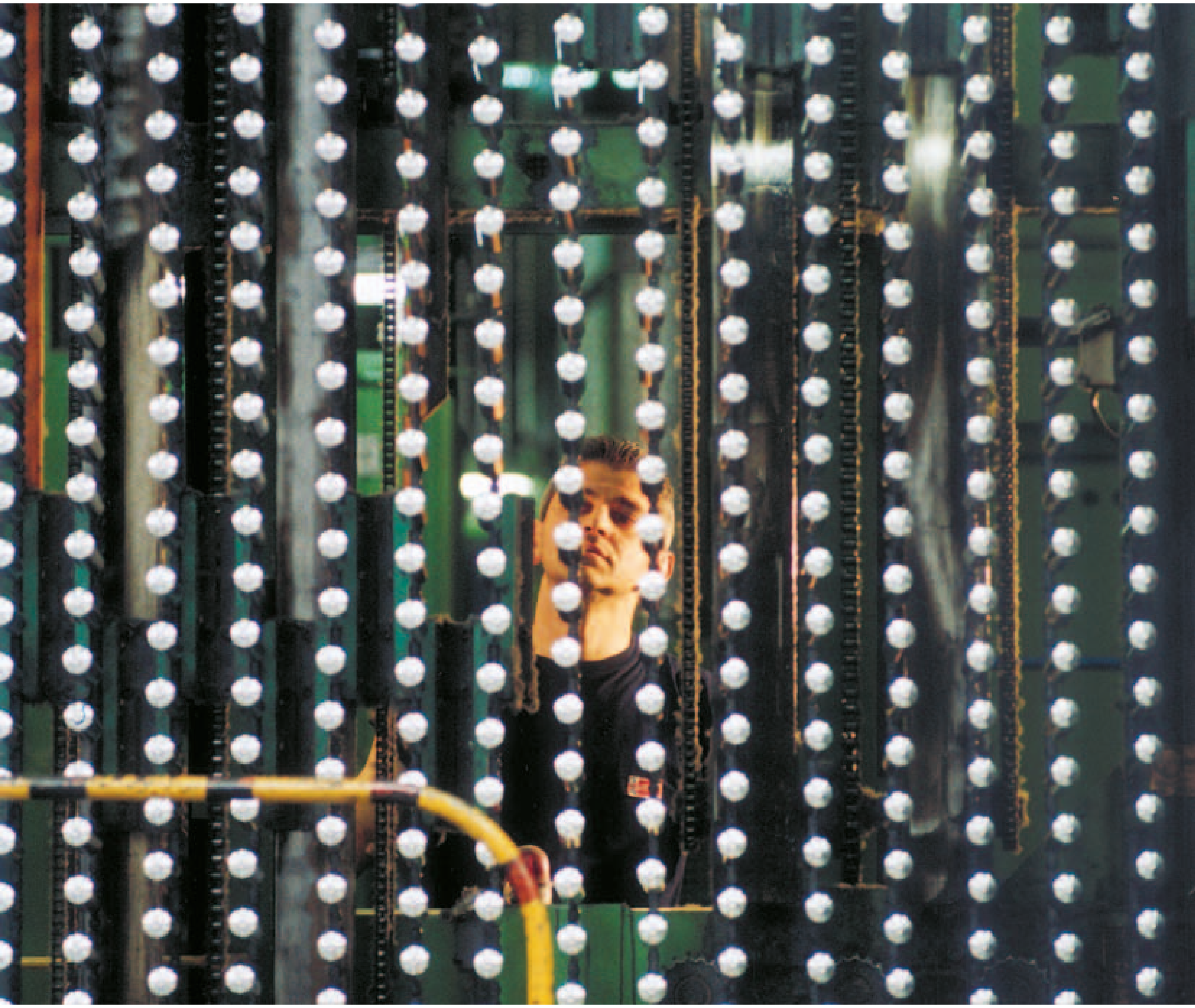


Photo by Giovanni Diffidenti

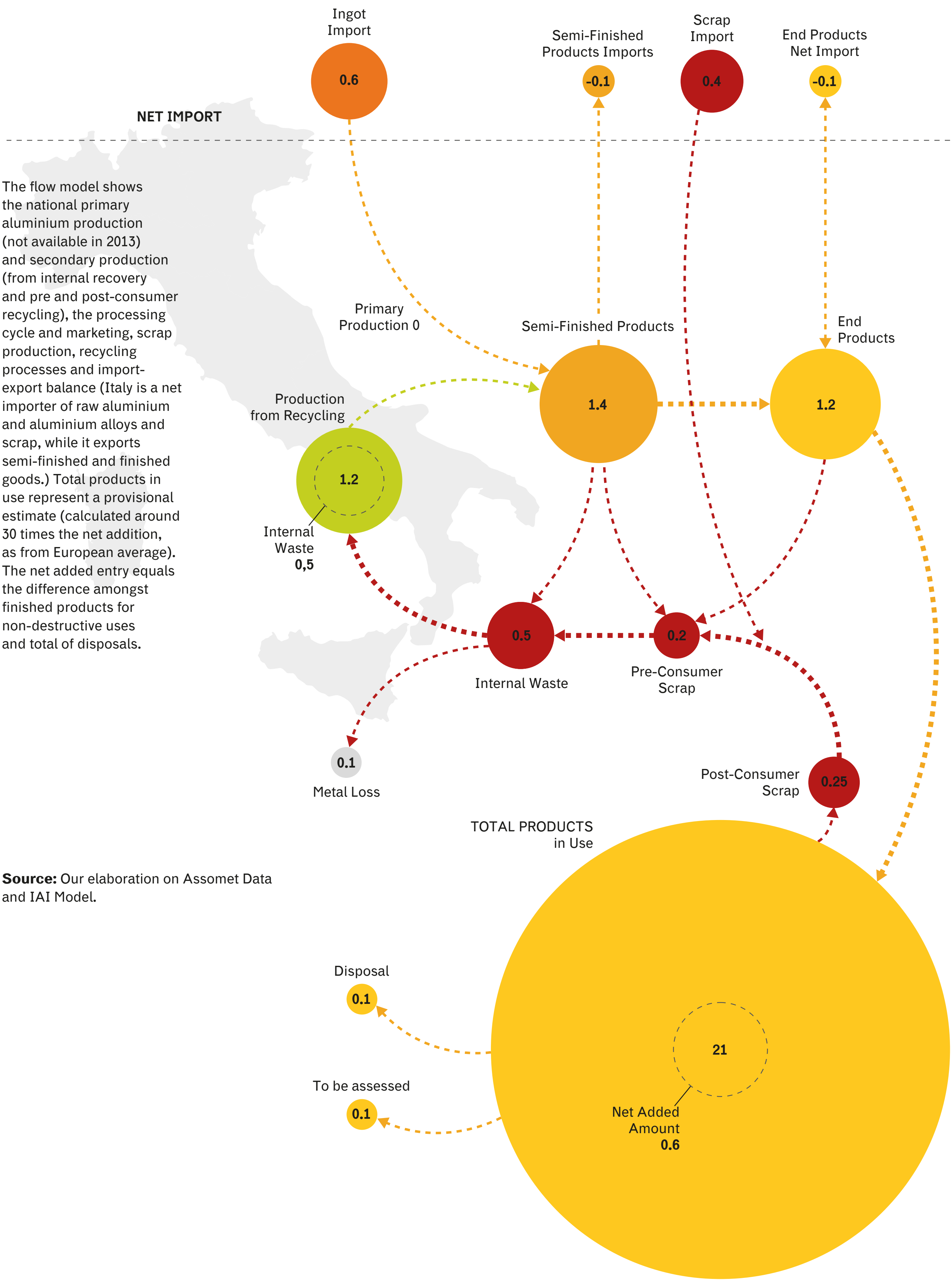
The Italian Context

The Italian Aluminium Flows

Italy is Europe's second largest producer, with a 100% production from recycling.

In Italy, the production of primary aluminium stopped in 2013. Basically, we only produce secondary aluminium, from recycling, derived both from internal recovery (waste from rolling and extrusion processing integrated with remelting plants), and pre-consumer (from industrial processes) and post-consumer fractions (scrapping of means of transport, building demolitions, waste from consumer goods and packaging).
Overall, in Italy, the aluminium production is fuelled by over 1.3 million tonnes of internal waste and scrap, and a substantial share of scrap is imported. Remelting plants produce 487,500 tonnes of alloys in shapes (rolled items and billets) for rolling ▶

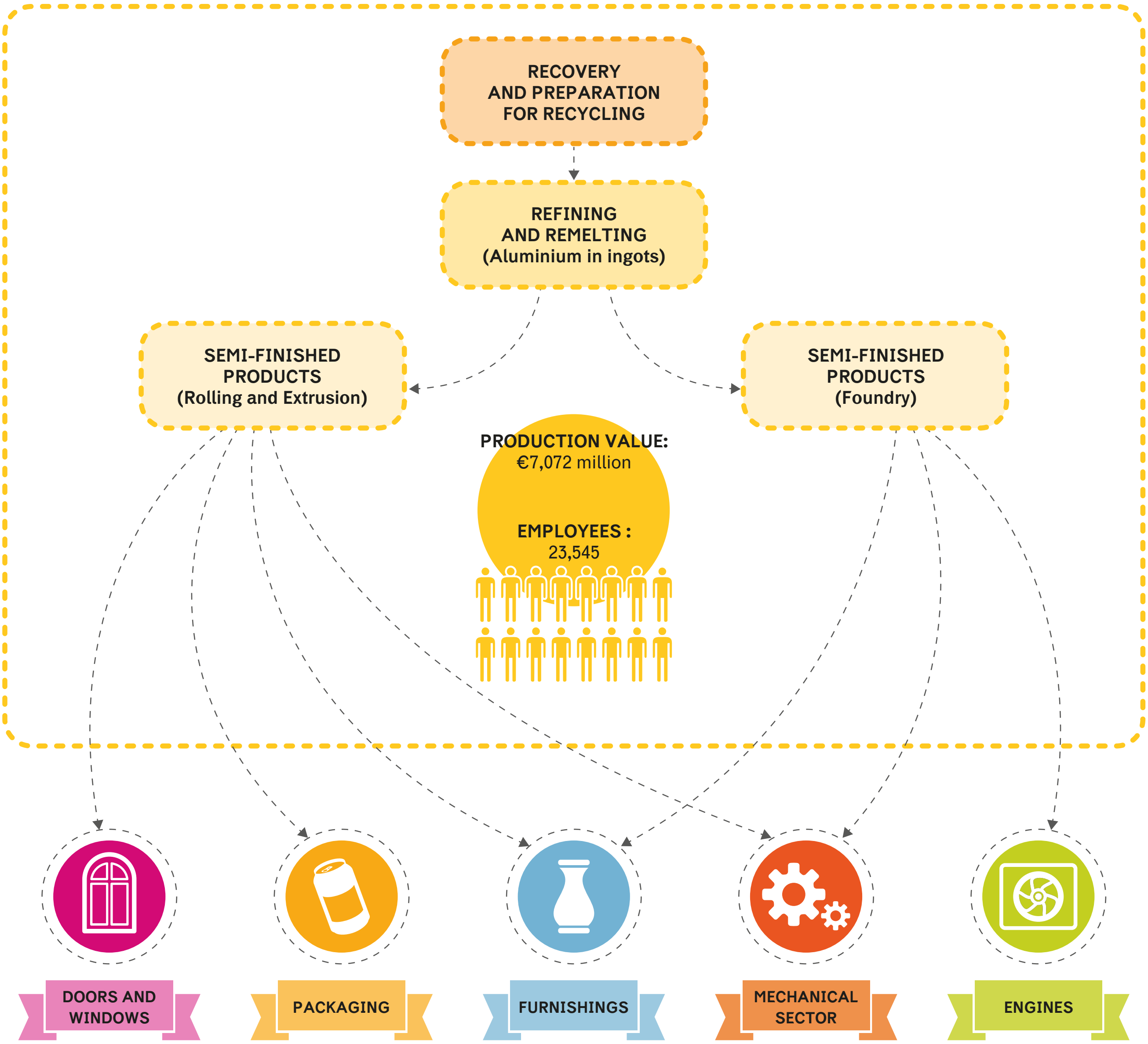
Production Flow and Aluminium Consumption, Italy 2013 (Millions of Tonnes)



The flow model shows the national primary aluminium production (not available in 2013) and secondary production (from internal recovery and pre and post-consumer recycling), the processing cycle and marketing, scrap production, recycling processes and import-export balance (Italy is a net importer of raw aluminium and aluminium alloys and scrap, while it exports semi-finished and finished goods.) Total products in use represent a provisional estimate (calculated around 30 times the net addition, as from European average). The net added entry equals the difference amongst finished products for non-destructive uses and total of disposals.

Source: Our elaboration on Assomet Data and IAI Model.

The Aluminium Industry



and extrusion; the refining plants, 663,700 tonnes of alloys in slabs for foundries and deoxidising products for steel mills. Companies manufacturing semi-finished items import about 640,000 tonnes of raw aluminium and produce 789,000 tonnes of semi-finished products for extrusion and rolling and 625,000 tonnes of castings for foundries.
After all disposals, the yearly aluminium flow amount to 700,000 tonnes, with a total of 20 million tonnes of products in use.

The Industrial Supply Chain of Aluminium

The industrial supply chain of aluminium consists of:

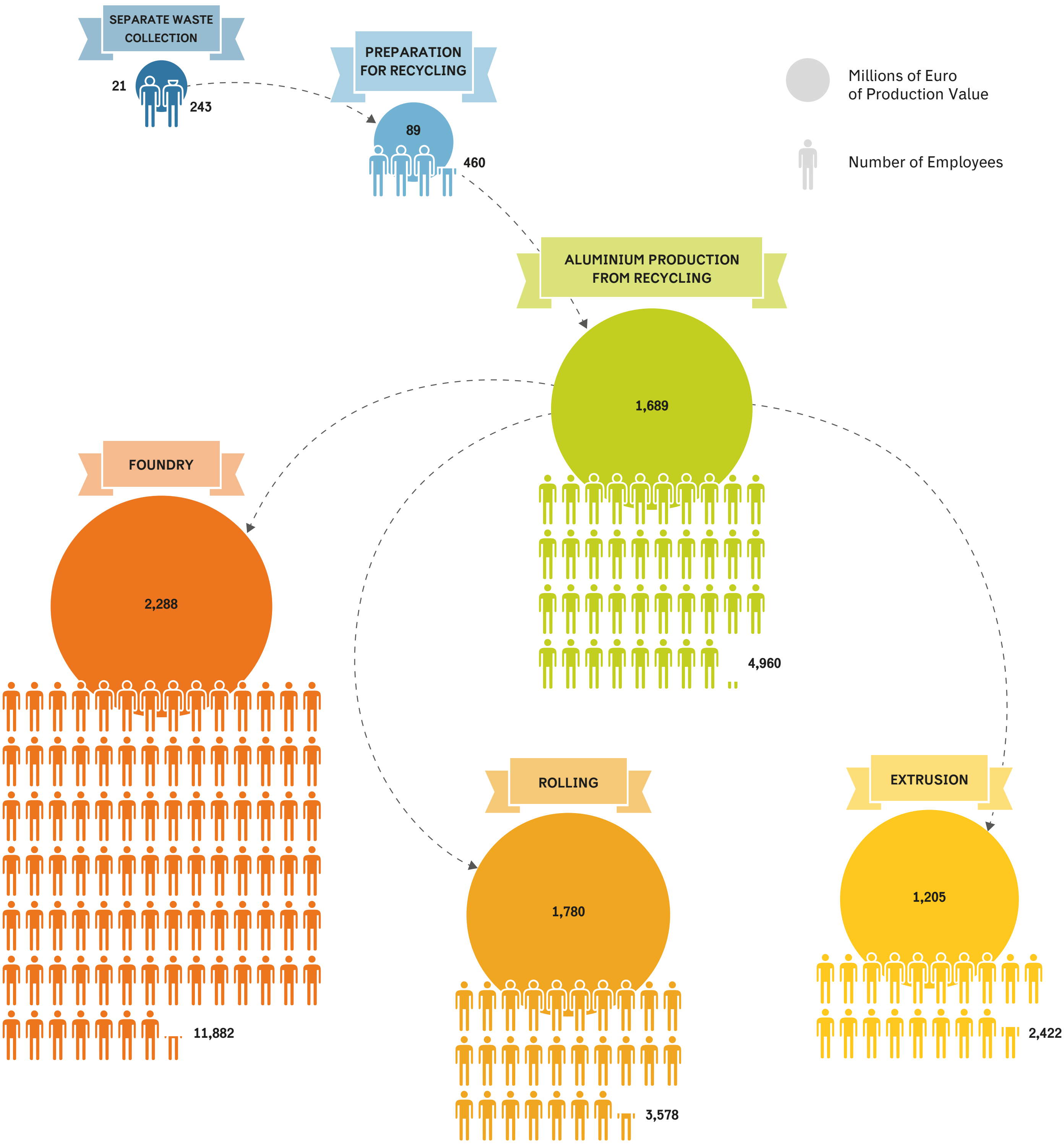
- scrap recovery (separate waste collection, marketing, preparation for recycling, first and foremost to post-consumer national scrap);
- refining and remelting for secondary aluminium production (billets, liquid, slabs and plates);
- production of plastic semi-finished products (extrusion, rolling and forging) – recorded in an integrated way with the refining and remelting industries – and the melting activities with the casting production;
- industrial activities employing aluminium semi-finished products (exclusively or as components for products) for processing and producing finished products in the construction, motor, transport, mechanical, furniture, packaging, electrical and electronic sectors. ▶

The first three phases are covered by statistical assessments or can be reasonably estimated (as is the case with the first of the three phases).
Overall, in Italy, the aggregate production exceeds 7 billion euro, with 24,000 employees.
The use of aluminium in the various sectors of industrial processing is only sporadically recorded; therefore, a reliable estimate of the economic and occupational value of these activities is impossible.

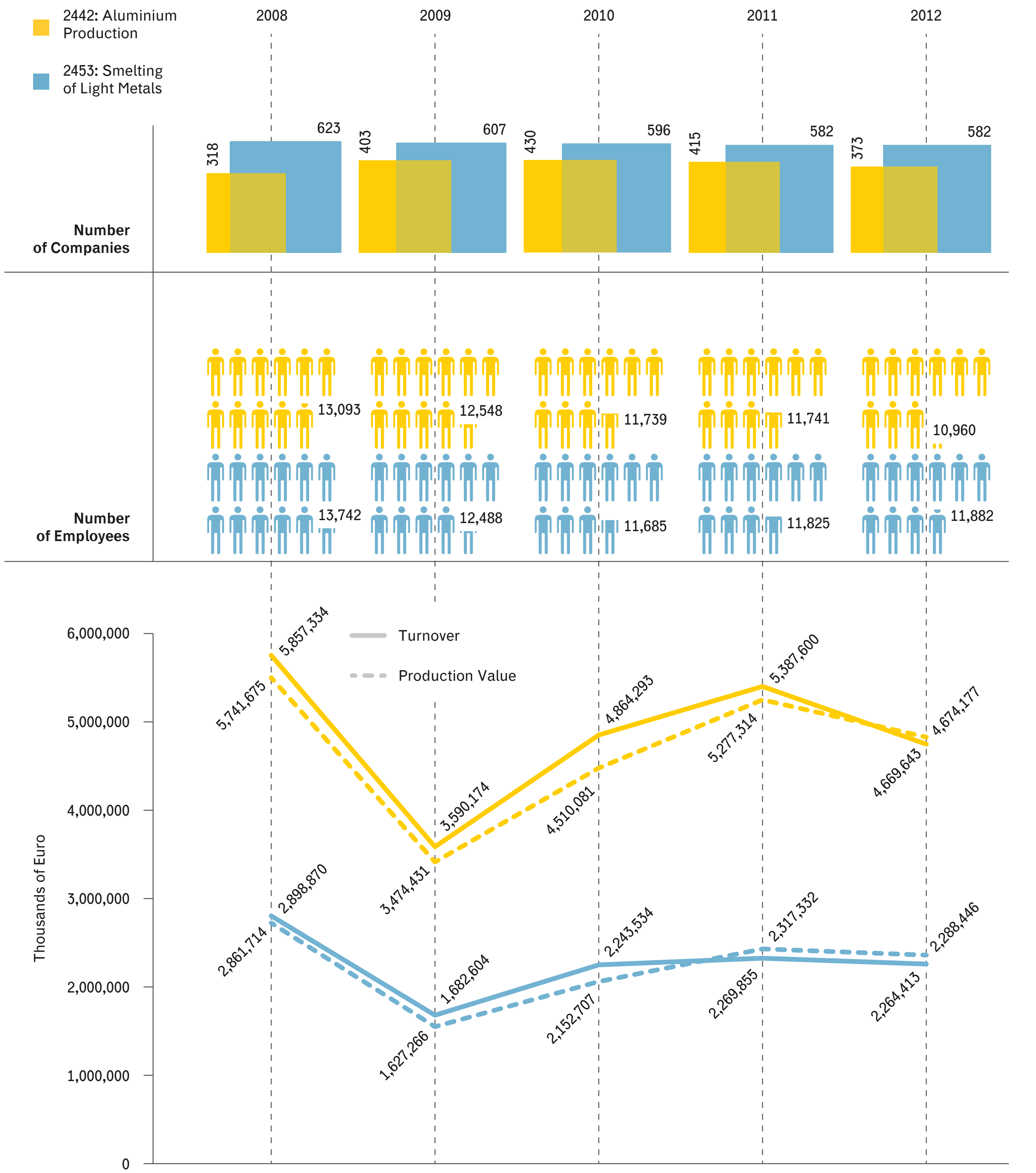
Relevant Sector Statistical Data

The industrial aluminium sector is characterized by the presence of a very limited number of medium enterprises – mainly refiners ▶

Economic Value and Employees of the Supply Chain of Aluminium Production in Italy



Aluminium Industry: Salient Statistics



Source: ISTAT; National Statistics on the structure of companies, 2014. ISTAT statistical sources and Assomet present some inconsistencies also due to classification criteria. In this study, ISTAT data on production value and number of employees have been used, using Asssomet's most disaggregated data (not very dissimilar to ISTAT's) to divide aggregated values of the "aluminium production" class amongst refiners-remelters, extrusion, rolling (activities that in many cases are significantly integrated, just as refiners and foundries). As for foundries, however, there is a more marked difference between Assomet's estimated turnover (4.5 billion) and the ISTAT's (2.3 billion).

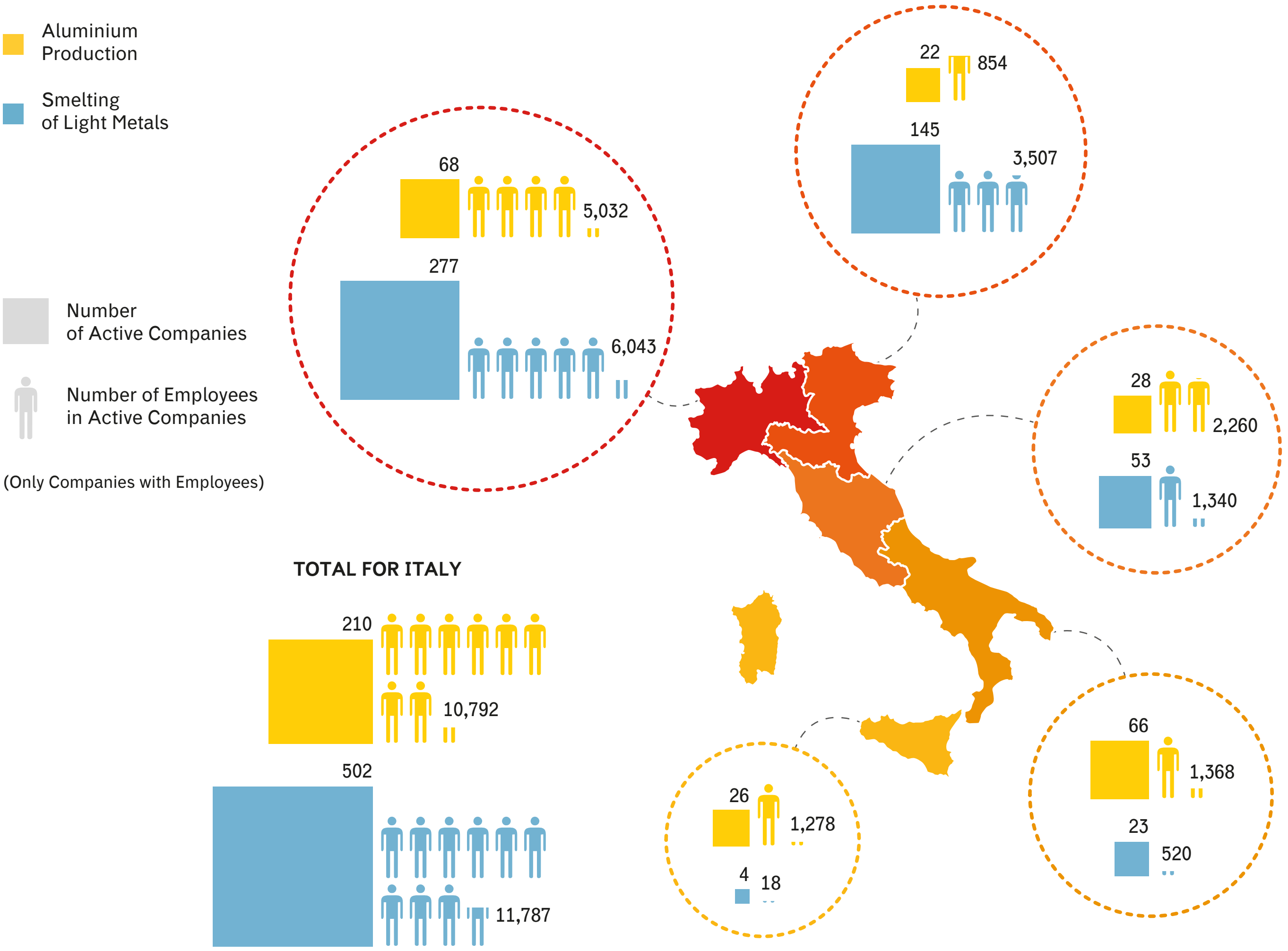
and remelters and integrated businesses in the supply chain – and by a wide number of small and medium enterprises, mainly dealing with smelting.
According to Assomet data, within the "aluminium production" class, the remelting and refining businesses are 27 and represent 36% of the turnover and 40% of the category employees.
It has to be mentioned that recession caused a turnover and production value decrease accompanied by a substantial employment reduction associated with the closure of some important companies and some concentration phenomena.

Photo by Giovanni Diffidenti

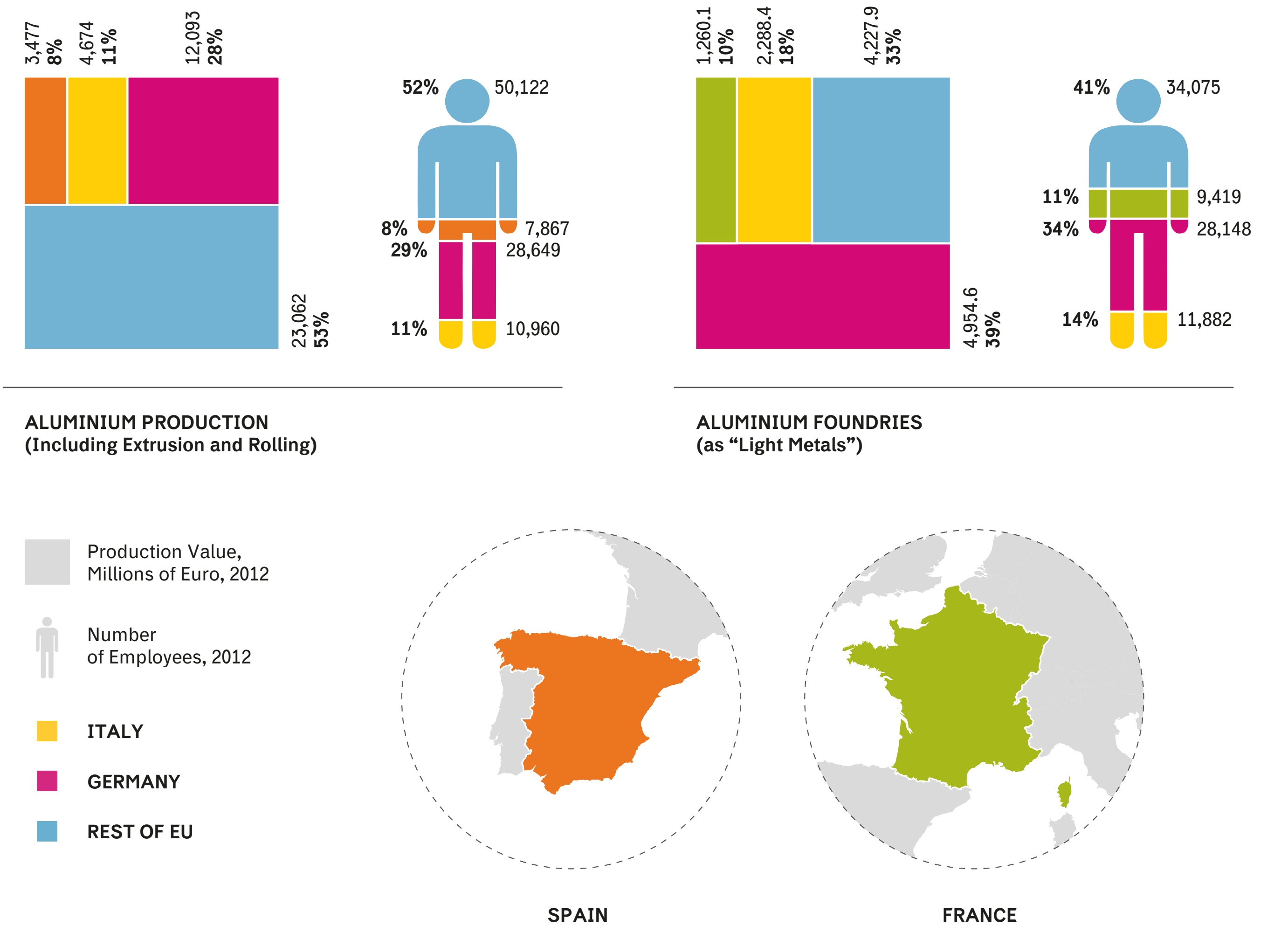
Territorial Distribution of the Aluminium Industry

While the primary aluminium industry production has strong location constraints associated with access to raw material, water availability and possibility of low cost energy supply, the secondary aluminium industry follows a distribution mainly linked to the integration with scrap suppliers and with industrial processing clients.
In Italy, there is a host of significant production hubs – in Lombardy, Piedmont, Veneto, Latium and Campania – with a wide distribution all over the country, in particular as far as smelting is concerned. ▶

Territorial Distribution of the Aluminium Industry



Aluminium: Production and Foundries



Italian Aluminium Industry in a European Context

The Italian aluminium industry is the second in Europe, behind Germany, both in the aluminium and in the semi-finished production, with a strong production of melting and castings production (a distinctive feature of the secondary aluminium industry). Overall, the Italian industry represents 14% of Europe's turnover and 13% of total employment.

National Production of Aluminium and Semi-Finished Products

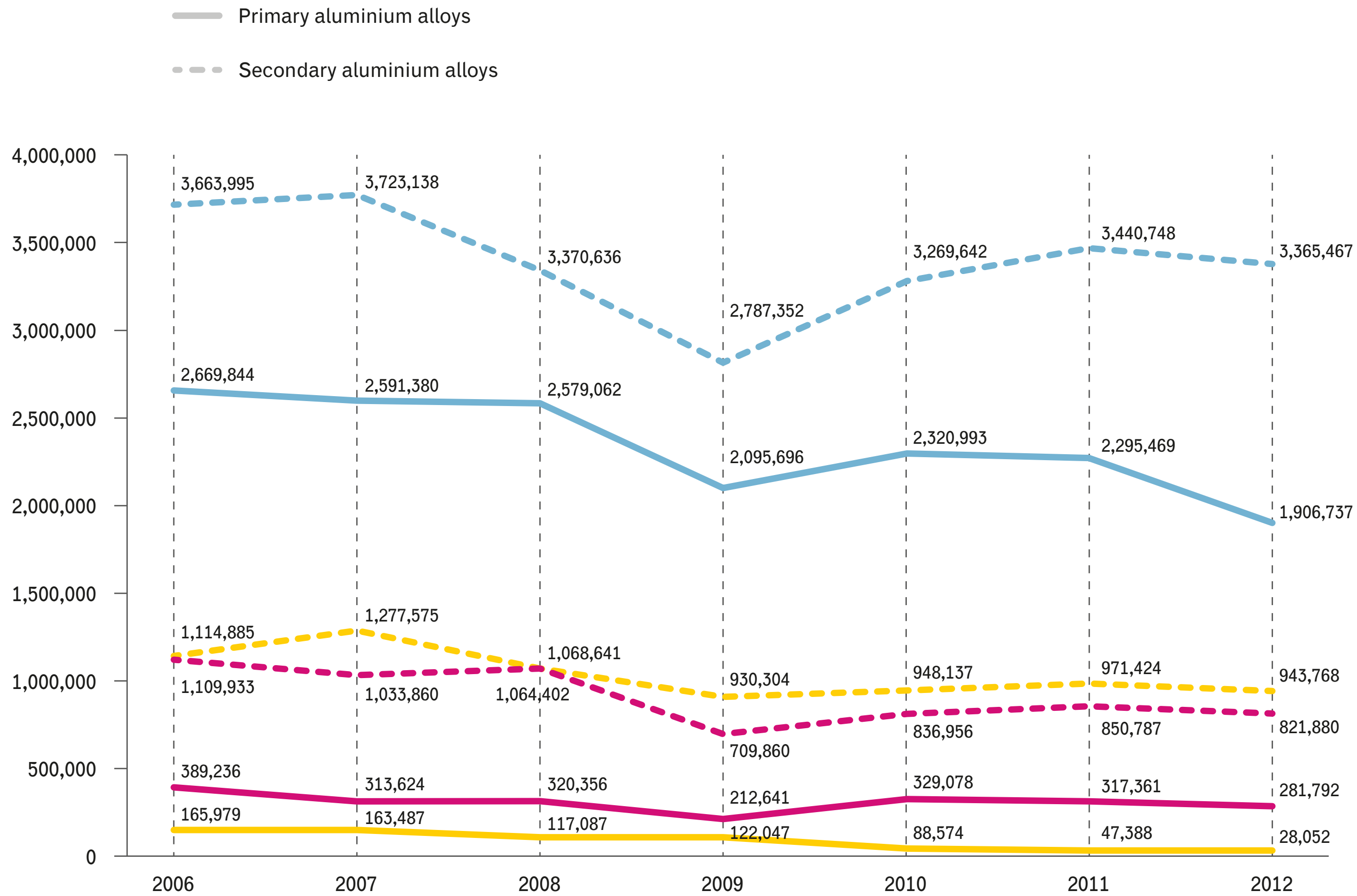
Italy – EU's second aluminium producer after Germany and third in Europe after Norway and Germany – is the first secondary aluminium producer.
44% of the national production is represented by foundry castings, 30% by rolled products and 26% by extruded and drawn items.
Historically Italian production has always been based on scrap, but since 2013 it has only come from secondary aluminium production: over a total of 1.15 million tonnes of aluminium ingots produced, 42% was secondary aluminium from remelters and 58% secondary aluminium from refiners (with a high component of post-consumer material).
From the 2009 crisis, total production has picked up, although still lower compared to pre-crisis peaks, in particular the production of rolled sheets and castings is still affected by the negative cycle of the construction and car industries.
The production of semi-finished items, based also on primary aluminium imports, is slightly over 1.4 million tonnes.

Photo by Alberto Bernasconi

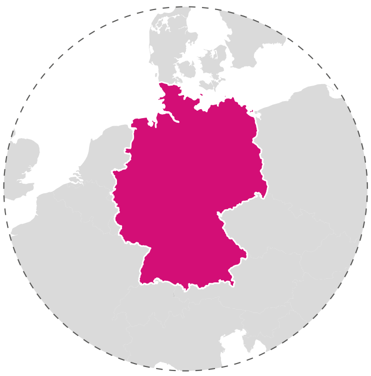
Primary and Recycled Aluminium Production in Europe

At EU level, primary aluminium production represents slightly over one third of total production.
The leading primary producer in the EU is Germany (outside the EU, in Europe, it is Norway). ▶

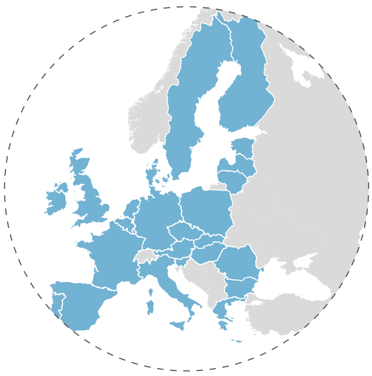
Primary and secondary Production of Aluminium Alloys (Tonnes)



ITALY



GERMANY



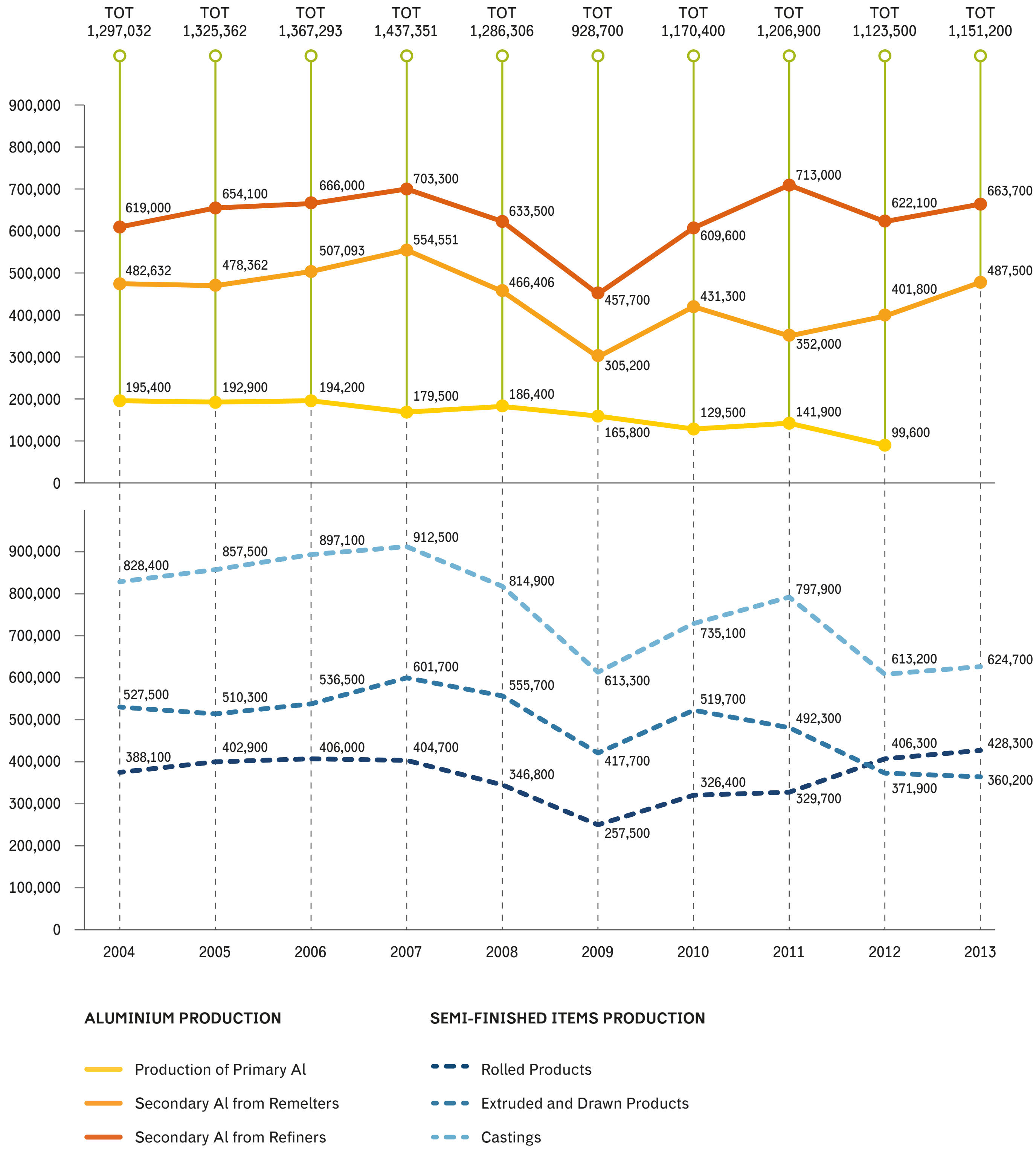
EU27

Secondary aluminium production, namely from scrap recycling (internal, pre and post-consumer items) is highly concentrated in Germany and Italy, which over the last few years has established its leading position as secondary aluminium producer in the Union.

Italian Aluminium Production from Recycling: Remelters

Remelters process wrought alloy scrap to obtain new wrought alloys: national ▶

Statistical Data on Aluminium and Semi-Finished Items Production in Italy (Tonnes)



Italian Production from Remelters (2013, Thousands of Tonnes)

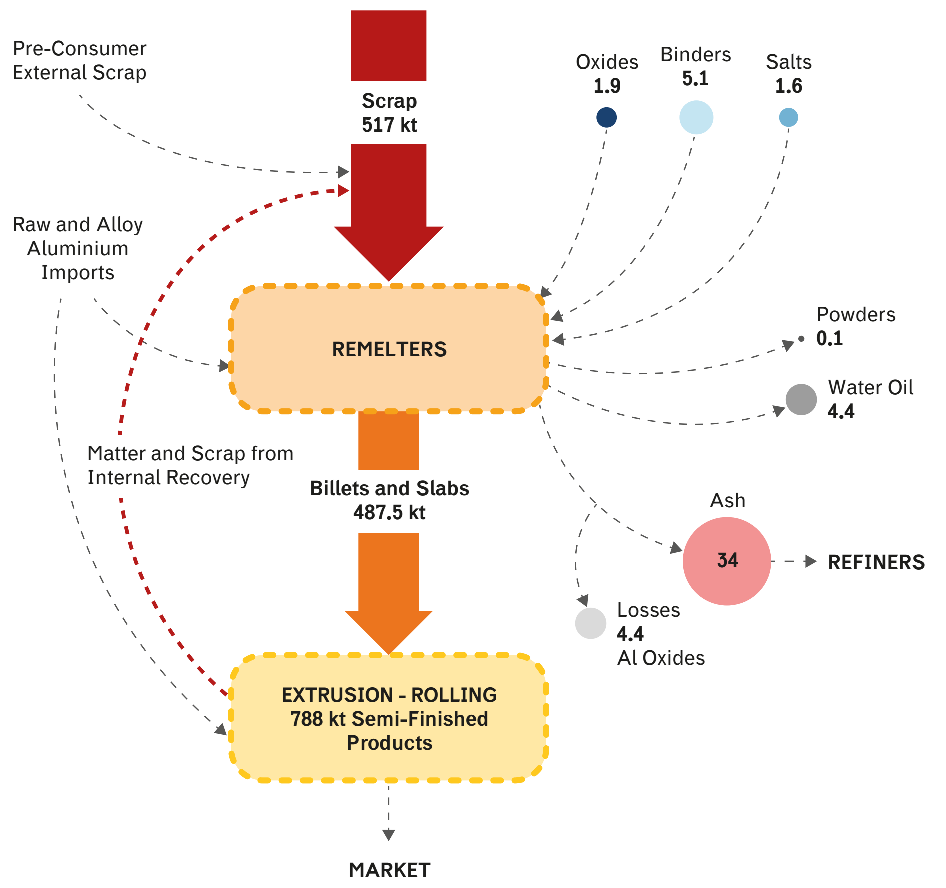



Photo by Alberto Bernasconi

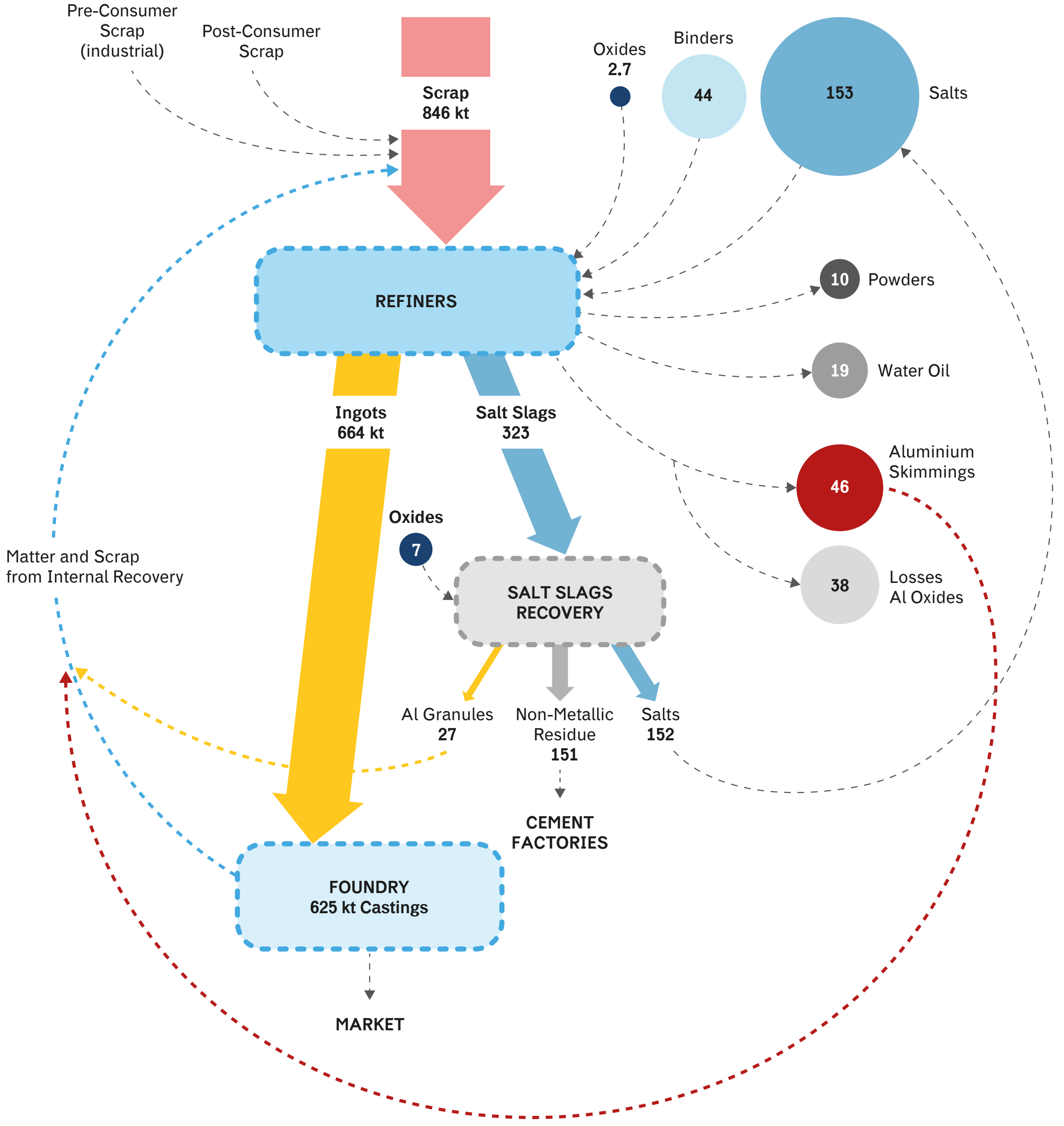

Photo by Alberto Bernasconi

production is 487,500 tonnes (2013 data). Net demand – excluding binders – of remelters amounts to 106% of the production of billets, slabs and continuous casting liquid. Scrap feeding remelters are mainly made of internal waste (rolled and extruded products in integrated plants) and pre-consumer scrap. Losses in processing (such as oxidized aluminium) are lower than 1%.

Remelters' main products are:

- extrusion billets (50 to 500 mm-diameter cylinders, up to 7 metres long) for the production of sections, tubes and rods;

Refiners' Italian Production (2013, Thousands of Tonnes)



- rolled sheets for the production of foil (up to 5 micron per foil).

Italian Aluminium Production from Recycling: Refiners

Refiners process pre and post-consumer scrap for the production of foundry alloys and deoxidized aluminium used in the steel industry.
Refiners' national production is 664,000 tonnes (2013 data).

Refiners' net demand amounts to 127.5% of castings production. Scrap feeding refiners derive from pre-consumer contents of semi-finished and manufactured products, from remelters' ashes, from salt waste recovery and post-consumer scrap from demolition and packaging.
Due to the lower level of purity of incoming alloys, the processing requires higher quantities of salts and binders and generates more losses, about 6%.
Refiners' main products are:

- foundry ingots, for castings production;
- aluminium for deoxidation in steel plants. ▶

Consumption of Scrap and Internal Waste

Secondary aluminium production is fed by three types of scrap.
1) Post-consumer waste, made of old scrap – even mixed with other substances (paints, other materials) – deriving from dismantling, disposals and separate waste collection of urban waste. The estimate for 2013 of post-consumer scrap amounted to 400,000 tonnes (of which less than 70,000 from urban waste).
2) Pre-consumer waste (marketed), made of new and clean alloys and both from production processes of semi-finished products and manufacturing processes (turning, cuts and out of spec).
The 2013 estimate for pre-consumer scrap amounted to 475,000 tonnes.
3) Internal waste (not marketed) of production processes, made from the recovery of waste and salt solutions, ingot production waste, rolling and extrusion waste in integrated processes. Such flows are not assessed in statistics and amount to 485,000 tonnes.

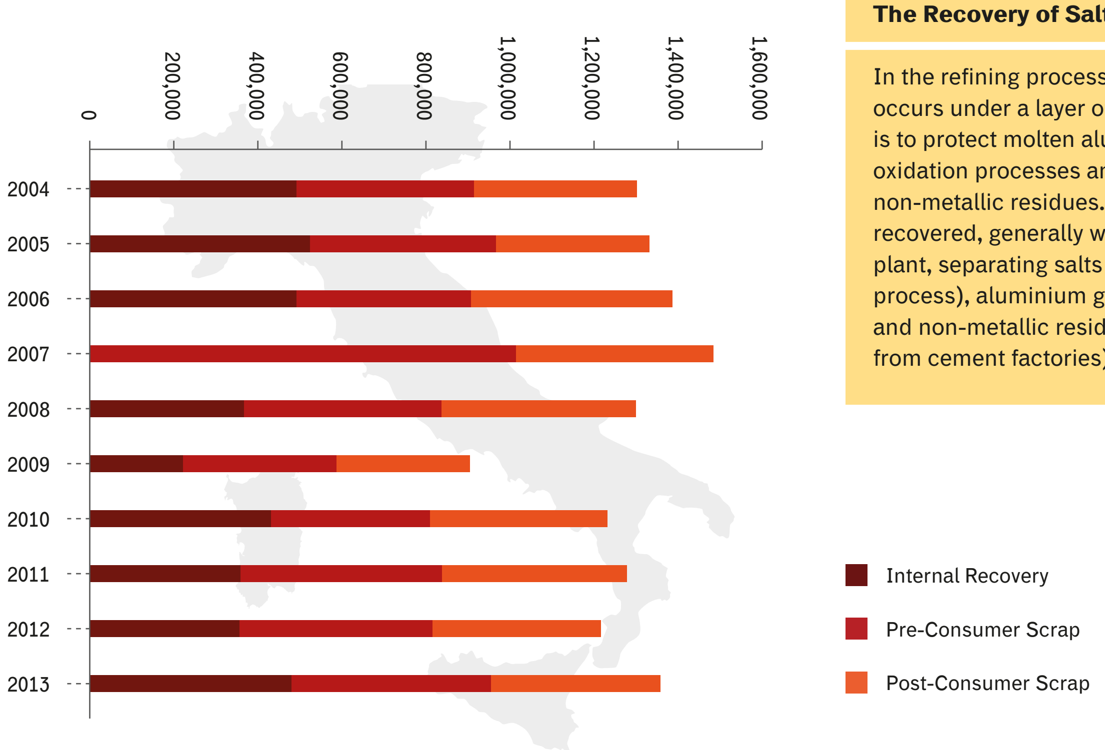
Internal Recovery and Pre-Consumer Scrap

By internal recovery we mean the recovery of production waste and non-marketed pre-consumer scrap (and therefore not included in statistics) occurring within the production cycle (such as the recovery of production slags or salt solution slags) or within the same downstream-integrated company, for example with extrusion or rolling. The most substantial recoveries are made of waste, turning and shavings from rolling or extrusion from foundries. Production waste varies according to the type of product, ranging from 20-30% of the end product.
Pre-consumer scrap is waste – marketed and therefore statistically relevant – of production and manufacturing processes. It is made of waste, turning and rolling, extrusion and foundry shavings (similar to those considered as "internal recovery") and from production waste for the generation of sheets, extruded items and castings.

Post-consumer waste

According to historical consumption and substitution rates, generated post-consumer waste is estimated around 39% of new products placed on the global market and 51% of new products in Europe (data from International Aluminium Institute). In Italy, based on these values, a post-consumer production of scrap between 430 and 560,000 tonnes can be estimated (for 2013). The internal post-consumer collection for recycling is estimated at around 250-300,000 tonnes.

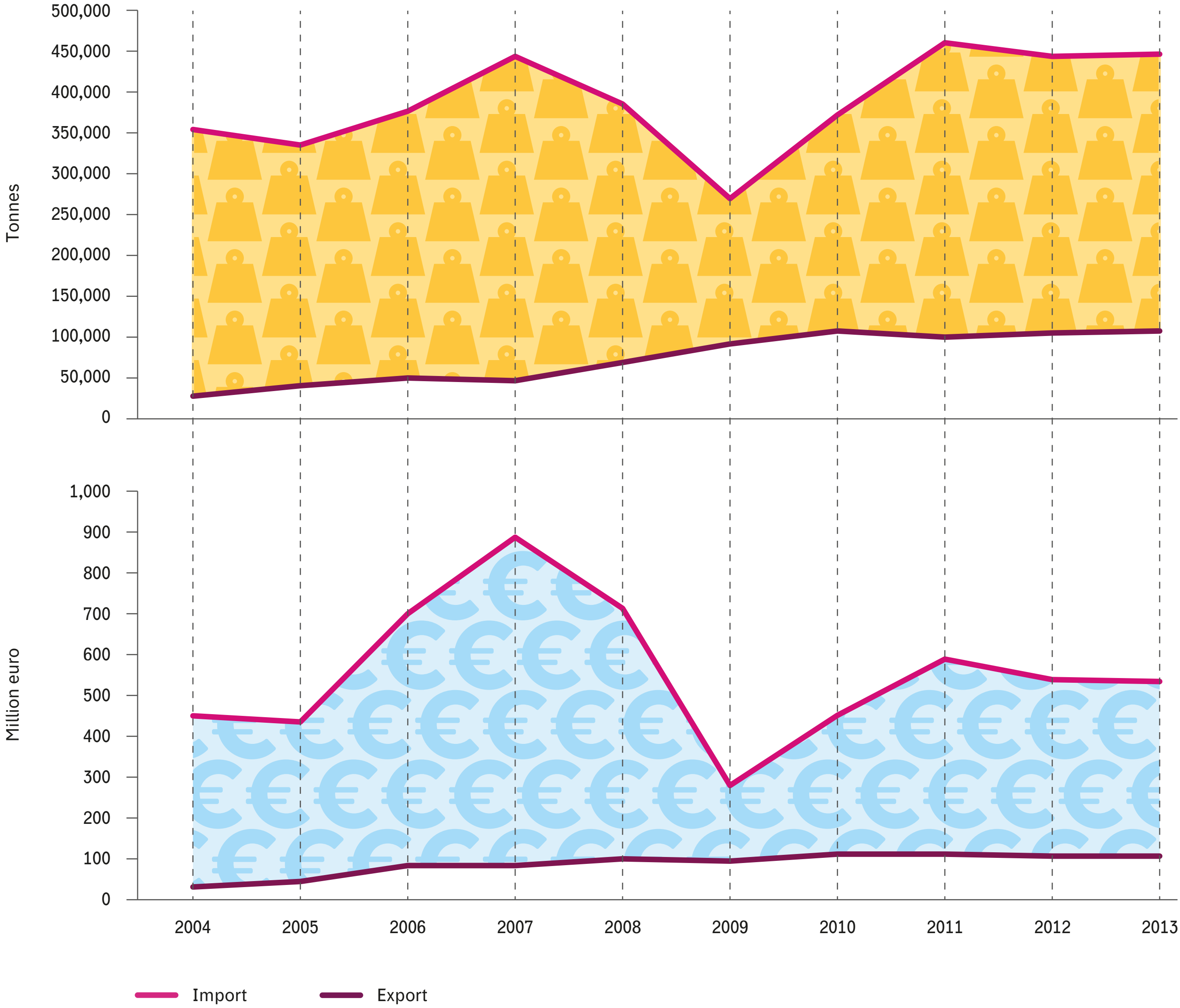
Consumption of Scrap and Internal Waste (Tonnes)



The Recovery of Salt Slags

In the refining process, scrap melting occurs under a layer of salt, whose function is to protect molten aluminium from oxidation processes and absorbs non-metallic residues. Salt slags are recovered, generally within the refiners' plant, separating salts (recycled in the process), aluminium granules, iron powders and non-metallic residues (recovered from cement factories).

Scrap Trade Balance



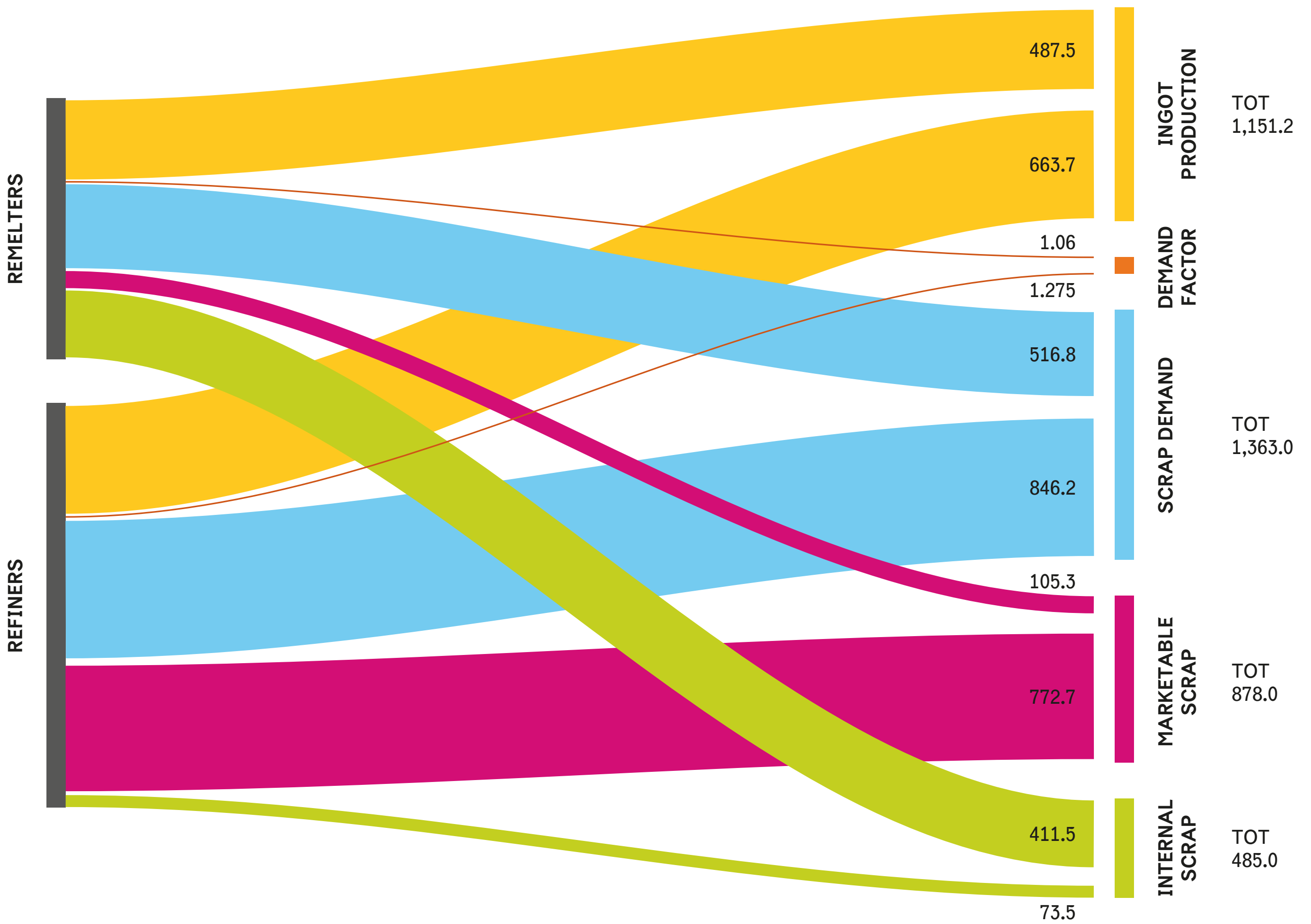
With the exception of packaging, post-consumer scrap is derived from products marketed on average 30 years ago.
The main sources of post-consumer scrap are:
• building demolition and renovation (doors and windows, facades) and demolition of infrastructure (pipes and piling);
• dismantling of vehicles (cylinder block and heads, pistons, brakes, wheels, heat exchangers) and means of transport (trains, underground);
• packaging (cans, trays, foil);
• electrical products (cables) and components of mechanical and thermal devices (radiators);
• waste from electrical and electronic devices (components from air conditioning devices, computers);
• durable consumer goods (furnishings, lighting and pots and pans).

Collection and recycling rates vary according to products, from less than 20% (for example for foil) to over 80% (building waste, cables).
Although aluminium is considered a precious metal, in many sectors waste generation rate is still very high (with considerable metal losses) between produced waste and collected waste from recycling.

Methodology Notes on Scrap Consumption

Statistical data show only information about marketed scrap consumption, which includes all post-consumer scrap and part of pre-consumer scrap.
All internal waste recovered and recycled within the same production process and pre-consumer ▶

Scrap Consumption (2013, kt)



waste (mainly from rolling or extrusion) of downstream-integrated remelters is excluded, even in separate production sites.
The scrap consumption is based on data published by CiAl in its reports, just as the separation between pre-consumer and post-consumer scrap.
The consumption of internal waste is estimated on the difference between the theoretical demand of scrap (calculated as 1.06 per tonne of alloys from remelters and as 1.275 per tonne of alloys from refiners) and the consumption of marketed scrap.
The resulting value is consistent with Global Model estimates by International Aluminium Institute (waste amounting to 34.3% of semi-finished products compared to 37% of Global Model). For refiners, the consumption of internal waste amounts to the recovery of waste and salt solutions.

Scrap import-export

The Italian industry is a net importer of aluminium scrap: the historical peak was reached in 2011 with a value of 461,000 tonnes, whilst in 2012 and 2013 the values amounted to 445-450,000 tonnes.
Since 2009, the scrap aluminium exports have grown considerably (107,000 tonnes in 2013, as opposed to 67,000 in 2008): in 2013 our trade balance deficit was of 341,000 tonnes and €427 million.
Prices of aluminium scrap soared considerably between 2006 and 2008, with a significant reduction in 2009 followed by a recovery close to historical peaks in 2010 and 2011, keeping constantly high levels throughout the following years.
In 2013, the average value of scrap imports amounted to 1,192 euro/tonne (1,200 in 2012) while the average value of scrap imports was 1,000 euro/tonne (1,034 euro/tonne in 2012).
Imports and exports mainly refer to pre-consumer scrap.
Prices of aluminium scrap from cans varied between 800 to 900 euro/tonne, while that from mixed non-selected scrap (one of the lower qualities of post-consumer collection) was estimated at around 150 euro/tonne. ●

The estimate is only provisional and does not take into account the direct inputs of primary aluminium.
Scrap import-export is based on ISTAT-Coeweb data and refers to NC8 code "76.02 aluminium waste and scrap."

Photo by Giovanni Diffidenti

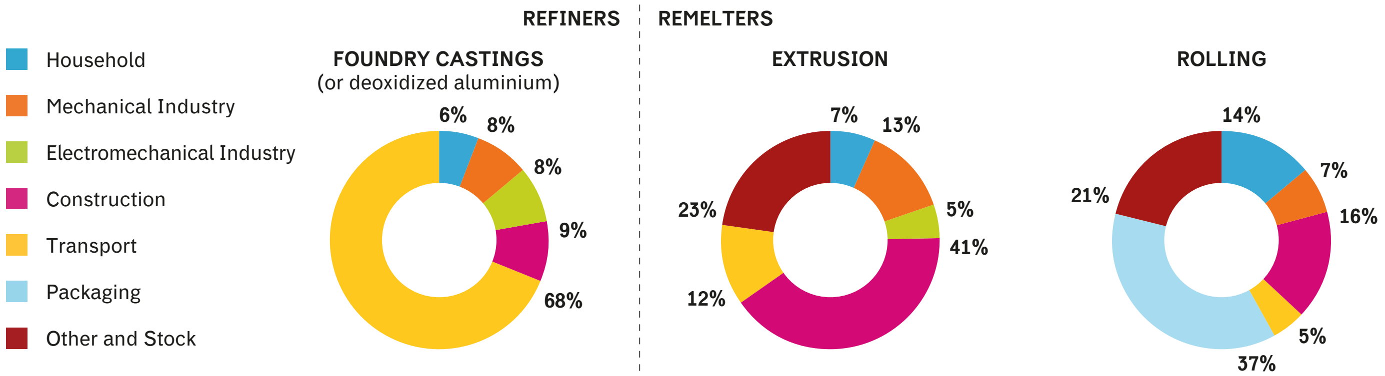
Products from Recycling

End uses

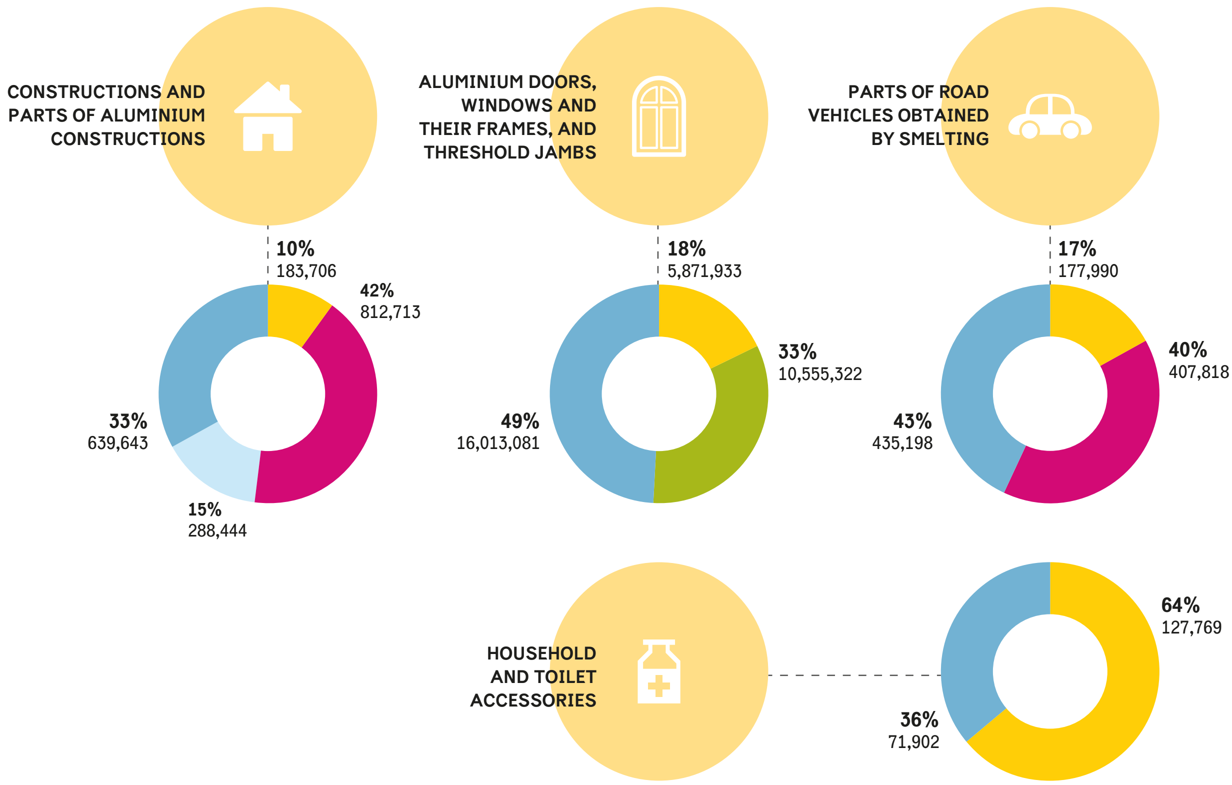
The most extensive uses of aluminium production are in the engine design business and transport (mainly from foundry castings), in the construction sector (mainly extruded products), in the production of foil and packaging (sheets), in household and office products and in the mechanical sector.

Italy is the undisputed leader in the multifaceted field of the production of household items and toilet accessories. After Germany, it is the producer of automotive and transport components and is the leading country for some types of smelting products for engines and motor vehicles.
The Italian industry is also the largest in some building productions: for doors and windows it ranks only second for quantity, but first for turnover.
It is the second largest producer in Europe, after Germany, for foil stock. ▶

Refiners and Remelters



Specialization of Italy's aluminium industry in Europa (2013, Tonnes)



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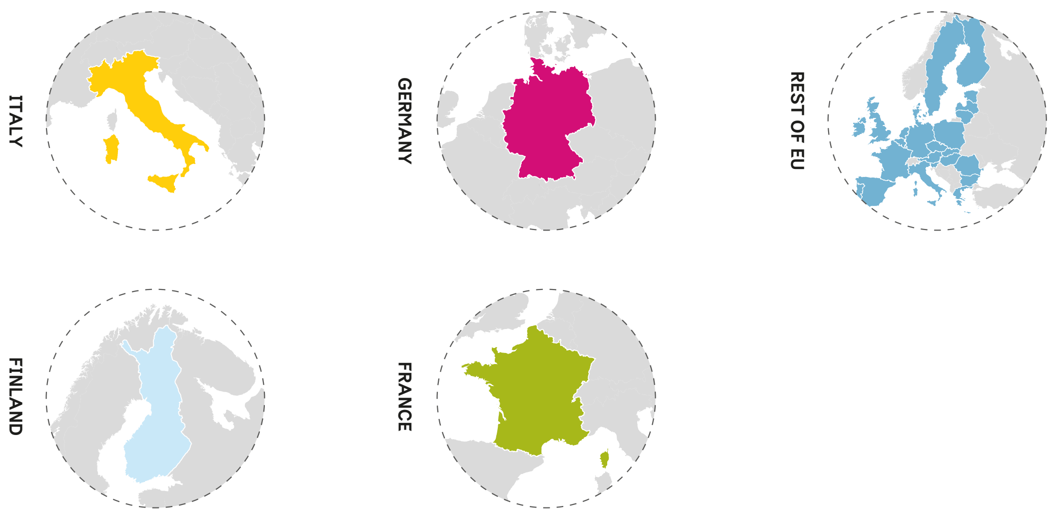
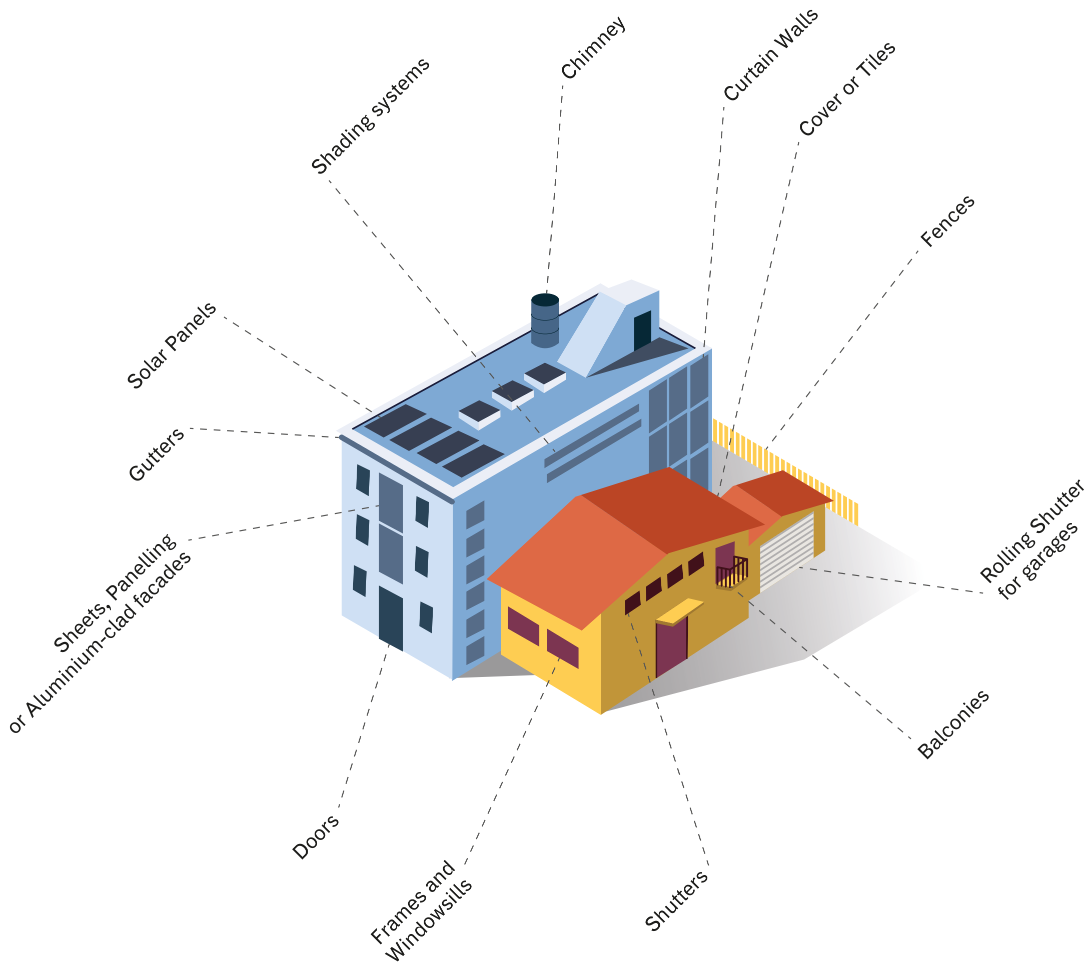


Aluminium Uses in the Construction Sector



Products: Doors and Windows and other Uses in Building

The construction industry represents around 18% of the end uses of Italian production and 22% of end uses in Europe. Aluminium rolled and extruded products represent 77% of Italian production.
Aluminium is widely used in the construction sector: doors and windows, structural elements such as curtain walls, cover and ceiling sheets, bar sections or castings for air-conditioning or heating systems.
In these types of uses, lightness, corrosion, shock resistance and conductivity are particularly important.
One of the most significant industrial uses is for doors and windows, where aluminium covers 30% of the Italian market.
Uses in the building sector are long lasting – from 20 to 50 years depending on the various products – with a high recovery and recycling rate. Doors and windows and panel recycling follow a well-established and efficient recovery procedure,


Photo by Giovanni Diffidenti

through the same installation companies, guaranteeing 85-90% recycling. Scrap from doors and windows, casings and building uses can be estimated at around 110-130,000 tonnes per year (with a consumption of 4-4.5 million pieces a year in the mid 90's.)

Products: Car Components and Means of Transport

In Italy, 35% of aluminium production has transport as its end-use target, with a strong production of engine blocks and other cast components. At a European level, 29% of aluminium is used for cars and about 12% for other means of transport (heavy vehicles, underground, trains, aircrafts, ships).
In motor vehicles, the average aluminium content is about 140 kg (2012 European average), with a higher percentage in D-segment vehicles (184 kg/vehicle) and E (301 kg/vehicle) and lower in A-segment vehicles (75 kg/vehicle) and B (109 kg/vehicle). ▶

Aluminium Components (car fleet average)

Body: average 26 kg, about 20 components. Main uses: bonnet, doors, front structure, bumpers.
Chassis and shock absorbers: average 69 kg, about 17 components. Main uses: wheels, suspension arms, steering systems.
Transmission group: average 69 kg, about 25 components. Main uses: engine and head block, radiator, and gearbox.

Source: Ducker Worldwide: Aluminium Penetration Cars. Final Report, EAA 2012.

Photo by Alberto Bernasconi

Recycling of Insulated Aluminium Windows

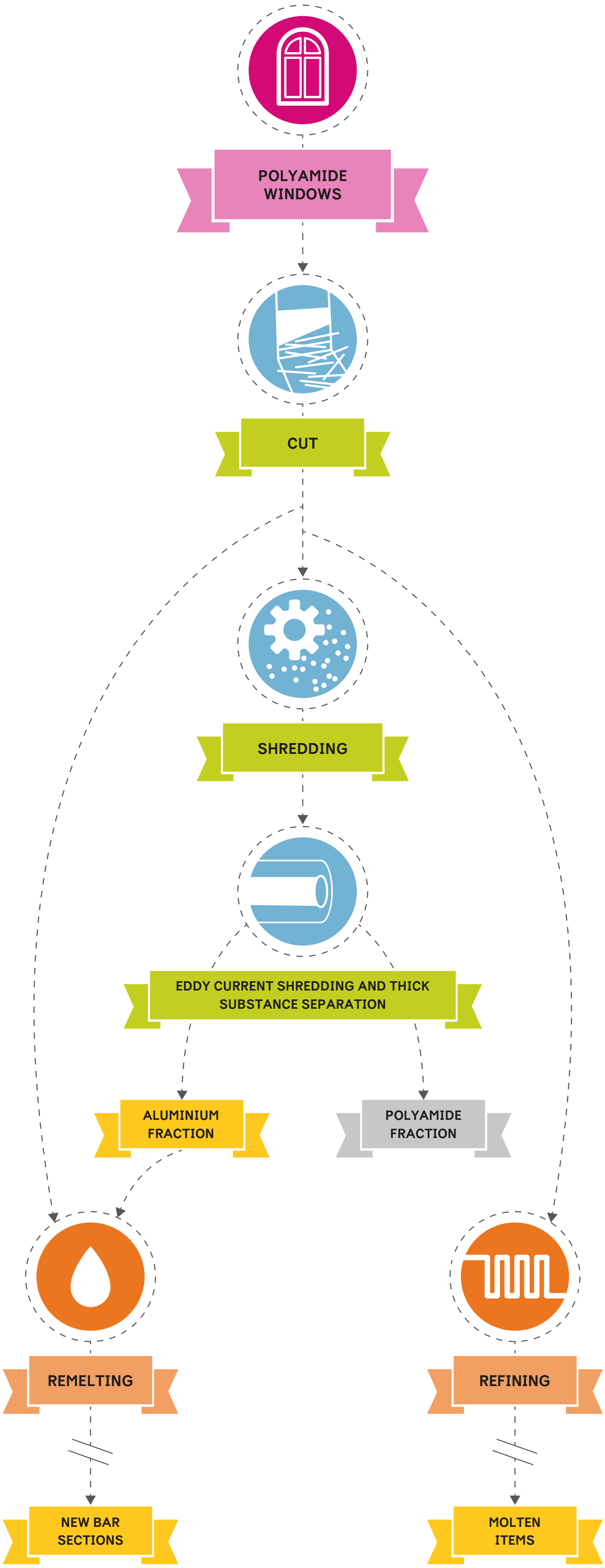


Photo by Giovanni Diffidenti

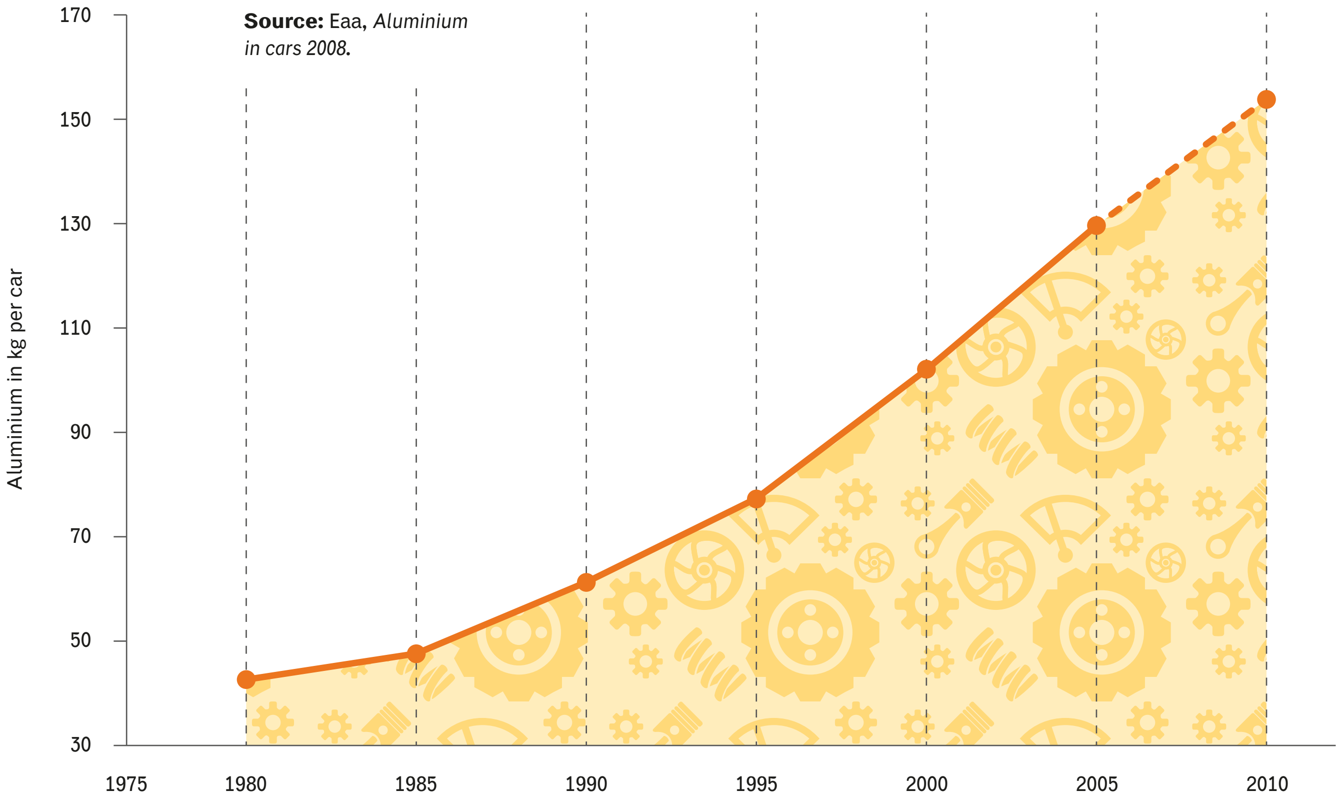
The main aluminium components in any vehicle are wheels, engine blocks, radiators and also structural parts. 73% of aluminium is made of castings, 13% of rolled products and 10% of extruded items.
The employment of aluminium in heavy vehicles for freight transport and electric vehicles for public transport (trams, undergrounds and trains) is considerable and still growing.

Evolution of the Use of Aluminium in Cars

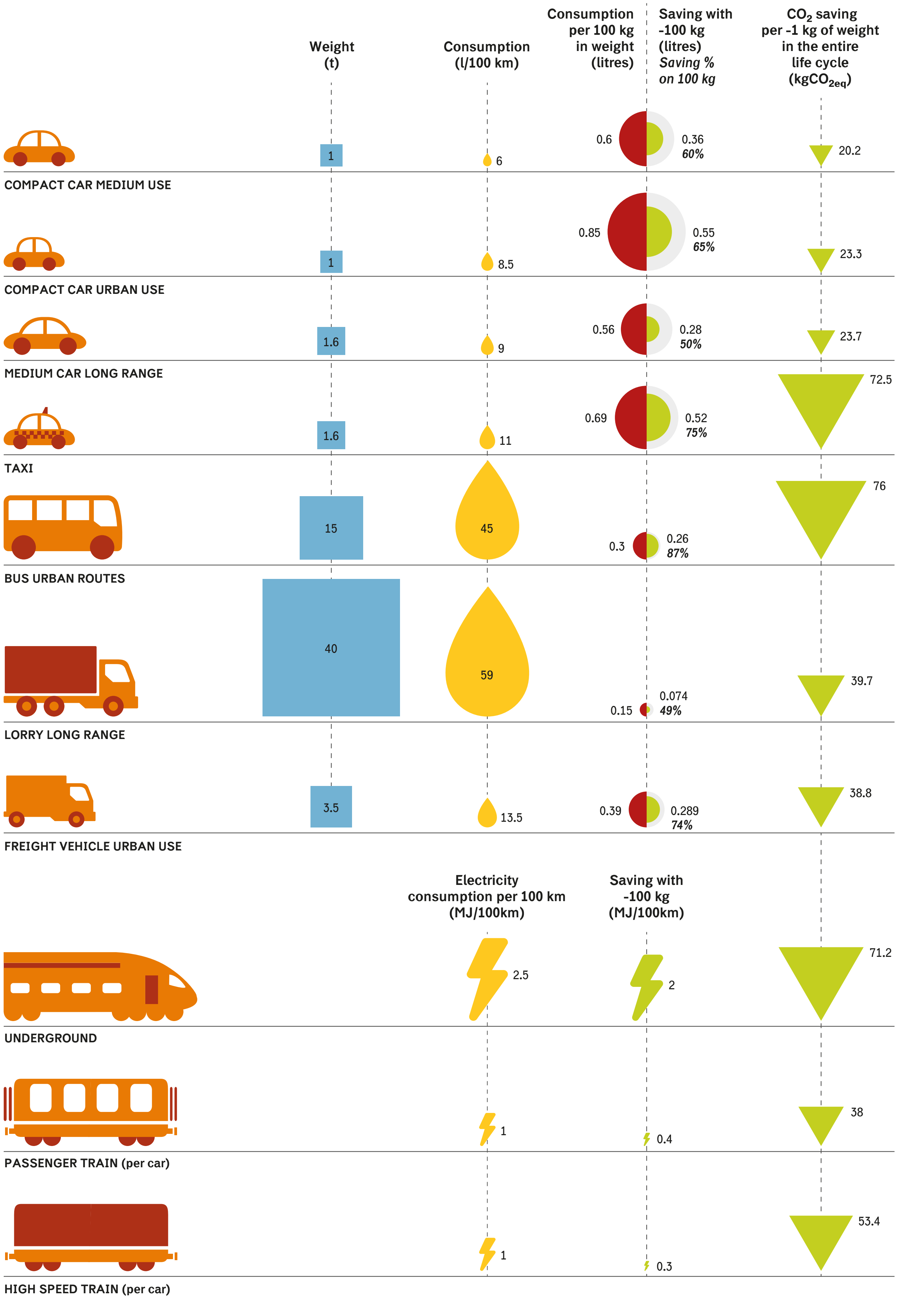
Over time, the use of aluminium in means of transport experienced a strong growth. In Europe, the aluminium production for means of transport has more than doubled in 20 years: from 2.1 to 4.4 million tonnes. But, more importantly, the quantity of aluminium contained in cars keeps on growing, amounting to an average of 50 kg in 1985, to about 100 in 2000 and 140 in 2012. The quantity of aluminium is greater, even compared to weight, in the higher segments: it varies from 8% ▶

Photo by Alberto Bernasconi

Evolution of Aluminium Content in European Cars



Transport's energy consumption and CO_2 emission reduction in relation to weight reduction through the substitution of ferrous metals with aluminium



of the total weight in the A-segment vehicles (for instance Fiat Panda) to 10% in the C segment (for instance Ford Focus) up to 17% in the E segment (for instance Mercedes E-Class).

More aluminium in vehicles significantly contributes to a reduction in energy use and therefore in emissions.
The impact of aluminium on energy efficiency of vehicles is – first and foremost – determined by the reduction of mass due to the use of this material as a substitute for iron or copper materials. The energy necessary to move a vehicle is, with the exception of the aerodynamic resistance, directly proportional to its mass. The specific weight of aluminium (2,700 kg/m^3) is about one third of that of steel, although in order to replace the mechanical parts it is necessary to increase the thickness of aluminium used. Therefore, the achieved weight reduction is about 50%. In other words, the use of 100 kg of aluminium replaces that of 200 kg of steel and therefore generates a net weight reduction of the vehicle of 100 kg.
In a normal car, a mass reduction of 100 kg means a reduction of consumption of about 0.35 litres per 100 km and of 9 g of CO_2 per km. This is tantamount to a reduction of 7% compared to current average emissions of the new EU car fleet, while the avoided emission over the whole life cycle amount to 20 tonnes of CO_2 per vehicle.


Photo by Giovanni Diffidenti

Products: Furniture, Household and Personal Hygiene Items

Aluminium is widely used both in household and furniture items. Just taking into consideration household, kitchen and toilet items (including part of furniture items), in 2013 the Italian production amounted to 128,000 tonnes, with an apparent consumption (production+import-export) of 94,000 tonnes. Italy is characterized by a strong specialization both in terms of production (64% of European production) and consumption (34% of European apparent consumption).
Aluminium is used to produce furniture, bookcases, chairs, tables – both for indoor and outdoor uses – kitchens, pots and pans, bowls, coffee makers and personal hygiene products.
In the production of kitchen items, it is used ▶

Means of Transport's Aluminium and Emissions

Heidelberg-based IFEU (Independent Institute for Energy and Environmental Research) and other authors studied the potential impact of the use of aluminium on the emissions of several types of means of transport (Helms H., U. Lambrecht, *Energy savings by lightweighting*, part II IFEU, 2004). The lesser the impact of air resistance, the greater the consumption reduction – for a certain vehicle, engine size and driving conditions being equal – is directly proportional to mass reduction.
CO_2 savings on the whole life cycle consider the average mileage of various vehicle types. For electric vehicles, CO_2 emission reduction can vary, even considerably, according to the feeding mix of the electric system.
The actual quantity of usable aluminium while reducing other materials varies according to vehicle type.
100 kg of aluminium represent the current average content for lower-segment cars (about 140 is the average value of the new car fleet), while for lorries the average value is about 1,000 kg/vehicle (fluctuating between 500 and 3,000 according to the vehicle model).
As for cars, over the next years, a growth of 40-50 kg of aluminium is expected.

both pure and as a base for non-stick pots and pans coated with Teflon and other materials. The life cycle of these consumer objects varies, generally between 3 to 20 years. The waste flow ends up partly in urban waste, partly in bulky waste and partly in industrial waste.

Products: Radiators and Heated Towel Rails

Both from an energy and economic point of view, one of the most efficient uses of aluminium is in radiators and heaters. Using recycled aluminium enables matter and energy consumption reduction for the same size compared to steel. Aluminium radiators are available in tubular and plate designs and can use both convection or radiation. The success of aluminium in radiators production is also due to the possibility to transform heating modules into design and furnishing items. Italy is one of the main global producers of radiators and heating devices made of recycled aluminium.

Aluminium Products' Benefits for the Environment: Aluminium Efficiency for Heating

But above all, recent studies have shown that aluminium radiators guarantee better energy efficiency, particularly where there is no need for continuous usage. For the same heat output, aluminium radiators need far less water compared to the other two heating systems (28% less compared to cast iron and 45% less compared to steel): this means shorter heating times and less boiler's usage thus reducing energy costs.
It takes half the time to get a heating system with aluminium radiators up and running compared to those with cast iron and steel radiators or panel heating.
Less water, shorter heating times, less weight, these are the factors that make aluminium radiators extremely fast

Heating time (from 5 °C to 21 °C; Δt=30 °C)

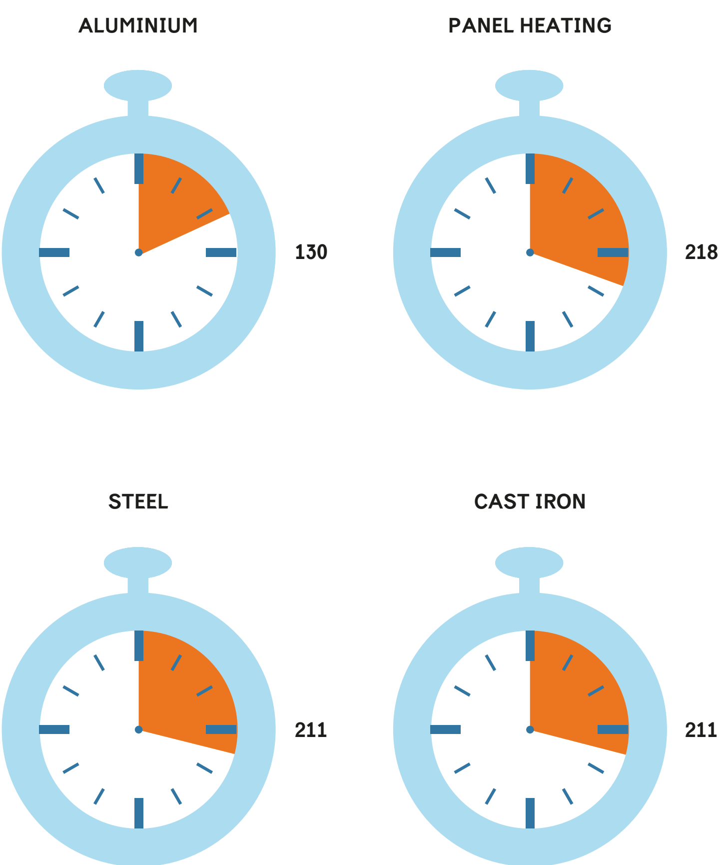
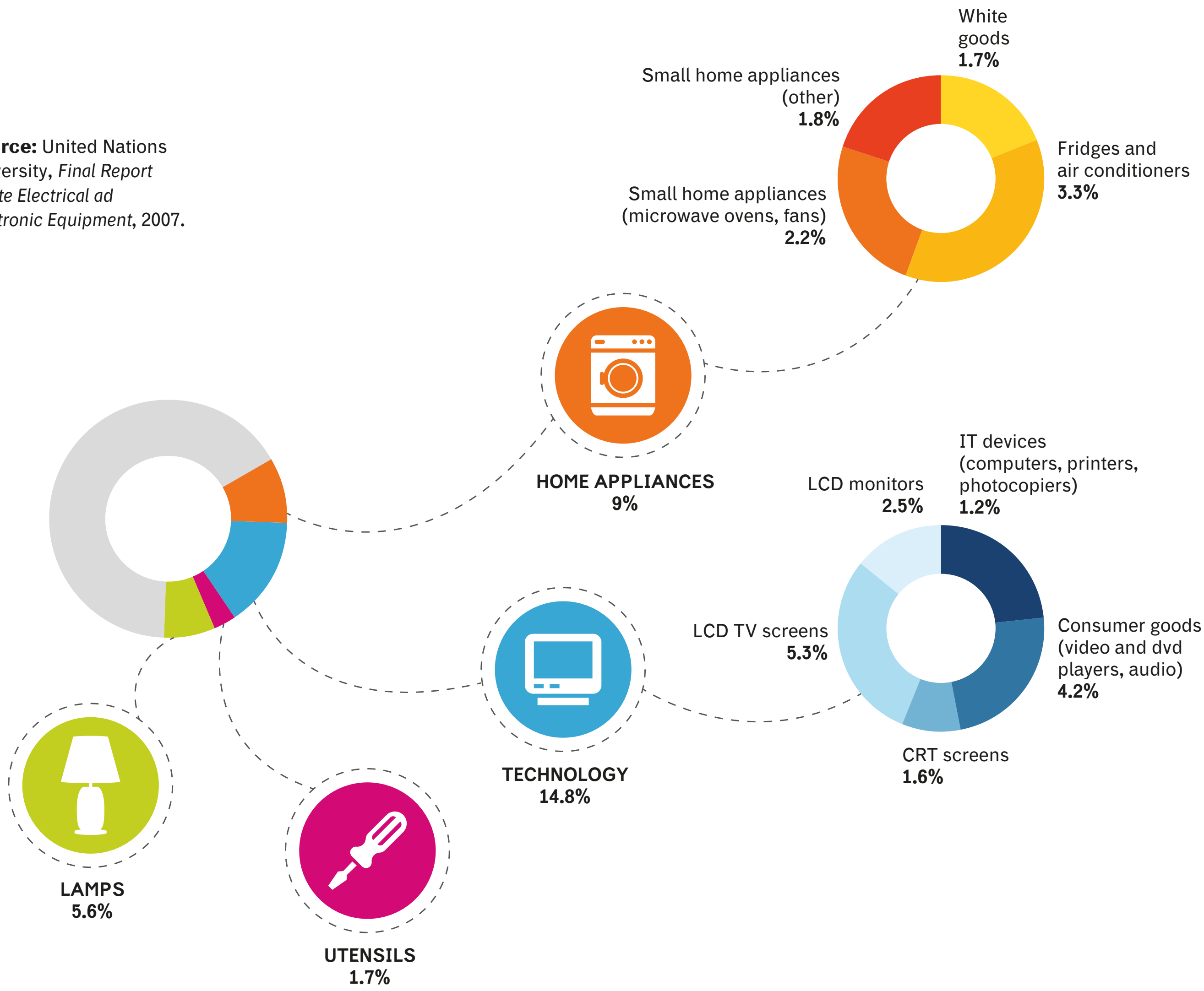



Photo by Alberto Bernasconi


Photo by Giovanni Diffidenti

Aluminium in WEEE (Al %)



Source: United Nations University, *Final Report Waste Electrical ad Electronic Equipment*, 2007.

in changing room temperature to adapt to different needs.
Aluminium radiators are also better than panel heating. According to studies carried out by Florence University's Energy Department, aluminium radiators have a lower energy consumption varying from 5% (for conduction with fixed constant temperature, ideal for panel heating) to up to 40% for intermittent heating systems.

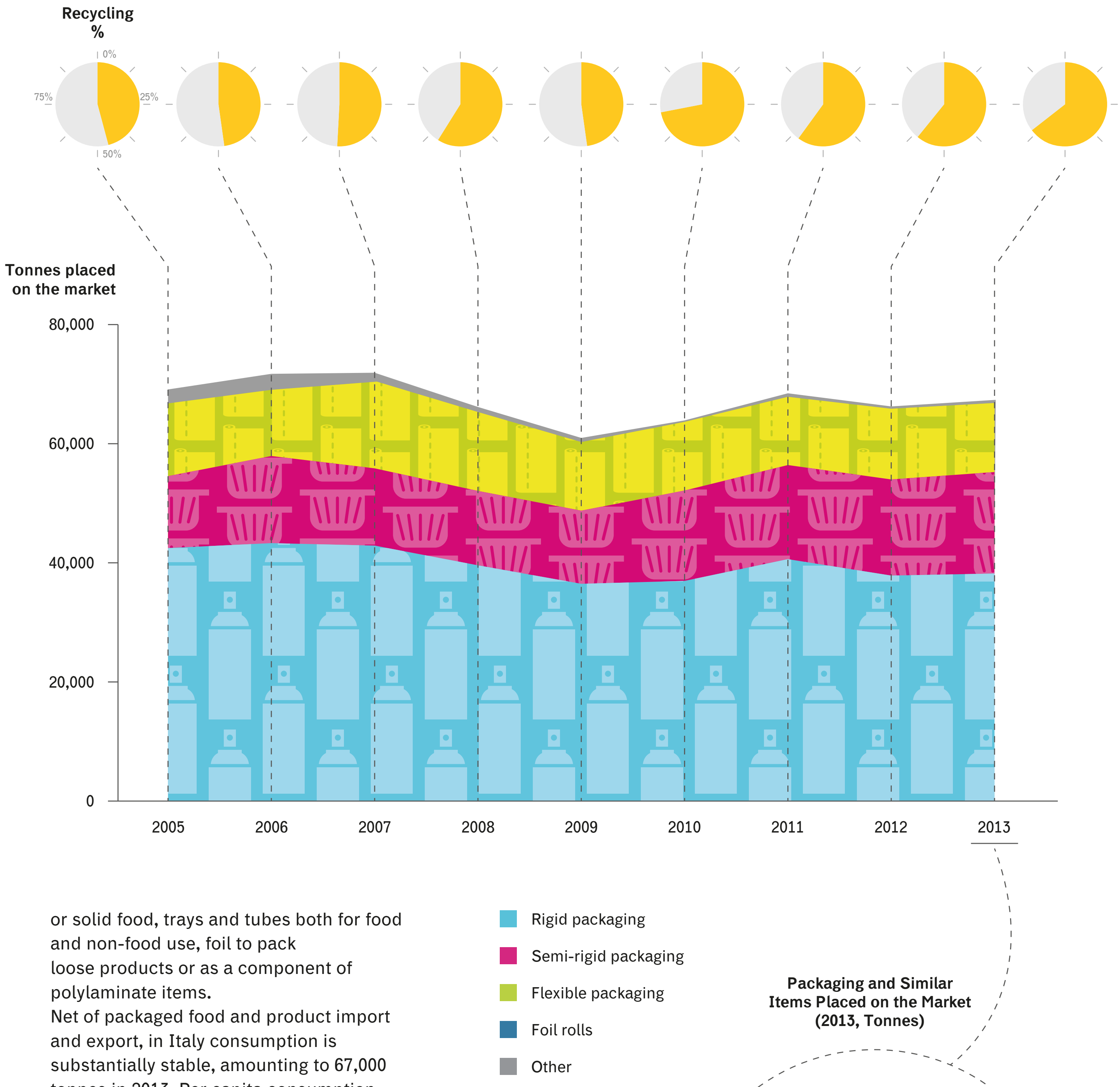
Products: Use in Electrical and Electronic Equipment

Aluminium is widely used in electrical applications together and in competition with copper. In particular, aluminium is used in bare and insulated cables for transporting and distributing electricity or in internal cables for industrial use.
Thanks to its functional and aesthetic characteristics, aluminium is also used, although to a lesser degree, in electrical and electronic devices, from computer and refrigerator casing to heatsinks, air conditioning units and holders for screens and monitors.
In Italy, the overall use in electrical and electronic devices amounts to approximately 20,000 tonnes per year.
Albeit increasingly subject to separate collection, this consumption flow has progressively shorter life cycles, unlike other more industrial and engineering applications.

Products: Packaging

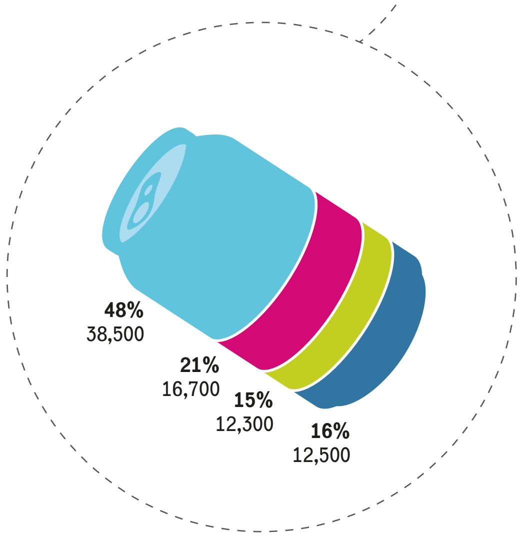
Thanks to its characteristics, ideal both for the optimization of product's preservation (it guarantees long shelf life thus reducing waste) and of transport rationalization and matter use (for its lightness), aluminium is widely used in packaging. It is used to manufacture cans and tins for drinks ▶

Packaging placed on the market and recycling



or solid food, trays and tubes both for food and non-food use, foil to pack loose products or as a component of polylaminate items.
Net of packaged food and product import and export, in Italy consumption is substantially stable, amounting to 67,000 tonnes in 2013. Per capita consumption (1 kg per person) is in line with that of Germany, but is less than half that of the UK and Nordic countries. Besides packaging known as such, the consumption for aluminium sheets for the same purpose amounts to 13,000 tonnes per year. Packaging aluminium has an extremely short life cycle, conventionally around a year. For its characteristics, aluminium and similar packaging are included in urban waste. ●

Packaging and Similar Items Placed on the Market (2013, Tonnes)



Foil rolls are not considered packaging

Photo by Alberto Bernasconi

Mines of Secondary Aluminium

Secondary Aluminium Mines Are still Untapped

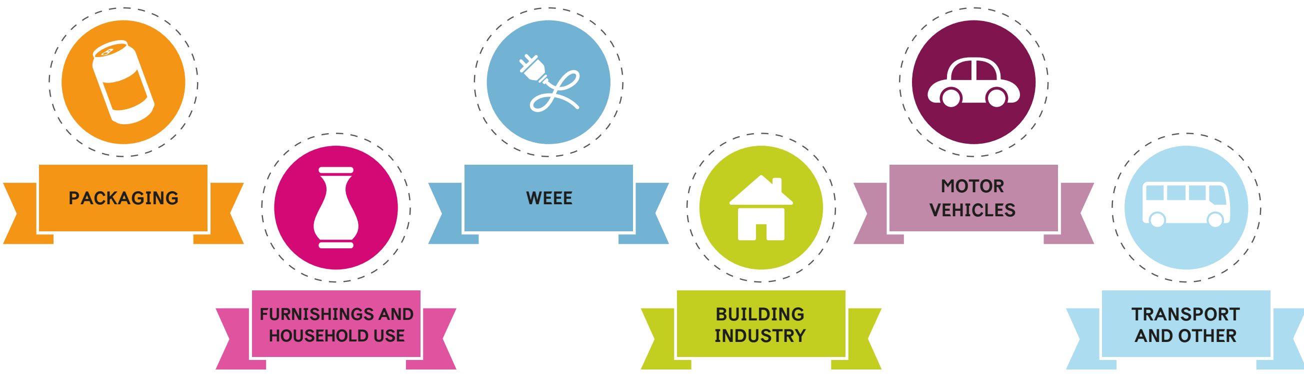
Production waste on the one hand and waste and used products on the other represent the huge mines of secondary aluminium.
These mines have an enormous economic and environmental intrinsic value.
While production waste (pre consumer) is recovered almost completely, the reconstruction of post-consumer waste flows is still rather complicated. Especially because there is the possibility that a huge recovery and trade grey area exists that escapes for example data gathering for tax reasons.
The quantity of waste generated every year varies between 400,000 and 500,000 tonnes. Post-consumer waste and scrap deriving from different uses are partly made up of homogeneous aluminium products (as it is the case for packaging

and cables). Partly from components of other products (as it is the case for vehicle and electronic devices components).
Not all this waste is, at least seemingly, actually recovered.
In fact, secondary aluminium "urban mines" still seem very rich: the ostensible total loss of aluminium, due to urban and industrial uses, is about 40%.
Actually, in some cases this loss can be as high as 58% of the total urban flows, 40% for packaging and similar uses, and over one third for end-of-life motor vehicles.
There is strong evidence suggesting huge wastage and loss above all in flows destined to the urban waste circuit: aluminium foil packaging and other types of flexible and semi-rigid packaging, everyday objects and furnishing items, components of electrical and electronic devices waste, and aluminium in incineration waste are only partly recovered.
From a potential recovery point of view, end-of-life motor vehicles are another seemingly critical area (unless we have incomplete data).
This failed recovery of aluminium is thought to amount to a potential loss of the recycling sector of €350 million and 1,350 jobs. ▶

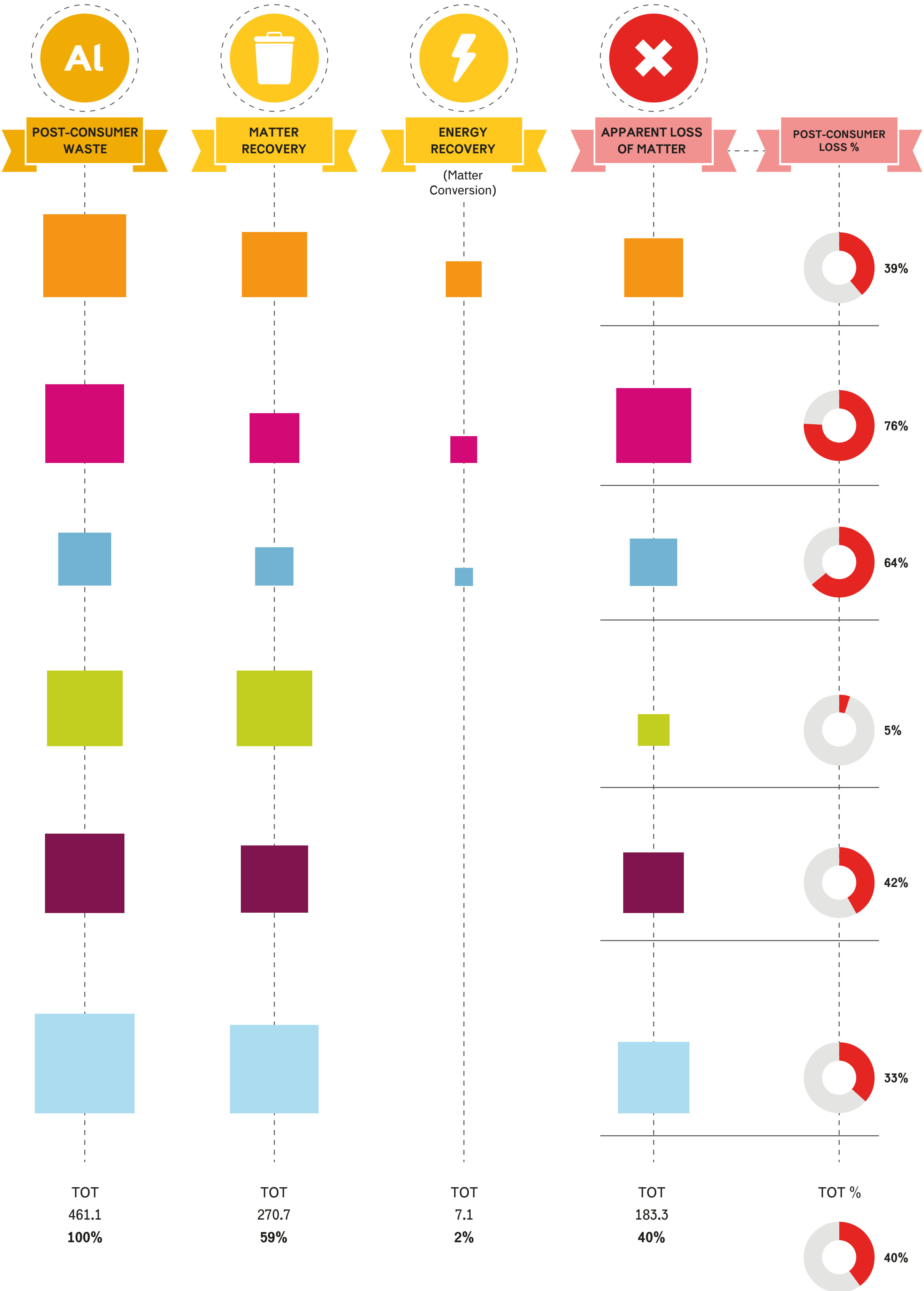
Photo by Giovanni Diffidenti

Photo by Alberto Bernasconi

Post-Consumer Waste Types



Post-consumer Aluminium Waste Management, Italy 2013 (Thousands of Tonnes)



- Packaging
- Furnishings and household use
- WEEE
- Building industry
- Motor vehicles
- Transport and other

Photo by Alberto Bernasconi

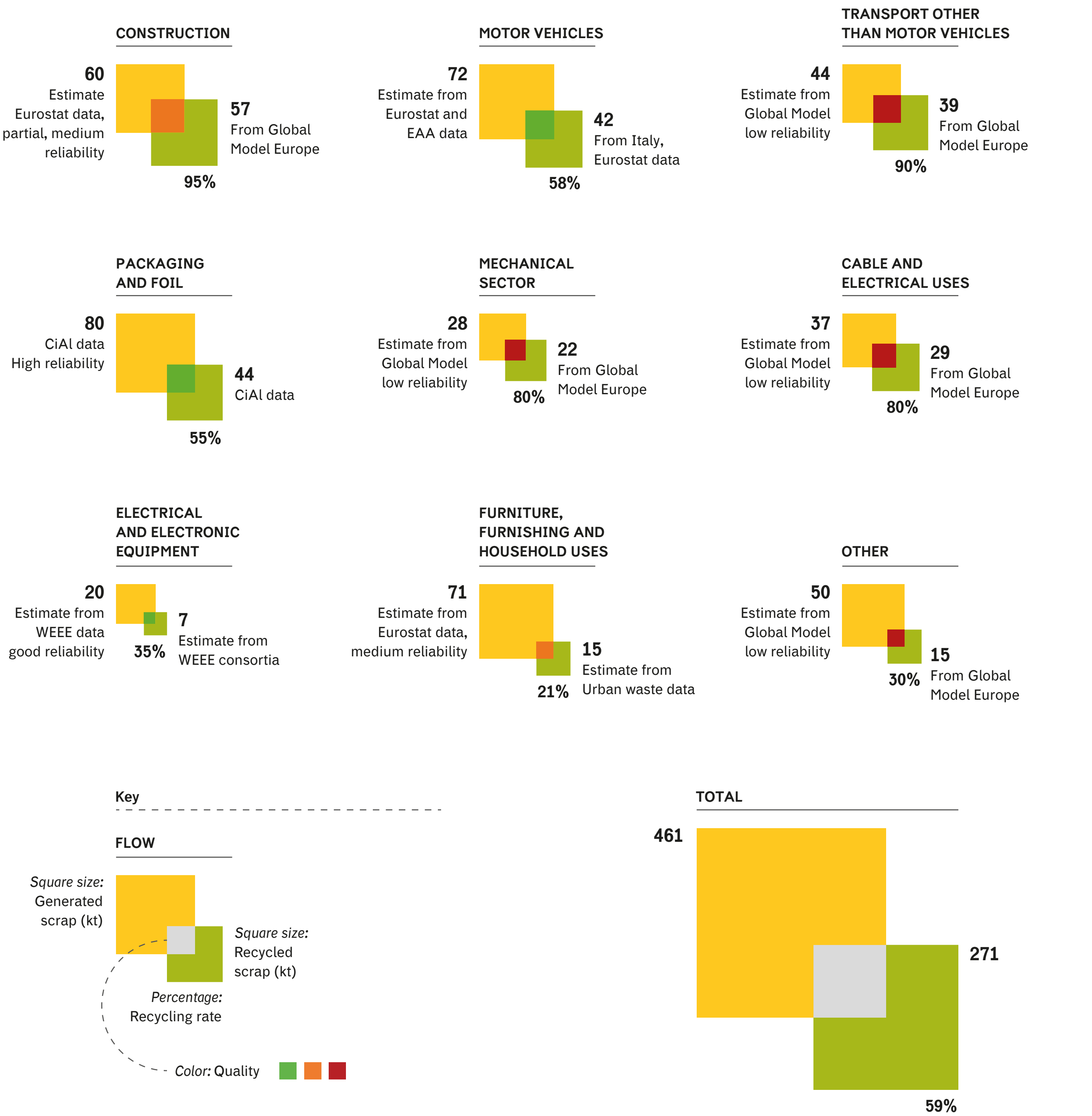
Post-Consumer Scrap Accounting Methodology

Produced Flows

Aluminium waste flows must be calculated together with historical consumption and products' life cycles. For waste deriving from packaging, it is assumed that consumption in 2013 (CiAl data), including the consumption of wrapping foils that cannot be considered packaging (13,000 tonnes), was 80,000 tonnes/y.
For waste deriving from motor vehicles, it is estimated that the average content of aluminium is 80 kg/vehicle in about 900,000 scrapped vehicles (Eurostat data, 2013).
For waste deriving from electrical devices, a specific evaluation was carried out on the content of aluminium in WEEE, demonstrating that they generate 20,000 tonnes/y.
For waste deriving from household use and furniture, it was estimated – based on Eurostat apparent consumption data and the average over the last ten years – at about 71,000 tonnes/y.
Overall, the building industry is thought to generate a flow of 60,000 tonnes/y.
It must be pointed out though that there are no specific data on scrap aluminium deriving from construction uses and buildings. In the first five years of the 21st century, the consumption in frames and casings for doors and windows amounted to about 4.7 million pieces, about 40-50,000 tonnes, but in previous years – particularly in the 1980s, period from which the current scrap derives – the consumption is thought to be lower.
The structural use of aluminium in buildings is even more recent: according to the available data for the first half of the 1990s, consumption was lower than 20,000 tonnes/y, while in the second half the average exceeded 200,000 tonnes/y. Even for aluminium used in cables and other electrical materials, in the mechanical sector, in transport means other than motor vehicles – the so-called "other uses" – we do not have specific data and the calculation is derived from that of the EAA global model, assuming for these fractions that the amount of scrap produced in Italy is equivalent to the quantity of the 2013 global estimate of generated scrap which assigned to Italy a share (2.6%) of the global amount of "aluminium in use". The total of these items (with low reliability) amounts to 158,000 tonnes. ▶

Photo by Alberto Bernasconi

Scrap Production and Recovery Estimate in Italy, 2013 (Thousands of Tonnes)



Recovered Flows

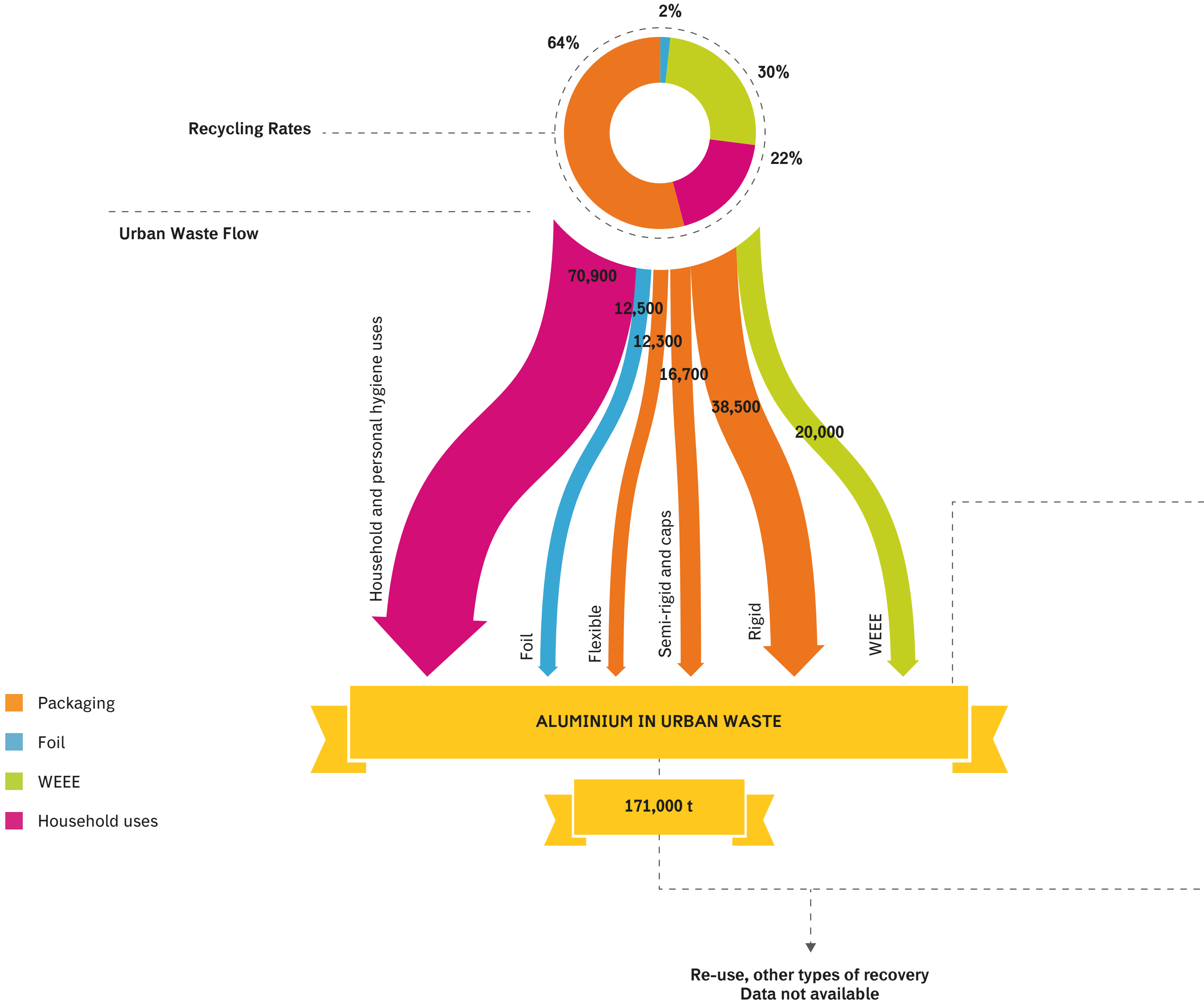
Recovered flows from the waste chain are based on data from CiAl (packaging), WEEE consortia (WEEE waste) and other sources from urban waste management.
Recovery from end-of-life vehicles is derived from the Eurostat management of end-of-life vehicles.
For other flows, we used estimates by the Global Model Europe of the International Aluminium Institute.

Urban Waste Flow

A total recycling rate of 38% and a loss of over 50% of aluminium.

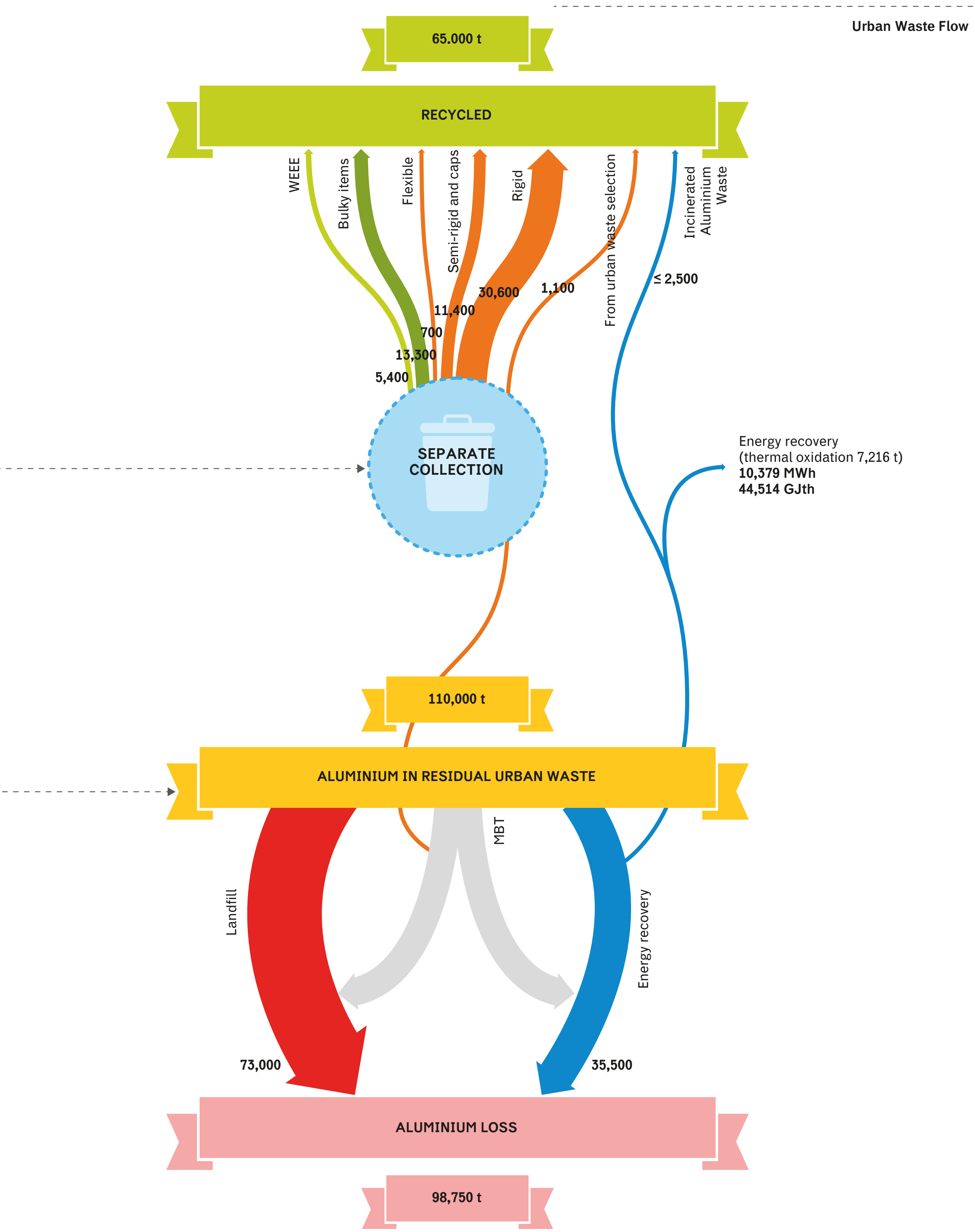
Household waste contains about 171,000 tonnes of aluminium, less than half is packaging. The “household and personal hygiene use” portion also includes furnishing, furniture and bulky items.
Through separate collection and, marginally, through sorting and recovery of residual waste, ▶

Recycling Rates and Urban Waste Flow

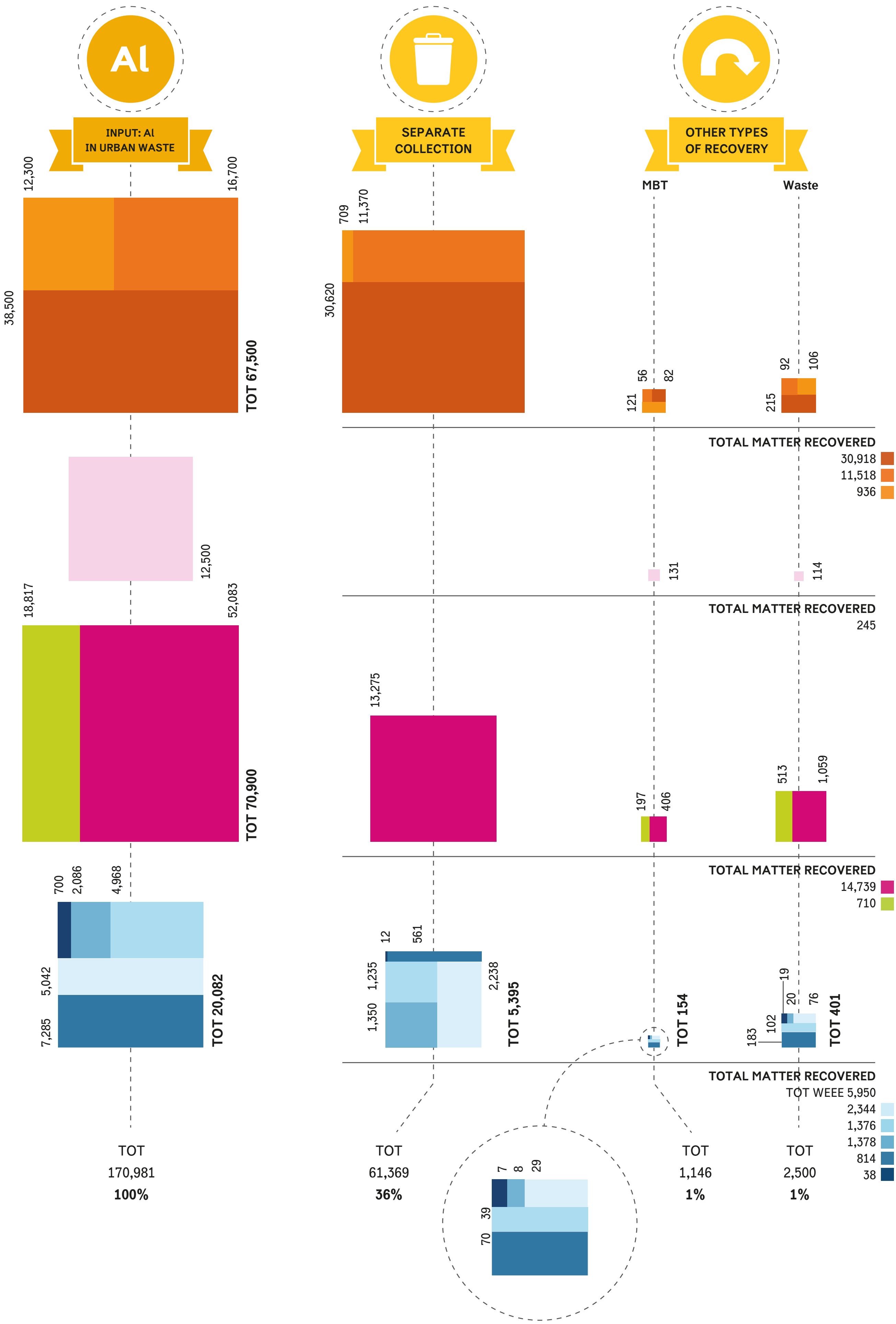


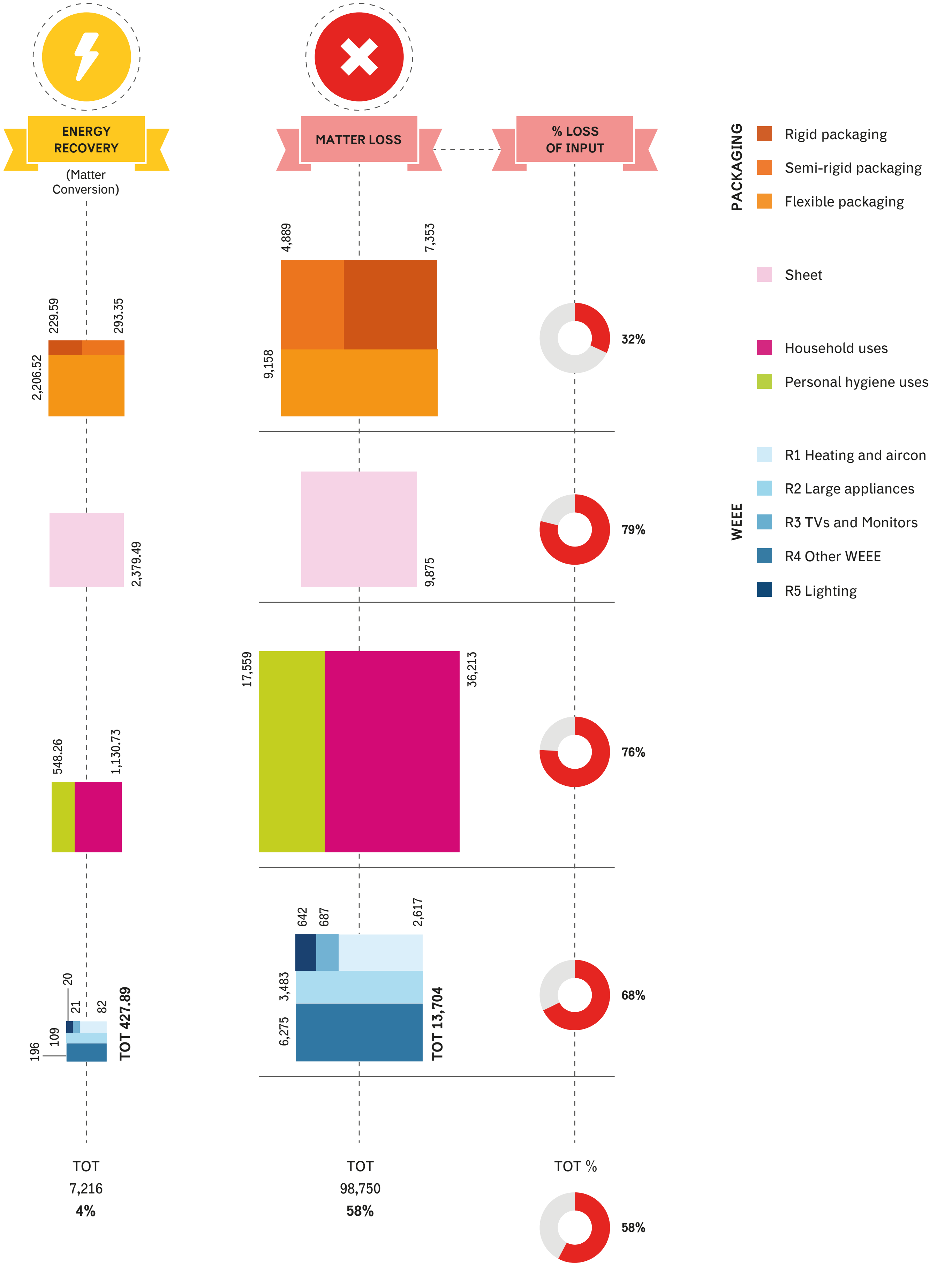
65,000 tonnes are recycled every year, amounting to only 38%.
There might be other types of recovery of part of aluminium flows (for instance, furniture and furnishing items) outside the urban waste network, but they cannot be assessed and verified.
Through incineration, as such or Solid Fuels Secondary (CSS), it is estimated that energy conversion amount to about 7,000 tonnes, producing 11 GWh.
These data reveal a loss of aluminium equal to about 99,000 tonnes/y, representing 58% of waste production. ▶

Photo by Alberto Bernasconi

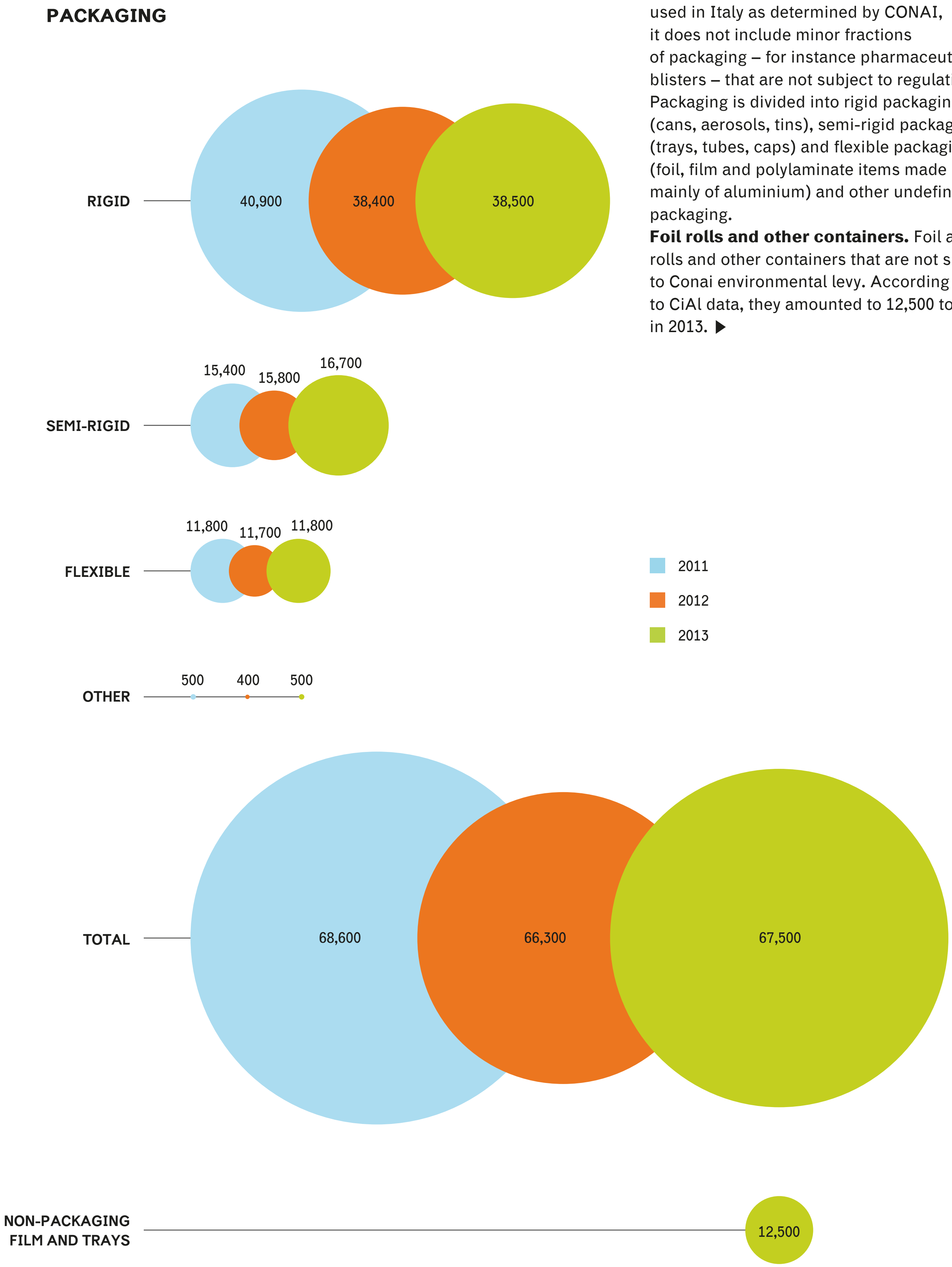

Urban Waste Flow
65.000 t
RECYCLED
WEEE
Bulky items
Flexible
Semi-rigid and caps
Rigid
From urban waste selection
Incinerated Aluminium Waste
≤ 2,500
1,100
30,600
11,400
700
13,300
5,400
SEPARATE COLLECTION
Energy recovery
(thermal oxidation 7,216 t)
10,379 MWh
44,514 GJth
110,000 t
ALUMINIUM IN RESIDUAL URBAN WASTE
MBT
Landfill
Energy recovery
73,000
35,500
ALUMINIUM LOSS
98,750 t

Management of Aluminium Waste in Urban Waste Flows, Italy 2103 (Thousands of Tonnes)




ENERGY RECOVERY
(Matter Conversion)
MATTER LOSS
% LOSS OF INPUT
229.59
293.35
2,206.52
4,889
7,353
9,158
32%
2,379.49
9,875
79%
548.26
1,130.73
17,559
36,213
76%
20
21
82
196
109
TOT 427.89
642
687
2,617
3,483
6,275
TOT 13,704
68%
TOT
7,216
4%
TOT
98,750
58%
TOT %
58%
PACKAGING
Rigid packaging
Semi-rigid packaging
Flexible packaging
Sheet
Household uses
Personal hygiene uses
WEEE
R1 Heating and aircon
R2 Large appliances
R3 TVs and Monitors
R4 Other WEEE
R5 Lighting

Quantifying Flows in Urban Waste (Tonnes)



Method of Quantifying Flows in Urban Waste

Flows in urban waste are calculated as follows: **Packaging.** This is the amount of packaging used in Italy as determined by CONAI, it does not include minor fractions of packaging – for instance pharmaceutical blisters – that are not subject to regulations. Packaging is divided into rigid packaging (cans, aerosols, tins), semi-rigid packaging (trays, tubes, caps) and flexible packaging (foil, film and polylaminate items made mainly of aluminium) and other undefined packaging.

Foil rolls and other containers. Foil and film rolls and other containers that are not subject to Conai environmental levy. According to CiAl data, they amounted to 12,500 tonnes in 2013. ▶

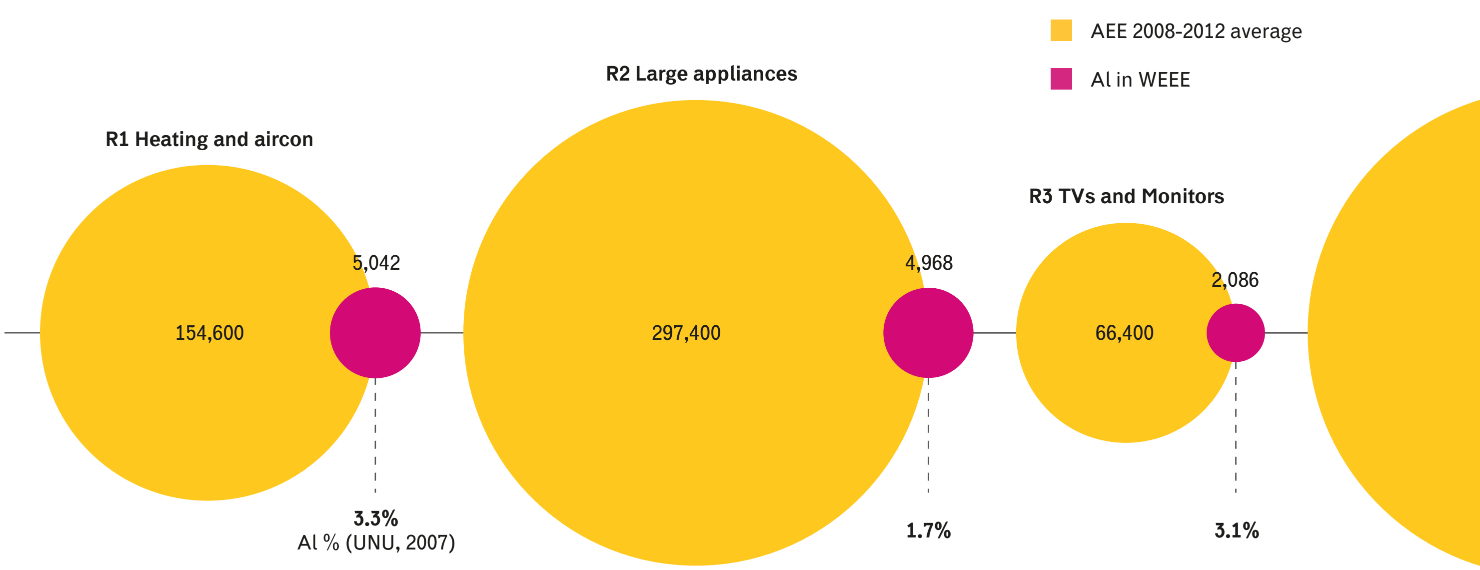
Method of Quantifying Flows in Urban Waste (Tonnes)

HOUSEHOLD USE

Household uses. They include apparent consumption (production – export + import) of those products belonging to Prodcom 25991255 and 25991257 (that is household and kitchen items and their aluminium components – aluminium deriving from casting or other types of metalworking) and 25991137 (personal hygiene and toiletry items). It mainly includes batteries of kitchen utensils, pots and pans, various household devices, furniture items entirely made of aluminium (such as tables, chairs, kitchen worktops) and scrubbing pads. Since these products have a life cycle longer than a year, calculations were made using the 2003-2013 average for household uses, and 2011-2013 for hygiene articles; these calculations also include the weight of other assembled items.
WEEE. They include aluminium components of electrical and electronic equipment; their quantity is calculated using the average content of aluminium for each product category multiplied by the number of devices placed on the market (an average of the 2008-2012 period; regulations though provide for considering the collection rate based on the average of the quantity placed on the market over the last 3 years). The average aluminium content for each product category is derived from the UNU 2007 Study (United Nations University, *2008 Review of Directive on Waste Electrical and Electronic Equipment*). The reported values are in line with the percentage of aluminium recovered in each product category.
Excluded flows. This calculation does not include, because unascertainable, the quantification of aluminium in furnishings items, if not included in "household uses". It does not include fixtures (doors, windows, casings) generated by house renovations and disposed of through urban waste collection.

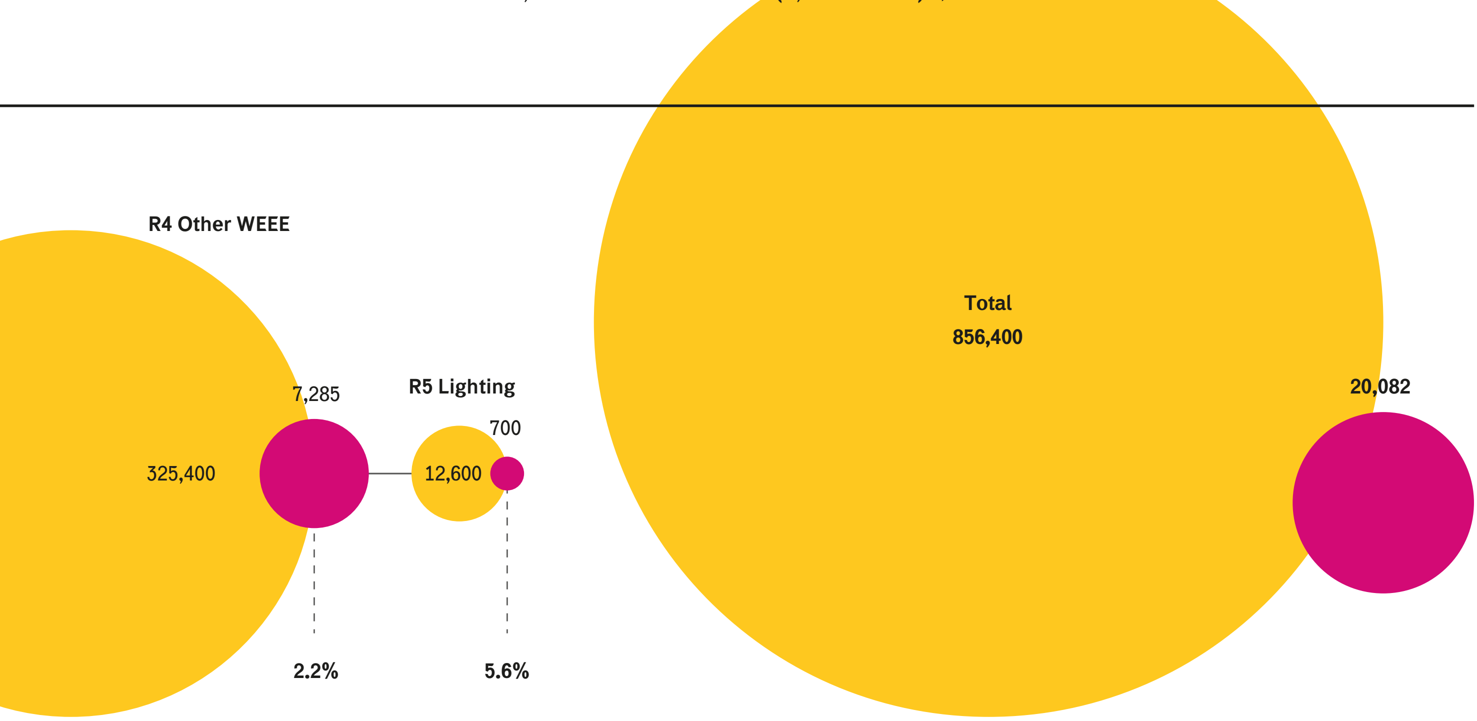
Method of Quantifying Flows in Urban Waste (Tonnes)

WEEE

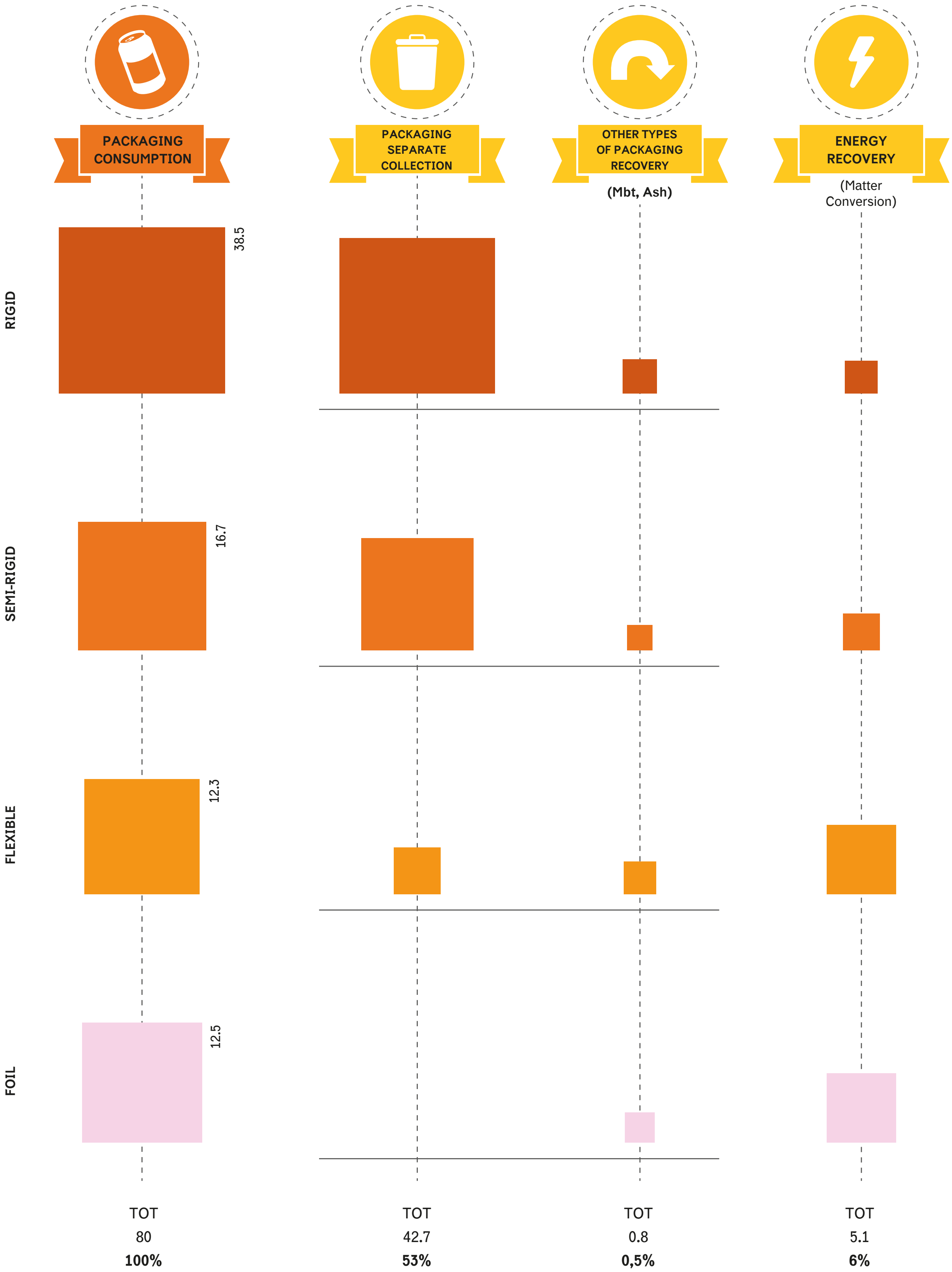


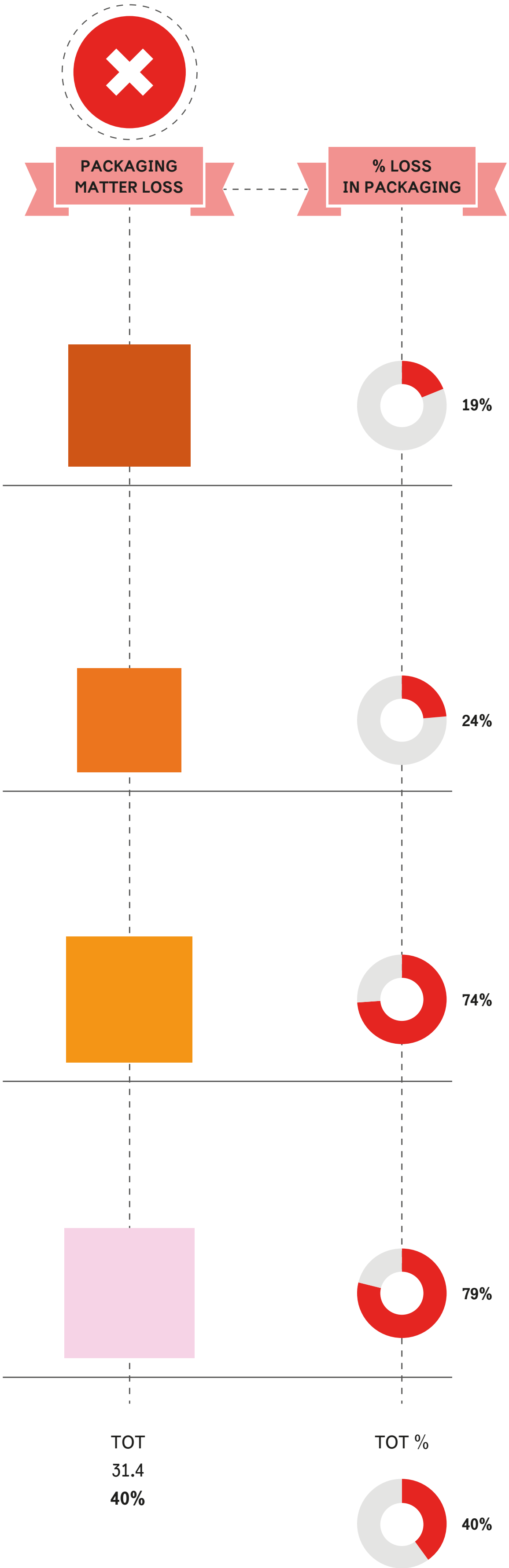
Method of Quantifying Recovery from Urban Waste

Recovery of aluminium products for recycling has been determined using the following criteria.
Packaging. It is the quantity of packaging sent for recycling determined by CiAl; the classification in rigid, semi-rigid and flexible packaging is based on the composition sent to CiAl. The total quantity (43,900 tonnes) includes semi-rigid packaging material from capsules and caps selected from glass collection (about 8,900 tonnes/y, calculation based on the quantity sent to CiAl compared to the total amount of recycled packaging), limited quantities (about 1,100 tonnes/y, calculation based on quantity sent to CiAl compared to the total amount collected) from residual waste separators in MBT (Mechanical Biological Treatment) plants and aluminium nodules recovered from waste incineration (sent to CiAl and amounting to 55 tonnes).
Bulky items. The amount of aluminium recovered through bulky waste collection networks and centres (aluminium items for household and personal hygiene uses) has been calculated taking into account bulky items direct recovery and non-ferrous fraction recovery in collection centres. On a 398,000-tonne flow of recovered bulky items (ISPRA data, 2014), it has been calculated that aluminium represents up to 7.5% of the total quantity of metals recovered from bulky items (in accordance with the Wrap composition of bulky items, since there are no data available for Italy), amounting to about 4,000 tonnes/y. To this quantity, we must add 15,000 tonnes deriving from waste sent to "non-ferrous metal" collection centres, calculation based on Regione Lombardia data (3,021 tonnes), using Lombardy total rate of separate collection on the Italian total, attributing aluminium a rate of 75% of the total.
WEEE. The quantity of aluminium recovered from WEEE, not available as aggregate data from WEEE Centro di Coordinamento (coordination centre), has been calculated for groups R1 and R2 based on recycling rate (3.6% and 2.2% of the WEEE flow respectively) measured by Ecodom (the leading collective consortium of one of the two groups); as for R3 group, the average recycling rate (1.96%) measured by Remedia (the leading consortium of this group) was used; as for groups R4 and R5, the recycling rate measured by Ecolight (1.49% and 1.05% respectively) was used.
MBT. Mechanical biological treatment plants are only partly equipped with Eddy Current Separators, ECS, that use induced current. It has been assumed that the quantity of aluminium recovered through MBT amounts to the quantity collected by CiAl, slightly over 1,100 tonnes/y.
Ash. Data on the quantity of aluminium recovered from ash (less than 2,500 tonnes) have been calculated assuming that they are treated adequately for aluminium separation, about 350,000 tonnes of bottom ash out of 580,000 tonnes sent to the recovery system. This is in line with Federambiente 2013 estimate on the quantity of bottom ash only sent to recovery and assuming an aluminium recovery rate of 0.7% of the amount found in some plants, albeit lower than the theoretical potential. For the recovery of ash, we used the nominal potential operation of the following plants, Lacchiarella (120,000 tonnes), Noceto (50,000 tonnes), Modena (30,000 tonnes), Conselve (150,000 ton), Massafra (5,000 tonnes). ▶



Management of packaging and similar products in aluminium, Italy 2013 (Thousands of Tonnes)





Packaging Separate Collection and Recycling

In most Italian municipalities, aluminium separate collection is understood as “aluminium packaging” collection: in particular cans, even though CiAl also accepts the so-called “similar fractions”, that is household aluminium objects other than packaging (containers, coffee makers, pans and pots, foil etc.)
Separate collection of aluminium is carried out in four different ways:

- “light polymaterial” (aluminium, steel and plastic packaging), reaching about 43% of the population, this method is expanding;
- “heavy polymaterial” (aluminium, steel, glass and plastic packaging) reaching about 32% of the population, this method is declining;
- “glass and metals” (aluminium, steel and glass packaging), reaching 18% of the population, common in public areas;
- “mono-metal” (aluminium and steel) common in some areas in Emilia Romagna, Sardinia and Trentino Alto Adige. It reaches the remaining 7% of the population.

Since aluminium collection is always combined with that of other materials, the quantification of collected aluminium is carried out before sorting: according to ISPRA data, in 2013 the separate collection of metal packaging (steel and aluminium) amounted to 96,900 tonnes.
According to CiAl data, the separate collection of aluminium packaging – excluding the quantity due to residual waste sorting – amounted to 42,700 tonnes, mainly deriving from urban separate collection flows. Matter recovery from aluminium packaging (calculated using the quantity collected by CiAl, which represents 25% of the total collection), 97% of packaging deriving from separate collection and the remaining % from residual waste treatment (in MBT and ash).
Rigid packaging (cans, aerosols and tins) represents 70% of separate collection, semi-rigid packaging (tray, tubes and above all caps and capsules) makes up about 26%, and the reaming percentage is made up by flexible foil packaging.
So, the recovery rate compared to consumption is very high for cans and rigid packaging (79.5%), high for semi-rigid packaging ▶

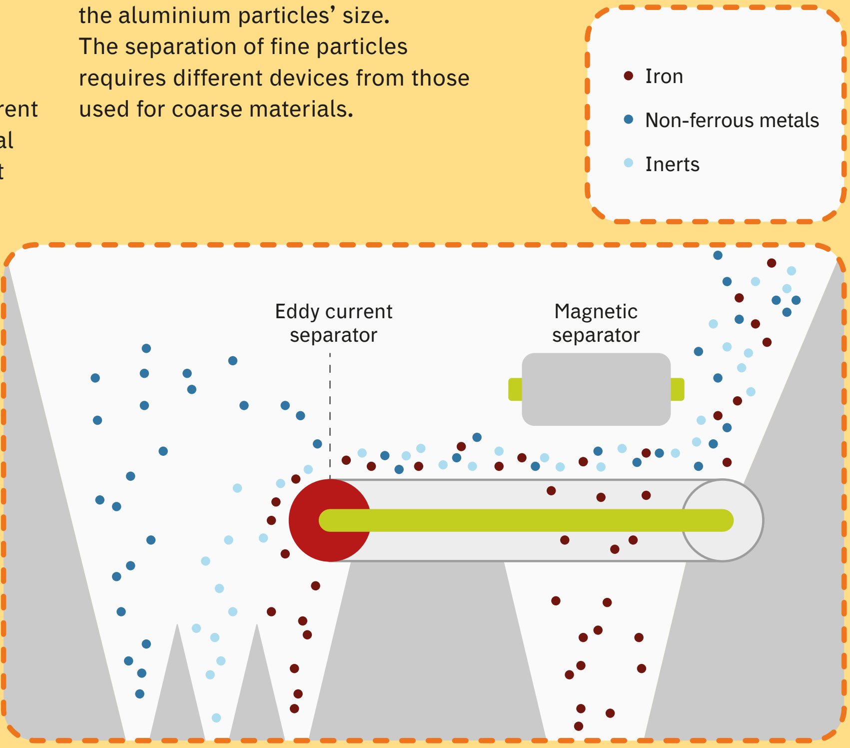
(about 68%), but almost negligible for flexible packaging (6% if calculated only on foil classified as packaging, less than 3 % if calculated on the total amount of aluminium foil).
In the packaging sector there is a high loss of flexible packaging, because it is not exploited or collected separately or because it is not adequately separated by ECS plants on the sorting flows of polymaterial collection and MBTs. So, taking into account the recovery from ash and energy conversion of part of aluminium, 40% of matter contained in packaging and similar products is lost.

Mechanical Recovery from Urban Waste

Recovery of aluminium – and of other non-ferrous metals – is carried out with Eddy current separators (ECS) based on the principle of induced current (or passive currents or Foucault currents) created by a rotating magnetic field.
ECSs are used in polymaterial sorting plants, separating metals from plastics or metals from glass.
In 2013, 55% of the 178 packaging treatment plants – that is 98 plants – was equipped with ECSs.
On the contrary, MBT plants are rarely equipped with ECSs, although they process just under 10 million tonnes of waste, as well as plants for the recovery of bulky items. In 2013, CiAl took waste from 11 MBT plants amounting to just over 1,000 tonnes. The latest disaggregated data available at national level for 2010 indicate that there were 13 plants processing 869 tonnes of non-ferrous metals (with yields, compared to the input waste flow, varying from less than 0.01% to 0.3 %). ▶

Aluminium separation technologies in urban waste flows

In non-ferrous metal separation plants, materials are first subjected to magnetic separation and then offloaded on a vibrating belt feeder that spreads them out and controls the flow. The ECS conveyor belt's speed can vary as well as that of the magnetic rotor (inductor). Induced currents going through non-ferrous metals to be separated create such a repulsion force that they jump thus separating from inert material.
Normally, they are separated in three different flows that are fed to three different hoppers, one for ferrous metals, a central one for inert material, and the outermost for non-ferrous metals.
Separation performance largely depends on operating conditions, on speed and on the distance of the various materials from the conveyor belt. Operating conditions of urban waste selection cannot guarantee, due to productivity reasons, an efficient detection of non-ferrous materials.
To a limited extent, ECS systems ensure the separation of different non-ferrous metals thanks to their unique mechanical and electrical properties; but a higher purity, especially in the separation of aluminium from copper, can be achieved with further density and floatation separation treatments (integrable potentials) or spectrometers (rarely used).
There are several types of ECS systems (concentric, eccentric, dry and wet systems) that must be optimized according to their use and in particular according to the aluminium particles' size.
The separation of fine particles requires different devices from those used for coarse materials.



It is reasonable to think that the high loss of household-use aluminium is due to the lack of adequate detection systems.

Al Recovery from Urban Waste Ashes

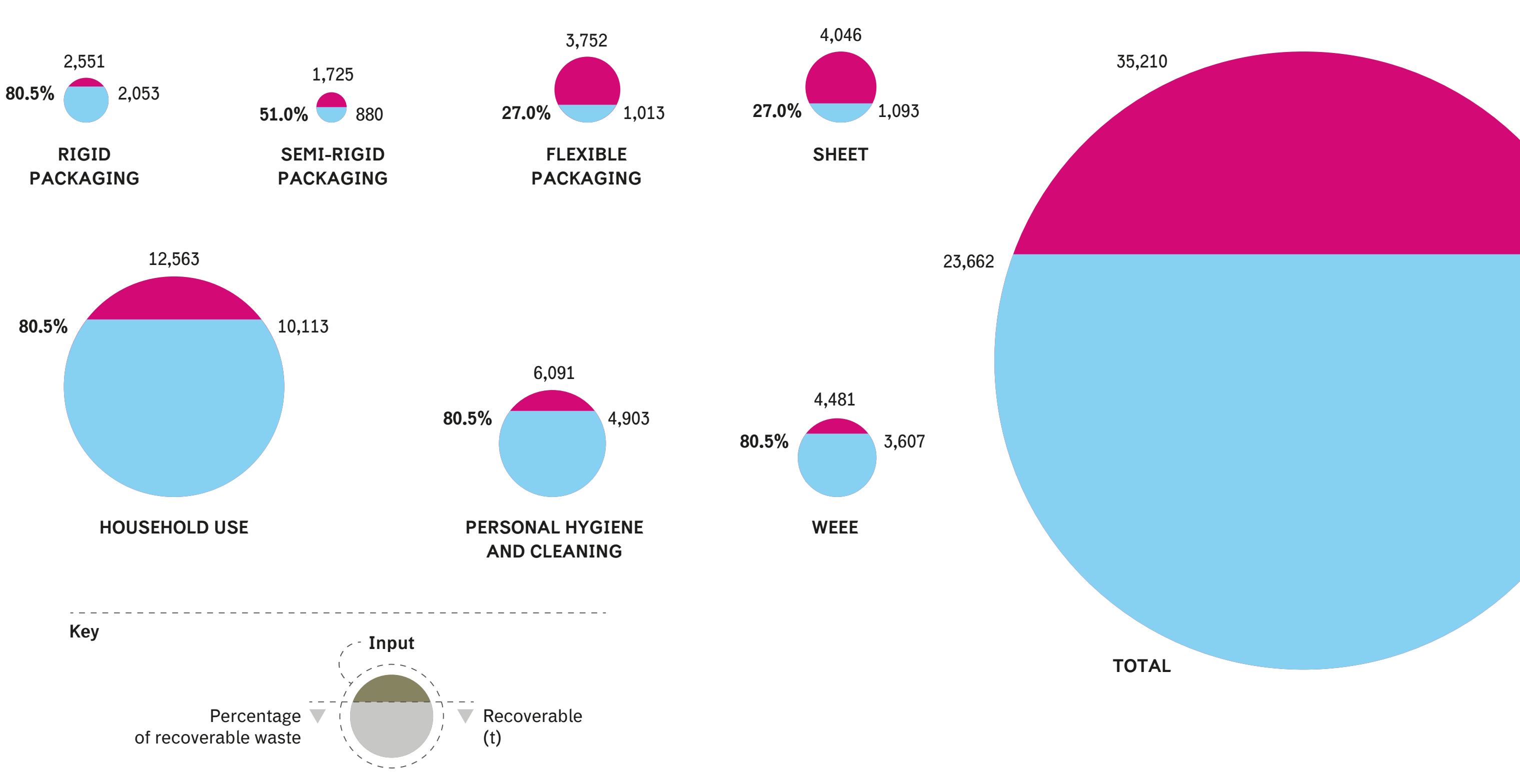
During incineration, only a fraction of aluminium is oxidized producing energy. The remaining fraction of non-oxidized metallic aluminium, theoretically available for recycling, is found in bottom ash, in fly ashes and in reaction's salts and deposits.
In fly ash, aluminium is mainly in oxidized form, high level of oxidation can also be found in bottom ashes' fine fractions.
The highest amount of metallic aluminium can be found in bottom ashes' "non-fine" fractions (> 0.5 mm).
Recovery through ECSs is efficient only with heavy fractions (>0.8 mm) contained in bottom ash; thanks to the use of new technologies (Wet ECS) we envisage an improvement of the detection capacity even in finer fractions.
The percentage of aluminium that can be theoretically recovered varies according to the type of material: from over 80% for cans to 51% for semi-rigid packaging and down to 27% for foil (Biganzoli, Grosso *et al.*, 2012, 2014).
For products other than packaging the percentage is expected to be similar to that of cans.

Out of the total of incinerated waste, based on waste composition and rates of separation, we can expect a recovery potential of up to 23,000 tonnes/y, equal to about 2.8% of generated ash, an amount in line with estimates of 2.3 % at European level.
Only with ECS systems adequately created to detect different particle sizes, real recovery can be as high as theoretical recovery.
At present, recovery in some plants is remarkably lower than theoretical recovery.
Recovery potential estimate is 10 times higher than what is currently recovered, processing only a fraction of ash and with inadequate technologies.

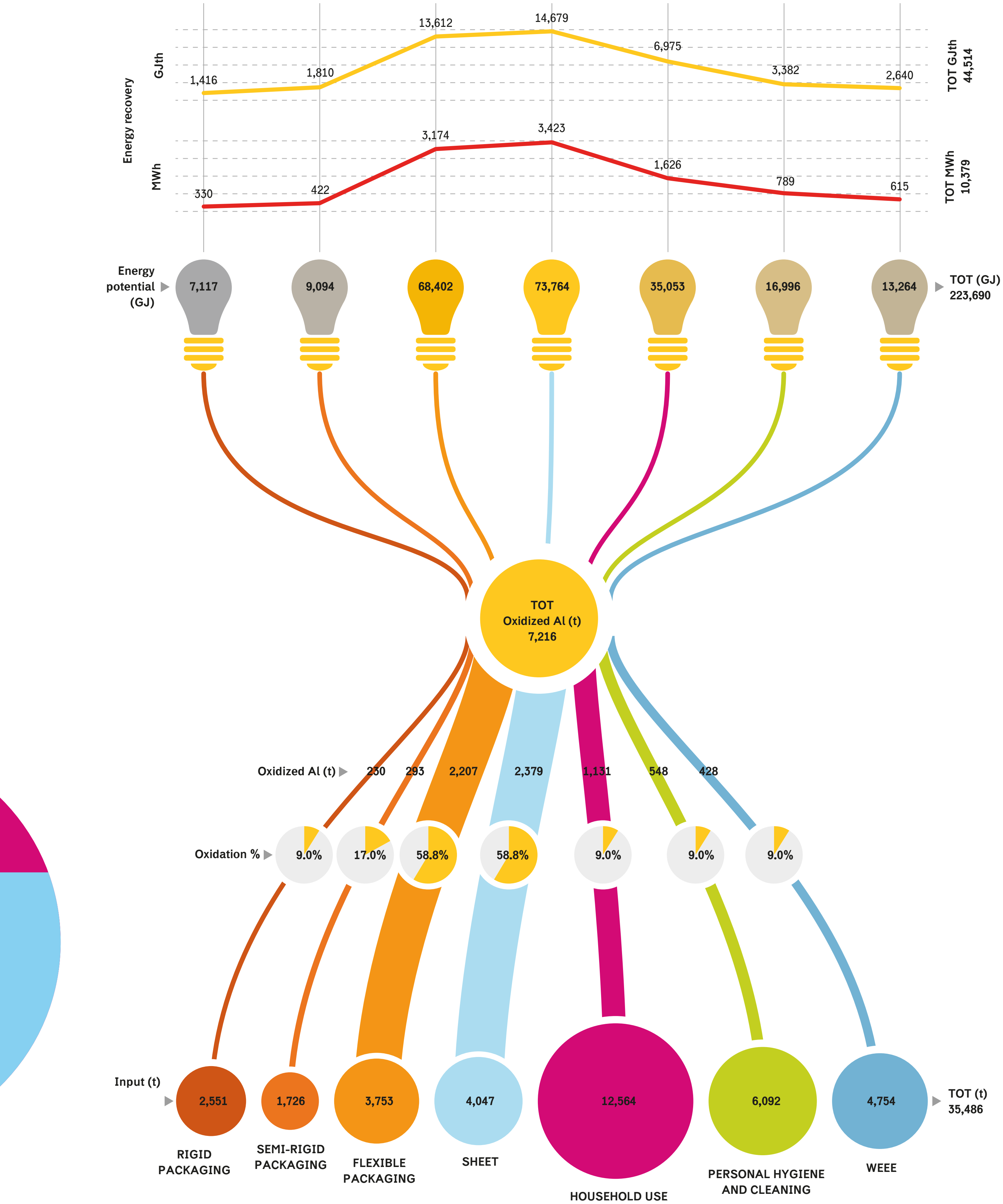
Energy Recovery from Aluminium Waste

Thermal treatment of aluminium partly oxidizes it, especially thinner materials (film and thin foil). During the oxidation process, aluminium releases energy, conventionally calculated as amounting to 31 MJ/kg, available for thermal recovery or electric conversion. That can be turned into thermal energy or electricity.
The percentage of oxidizable aluminium is different and varies according to products and their thickness. CEN 13431:2004 assumes than aluminium with a thickness < 50 micron is entirely oxidized during the incineration ▶

Theoretically recoverable Ash with current incineration (2013)



Energy Recovery from Aluminium Waste



process. However, recent studies (Biganzoli, Grosso 2012, 2014; Pruvost 2013, Lopez *et al.* 2013) have demonstrated that the oxidized fraction is actually lower than previously thought, especially in thin foil. This is due to the fact that during incineration molten aluminium tends to form tiny nuggets that drastically reduce the surface exposed to oxidation compared to the foil's original surface (Pruvost, 2013).
According to experimental estimates, the oxidation rate for packaging materials varies from 59% for foil to 9% for cans, a rate that with due caution can be expected for other aluminium items.
On the total amount of aluminium waste in dry residue (assuming an incineration rate similar to the Italian average of dry residue) theoretical energy production amounts to about 223,000 GJ. With current yields – calculated assuming an average production on waste with a calorific value lower than 10MJ/Kg, 464 KWh/t and 1.99 GJ/t – the actual energy recovery amounts to 10,379 MWh and 44,514 GJ, an average yield of 36.6%
So, even with maximum efficiency, energy recovery through incineration offers an energy saving lower than 10% of that obtained through recycling.

Aluminium Recovery from Car Scrapping: A Source only Partially Exploited?

Motor vehicles represent one of the main sources of aluminium scrap. Over the years, the aluminium content in motor vehicles has progressively grown. According to estimates dating back to the 90's – where data on scrapped cars[1] originated – point to about 70/90 kg per vehicle of aluminium. In theory, therefore, the aluminium content of scrapped cars in 2012 can be estimated between 63,000 to 81,000 tonnes. ▶

Avoided energy consumption with recycling and energy recovery from combustion (GJ/t)

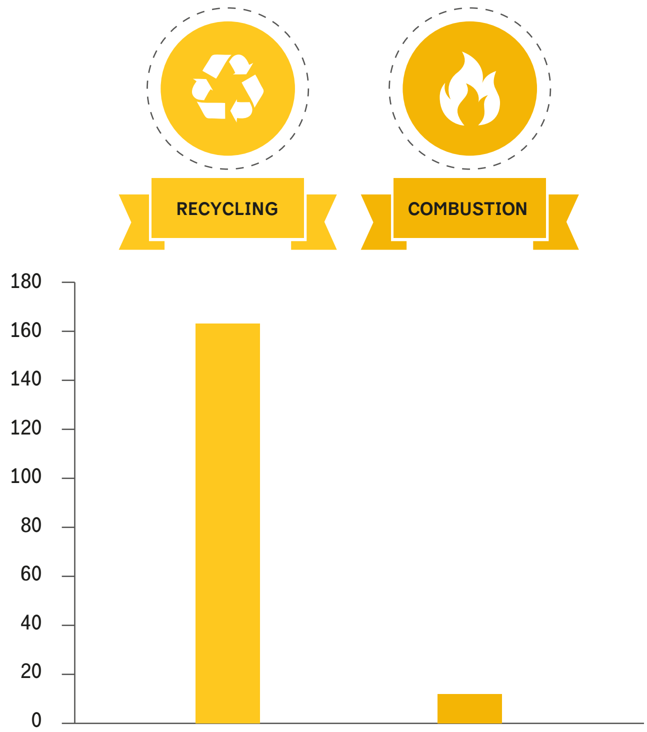


Photo by Giovanni Diffidenti

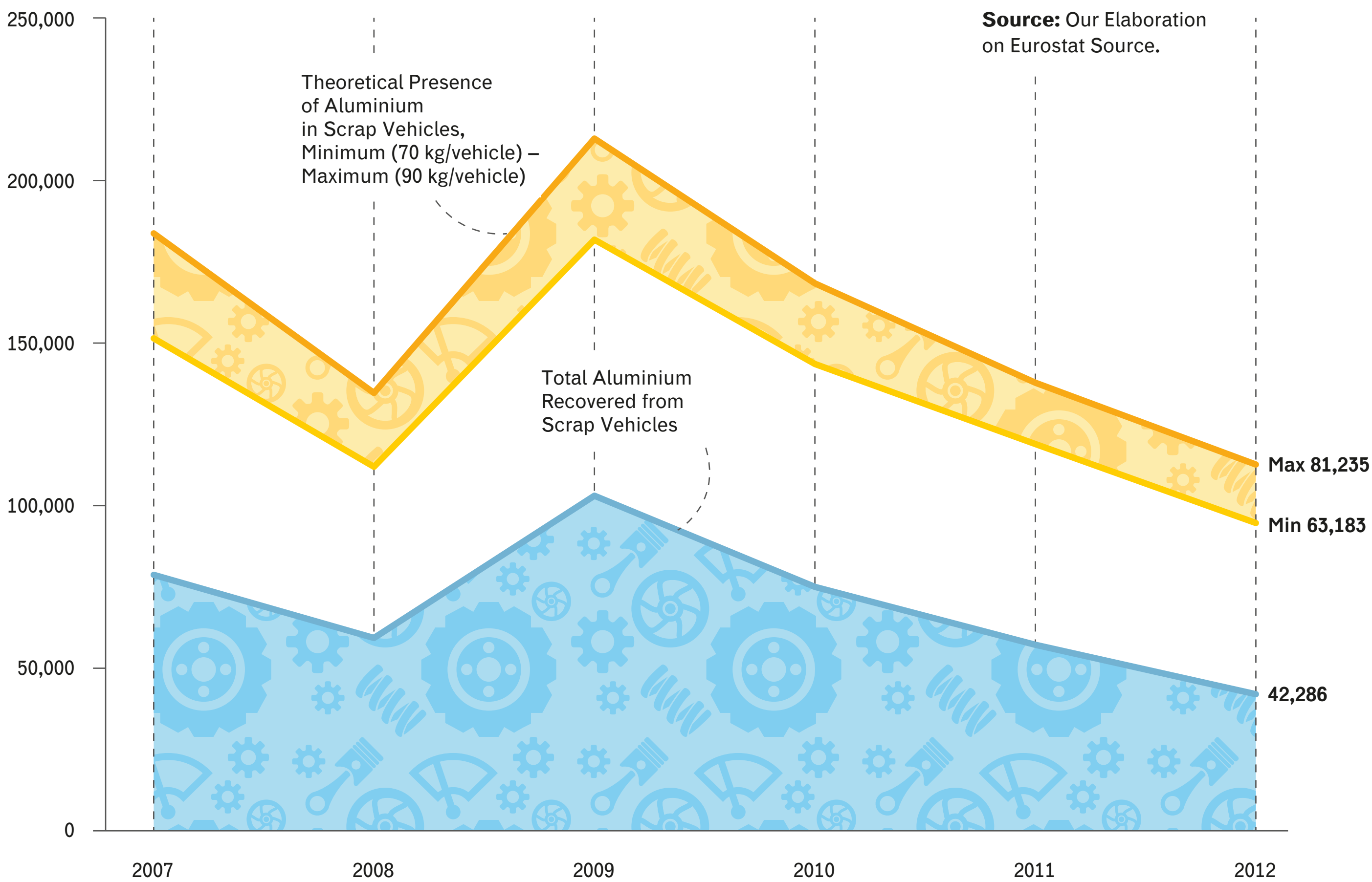
1. The average life of cancelled cars in 2012 was 12 years (ACI). Cancellation and scrapping are not the same thing, because scrapping, in 2012 accounted for only 60% of cancellations (the remainder depends on exports and other causes). It is estimated that the average life of scrapped cars is longer than that of cancellations.

Photo by Alberto Bernasconi

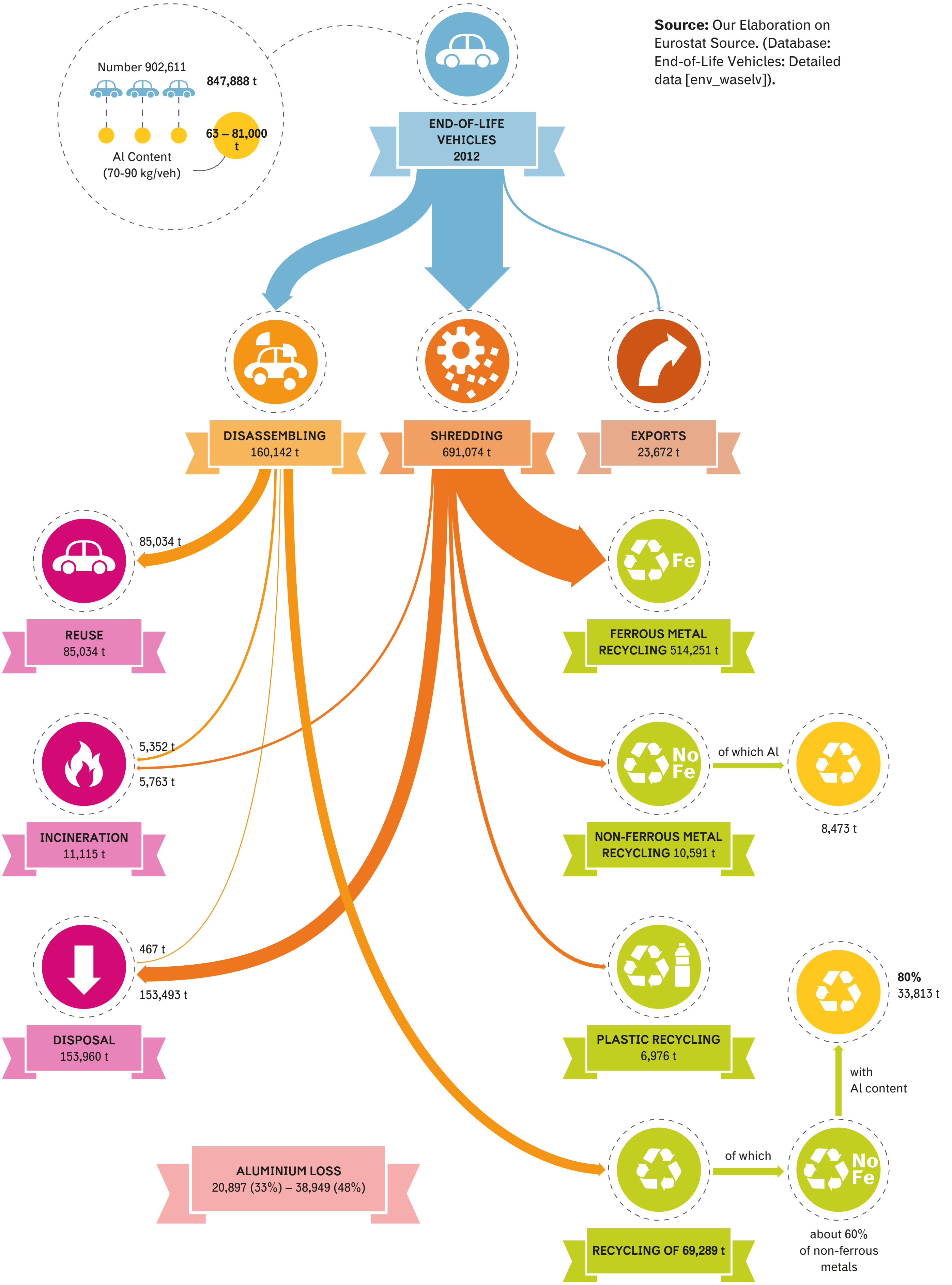
On the basis of this theoretical amount, the total of non-ferrous materials (including lead and copper as well) being sent to recycling amounts to a mere 10,591. Even considering other loosely defined materials as part of the recycling quota (69,000 tonnes of which – 60% – as in other countries such as Germany, France and Spain, are made of non-ferrous materials) the total of non-ferrous scrap is estimated at around 53,000 tonnes, of which about 80% is made of aluminium, equalling 42,000 tonnes/year, between half and two thirds of the estimated amount.
Despite being just estimates, the gap appears significant and points to an important and underestimated aluminium flow, roughly 40%. ▶

Photo by Alberto Bernasconi

Theoretical Presence and Recorded Recovery of Aluminium from End-of-Life Vehicles (Tonnes)



End-of-Life Vehicle Management in 2012

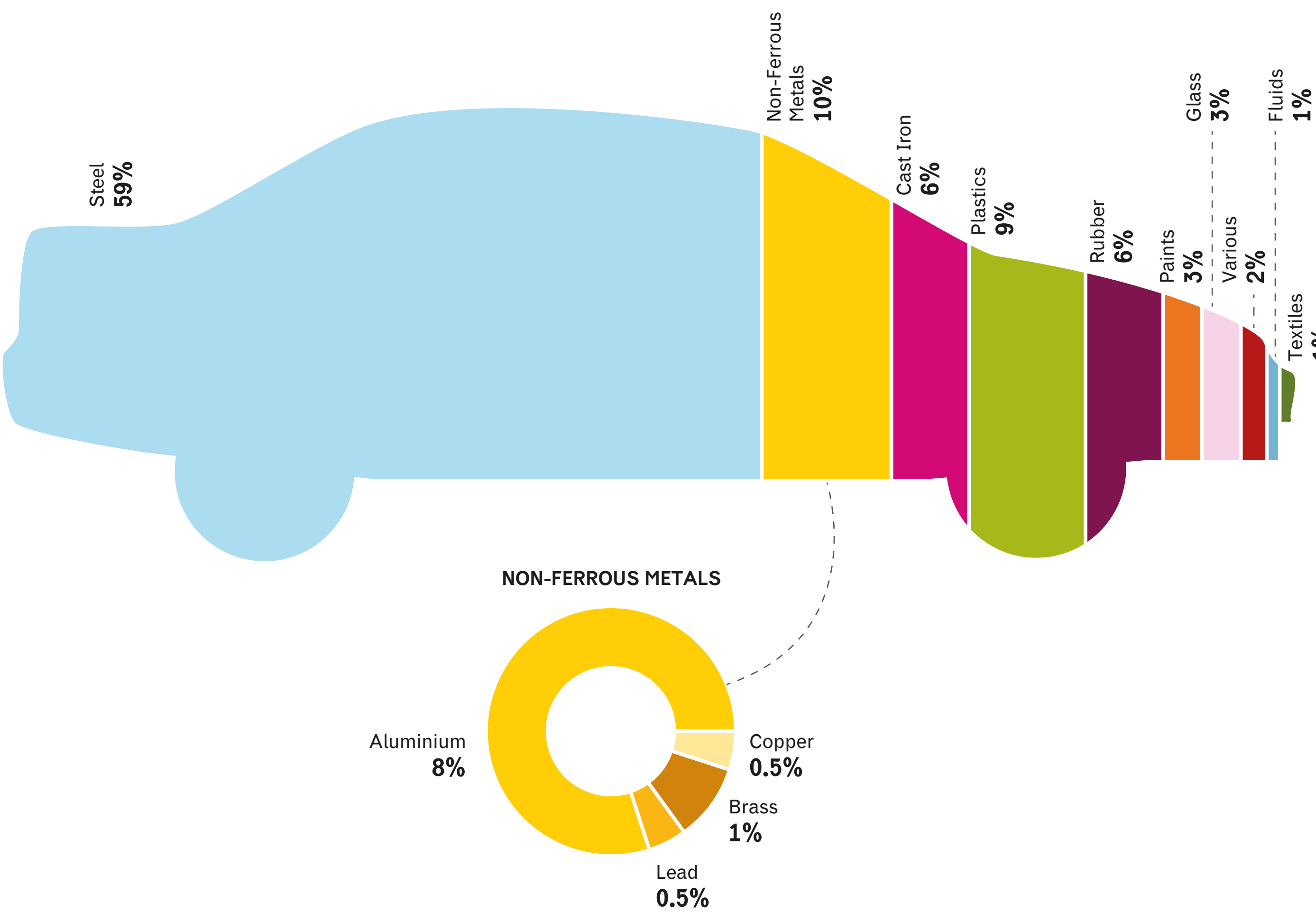


EU Composition of Vehicle Materials in the 90s

The composition of motor vehicles used is based on the assessment of the average composition of European car producers in 1998 published in Kanari, Pineau, Shallari, 2003 ("End of Life Recycling in the European Union", The Minerals, Metals and Materials Society).
1998 can be considered a significant point of reference for the composition of 2012-2013 scrap. The amount of aluminium is higher in cars with a bigger engine, therefore there is a variability due to the characteristics of the national car fleet (see EAA, *Aluminium in Cars, 2008*; Bio-Ghk *Study to examine cost and benefits of ELV directive*, 2006).

The subdivision of all non-ferrous metals is particularly important for subsequent estimates – not disaggregated to recovery and composition of vehicles statistical data. Overall, non-ferrous metals amount to 10% of a car average weight, but cars also contain brass, copper and lead besides aluminium. Margarido *et al.* (2014), revising a series of studies, suggest a percentage of aluminium in end-of-life vehicles of 78% (with 12% brass and 5% copper), similar to the value of the Kanari *et al.* 2003 study.

Material Composition of a Vehicle in the 90's in the EU



Methodology for Quantifying Aluminium Waste from Motor Vehicles

Aluminium Flow in End-of-Life Motor Vehicles

Available data register a presence of aluminium in motor vehicles produced in the 90's representing today's total end-of-life vehicles and scrap of around 8% of a car total weight (a car average weight varies between 900 to 1,100 kg).
In our estimates, we assumed that end-of-life vehicles scrapped in 2012 have a variable aluminium content, between 70 to 90 kg per vehicle (with an average vehicle weight scrapped for Italy of 969 kg, source Eurostat). In 2012, the potential for aluminium is therefore 63-81,000 tonnes.

Methodology for Quantifying the Aluminium Flow from Motor Vehicles

In an optimized car dismantling system, up to 95% of waste can be recycled; regrettably, in reality, recovery rates are significantly lower. ●

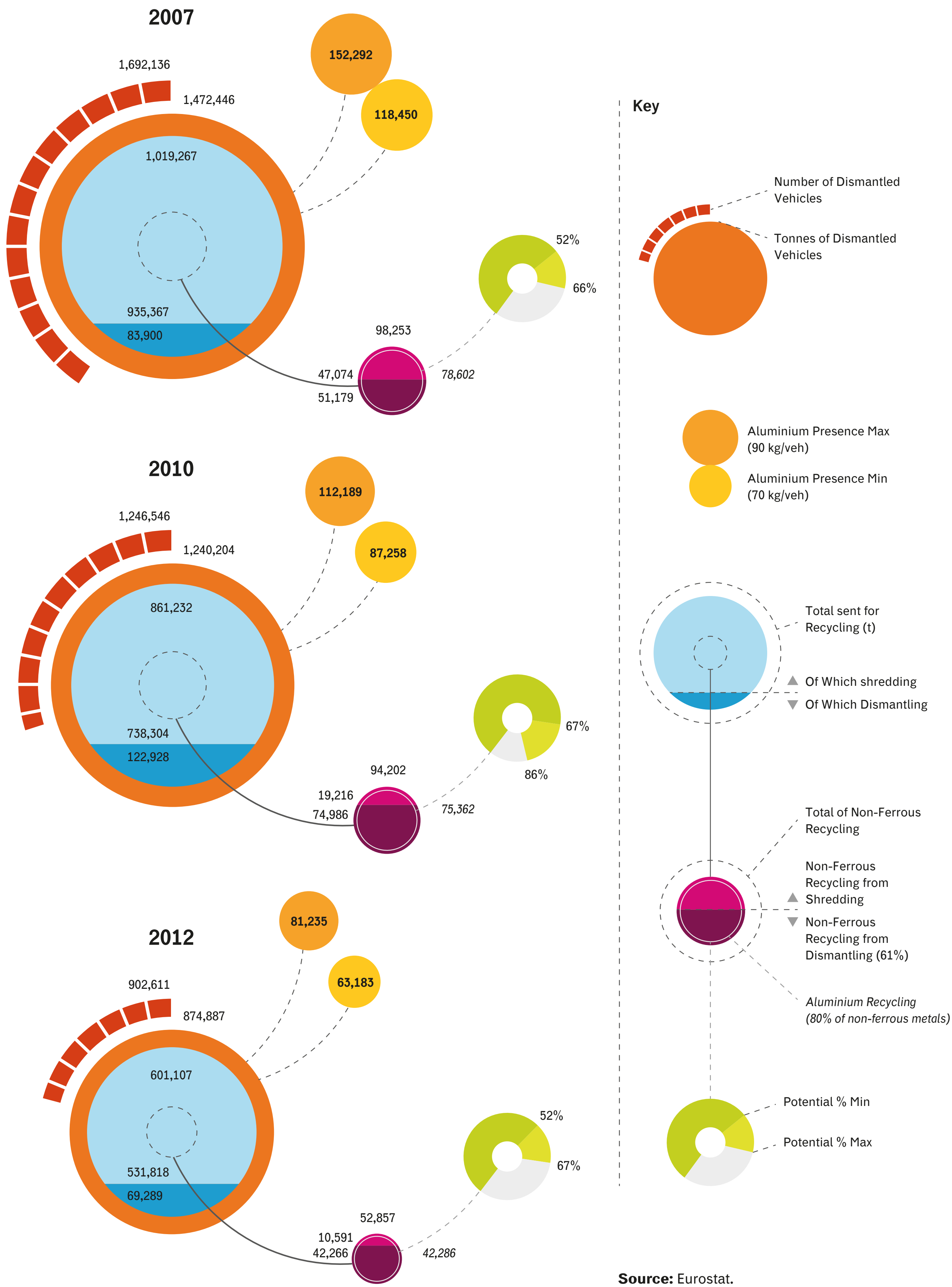
Recovered Aluminium Flow in End-of-Life Motor Vehicles

Eurostat can provide us material recovery data of end-of-life cars.
In 2012, in Italy, over 900,000 cars have been scrapped, with 875,000 tonnes of material. Out of all motor vehicles, after all reuses (85,000 tonnes/year), the recovered material for recycling amounts to 601,000 tonnes, of which 532,000 from shredding and 69,000 from dismantling. In the fraction of recycling from shredding, 10,591 tonnes of non-ferrous metals have been recycled (the remainder being ferrous metals and marginal plastic and rubber flows). As for the recycling fraction from dismantling, no disaggregated data are available for Italy, but from the available data for other countries (Germany, Spain, United Kingdom) 61% of non-ferrous metal can be estimated.
Therefore, statistical data calculate the amount of non-ferrous metals sent for recycling. For the estimate of the amount of recovered aluminium we assumed that 80% of non-ferrous materials was made of aluminium. The amount of non-ferrous metals sent for recycling would be around 53,000 tonnes/year and the aluminium alloy fraction 42,000 tonnes, between 52-67% of the potential presence.

Photo by Alberto Bernasconi

Photo by Alberto Bernasconi

Material Recovery from end-of-life vehicles treatment



Source: Eurostat.

Photo by Giovanni Diffidenti

The Economic Aspect of the Recycling Supply Chain

The Economic and Employment Aspect of the Recycling Supply Chain for Italian-Sourced Aluminium

As previously explained, Italy produces only secondary raw aluminium from marketed (pre and post consumer) and businesses' internal metal scrap, both nationally sourced and imported.
Marketed (i.e. not derived from companies' internal recovery), nationally sourced metal scrap alone represent roughly one third of production demand, the rest of it being imports and internal metal scrap.
By following the previously explained method, the Italian-sourced recycling supply chain ▶

Production Value of the Recycling Supply Chain for Nationally Sourced Aluminium

	Quantity (t)	Separate waste collection (euro/t)	Treatment for recycling (euro/t)	Production (euro/t)	Separate Collection (Thousands of euro)	Treatment for recycling (Thousands of euro)	Production (Thousands of euro)
Industrial pre-consumer metal scrap	177,865	1,000.0				177,865	0
Post-consumer metal scrap							
From packaging	42,699	234.0	124.6		9,992	5,320	0
From bulky waste and WEEE	18,670	295.0	337.0		5,508	6,292	0
From cars	42,000	120.0	246.0		5,040	10,332	0
From construction, transport and others;	162,899	1,000.0				162,899	0
From sorting	1,146		155.7		0	178	0
From ash	2,500		155.7		0	389	0
Energy recovery	7,191		142.4		0	1,024	0
Al production (ingots, liquid) from post-consumer matter	211,613			1,600			338,581
Al production (ingots, liquid) from pre- consumer matter;	167,798			1,600			268,476
Subtotals					20,539	364,300	607,057
TOTAL						**991,896**	

Photo by Alberto Bernasconi

has been estimated, with considerable uncertainties, in its economic and employment aspect.
Production value totals little less than €1 billion, about 40% of which comes from collection and treatment for recycling (including metal scrap marketing). Employment totals roughly 2,700 jobs, over 1,000 of which are related to collection and treatment for recycling.
Aluminium “losses” represent a missed value of about €350 million and a loss of 1,350 jobs. ▶

Values in thousands of tonnes of scrap

Values in millions of euro of production value

Number of employees

Italian-sourced waste

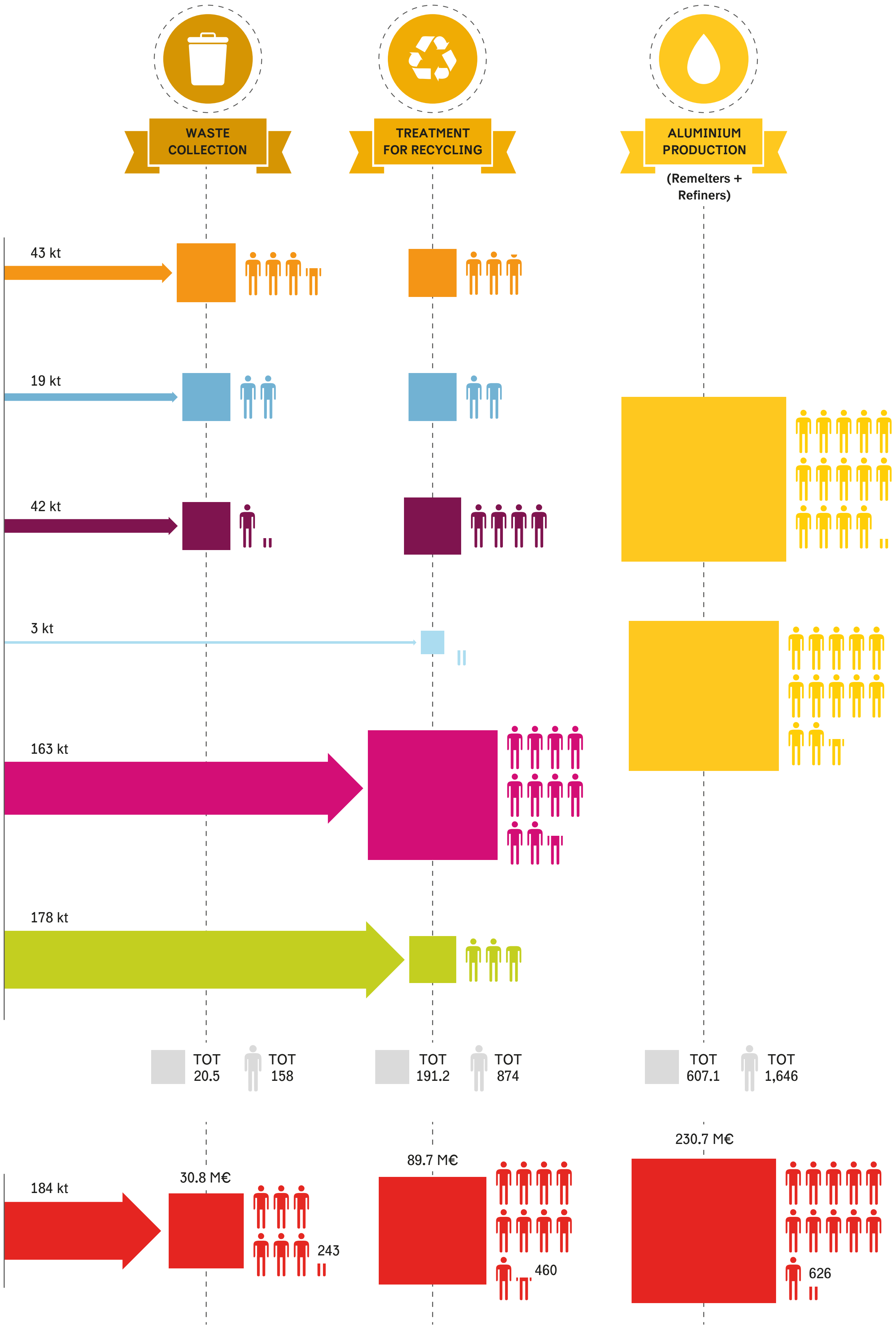
- Packaging
- WEEE + household use
- Vehicles
- Urban waste sorting + ash
- Construction, transport, mechanical industry and others
- Pre consumer

- Aluminium losses’ value

Employees of the Recycling Supply Chain for Nationally Sourced Aluminium

	Quantity (t)	Separate collection (Employees per 1,000 t)	Treatment for recycling (Employees per 1,000 t)	Production (Employees per 1,000 t)	Separate waste collection (Employees)	Treatment for recycling (Employees)	Production (Employees)
Industrial pre-consumer metal scrap	177,865	0.38			68		
Post-consumer metal scrap							
From packaging	42,699	2.26	1.67		97	71	0
From bulky waste and WEEE	18,670	2.39	1.9		45	35	0
From cars	42,000	0.38	2.74		16	115	0
From construction, transportation and others	162,899	3.58				583	0
From sorting	1,146		0.5		0	1	0
From ash	2,500		0.33		0	1	0
Energy recovery	7,191		0.5		0	4	0
Al production (ingots, liquid) from post-consumer matter	211,613			4.34	0	0	918
Al production (ingots, liquid) from pre-consumer matter	167,798			4.34	0	0	728
Subtotals					225	810	1,647
TOTAL						**2,681**	

Economic Value and Employment of the Recycling Supply Chain for Nationally Sourced Aluminium, Italy



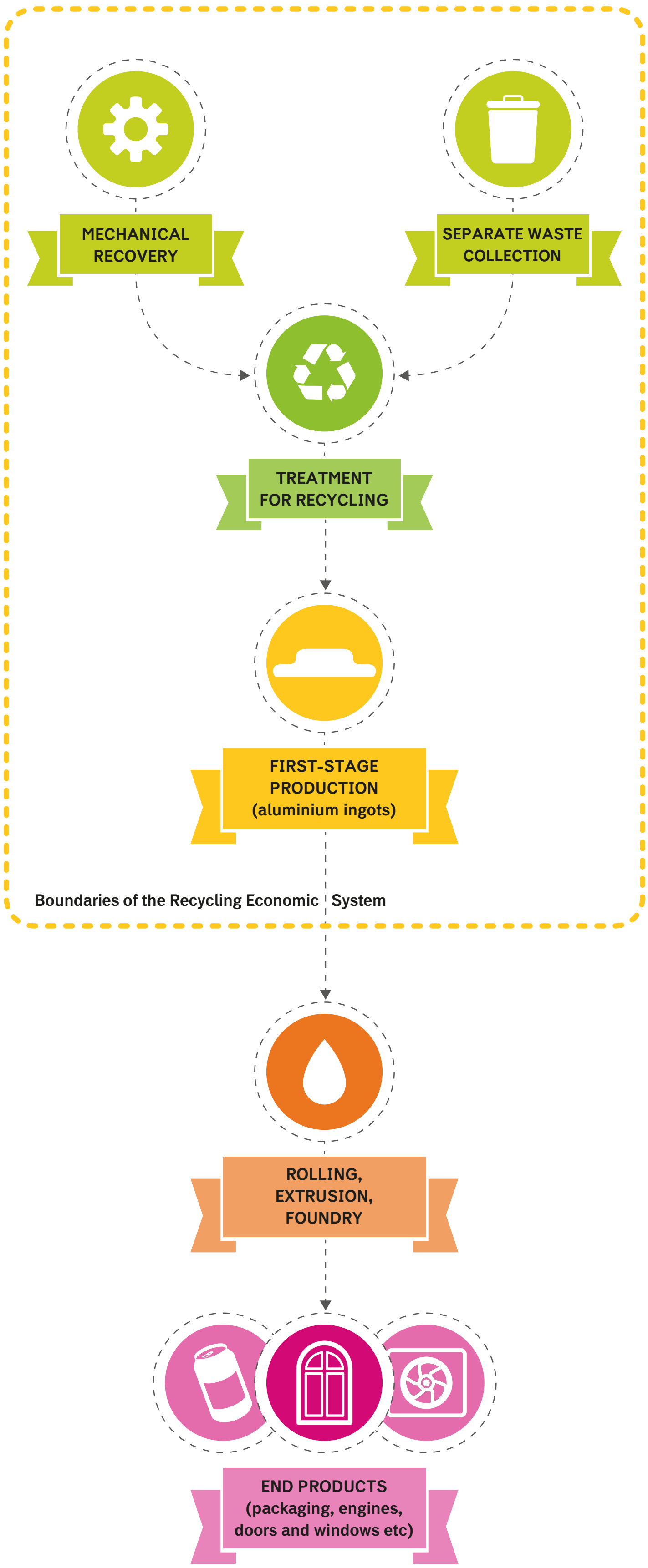
Classification Method of the Recycling Supply Chain: Boundaries

According to the classic definition provided by Beck (2001), the boundaries of the recycling economic system extend to:
1. Activities connected to supply and related to collection and collected materials' treatment for recycling, i.e. separate waste collection. Treatment for recycling includes activities such as sorting, cleaning, dismantling and/or mechanical and chemical processing (also on residual waste) in order to produce secondary matter meeting the manufacturers' specifications;
2. Activities connected to demand where recovered materials or used products reach the first section for competing directly with their raw or virgin equivalent, especially with respect to the manufacturing of "first stage" products containing recycled materials. Here, "first stage" refers to the first type of product, which in our case is raw aluminium in slabs, billet and liquid form.
For the record, energy recovery has been included.
Starting from many sources, we have determined, with considerable uncertainties, the production value and employees' number for each phase.

Classification Method of the Recycling Supply Chain: Estimated Production Value

Our estimated production value takes into account:
• The production value of aluminium packaging separate waste collection, calculated on unified service costs for light polymaterial waste collection as found in Bain-Federambiente 2013 (€234/tonne);
• The production value and separate collection of bulky waste and WEEE, based on the average WEEE collection cost established by ISPRA 2014 (Higher Institute for Environmental Protection and Research), i.e. €295/tonne;
• The production value of aluminium packaging treatment for recycling, estimated to be the same as the average sorting and logistic cost of various operations and productions carried out by CiAl (Aluminium Packaging Consortium), namely €124.59/tonne on incoming material.
The value equals the average plastic sorting cost of €140/tonne set by Corepla (National Consortium for the Collection, Recycling, and Recovery of Plastic Packaging), considering that

The Boundaries of the Recycling Economic System: What is in and What is out



aluminium is recovered mainly from the sorting of light polymaterial waste mostly composed of plastic;

- The production value of WEEE and bulky waste treatment for recycling, estimated at €337/tonne, i.e. the average production value of WEEE recovery services. The value is calculated as a ratio between production value and quantity managed by Ecodom, the main Italian consortium for household appliances' recovery and recycling.
- The production value of end-of-life vehicles' dismantling and recovery, calculated at €246/tonne, which is the value set by ADEME 2011;
- The production value of energy recovery, which equals the average service cost of €113/tonne (RifiutiLab Benchmark impianti 2012) and is increased by the revenues of energy sale, estimated at 26% of the price;
- The production value of ash recovery, estimated to equal recovered aluminium's value, i.e. €155.7/tonne, which is conventionally the buying price for CiAl (2013);
- The production value of collection and treatment for recycling of pre-consumer metal scrap and other post-consumer types of waste. Considering both values and using a method similar to ADEME's, the value has been calculated as equivalent to the average metal scrap sale price (i.e. €1,000/tonne in 2013, which matches the average value of metal scrap destined to export,);
- The production value of industrial recycling processes, calculated at €1,600/tonne based on the value of secondary aluminium sold production (liquid or billet) from ISTAT data 2014 on 2013 production. The secondary aluminium's quantity from internal metal scrap collection is considered to equal a 94% yield for pre-consumer metal scrap (following remelters' model) and a 78.4% yield for post-consumer metal scrap (following refiners' model). Therefore, the whole raw aluminium production from pre and post consumer national collection totals 379,419 tonnes, namely 85% of internal collection (excluding businesses' internal recoveries).

Classification Method of the Recycling Supply Chain: Employment Estimate

This employment estimate has taken into account direct employment only:

- Operators of aluminium packaging collection services have been calculated by Bain-Federambiente on an average performance at 2.6 employees every 1,000 tonnes for door-to-door and multi-material waste collection (accounting for 76% of aluminium collection) and at 1.2 employees every 1,000 tonnes from on-street collection (which represents 24% of aluminium packaging collection), achieving a total of 2.26 employees every 1,000 tonnes/year;
- Operators of bulky waste and WEEE collection services have been calculated on an average technical performance at 6.25 employees every 1,000 tonnes/year for door-to-door collection (25% of the whole) and at 1.1 employees every 1,000 tonnes/year for delivery to collecting facilities (75% of the whole), achieving a total of 2.39 employees every 1,000 tonnes/year;
- Operators of the pre-consumer (marketed and manufactured) metal scrap collection cycle have been calculated on a technical performance of 0.38 employees every 1,000 tonnes/year (estimate by ADEME 2011 on industrial waste selected collection);
- Operators of services for aluminium packaging treatment for recycling have been calculated on an average technical performance at 1.67 employees every 1,000 tonnes/year (600 tonnes per employee, just like in sorting facilities for light polymaterial waste);
- Operators of services for bulky waste and WEEE treatment for recycling have been estimated on an average technical performance at 1.9 employees every 1,000 tonnes/year (taking into account WEEE sorting facilities);
- Operators of services for used vehicles treatment for recycling have been calculated on an average technical performance at 2.74 employees every 1,000 tonnes/year (estimate by ADEME 2011);
- Operators of services for other post-consumer metal scrap collection and treatment for recycling have been calculated on an average technical performance at 3.58 employees every 1,000 tonnes/year, in compliance with ADEME 2011 estimate on non-ferrous metals;
- As for pre-consumer metal scrap treatment for recycling, zero employment has been estimated;
- Operators of incineration services have been calculated on an average technical performance at 0.5 employees every 1,000 tonnes/year;
- Operators of ash recovery services have been calculated on an average technical performance at 0.33 employees every 1,000 tonnes/year;
- Operators of aluminium manufacture activities have been calculated on an average technical performance at 4.46 employees per 1,000 tonnes of produced raw aluminium (a value obtained from an estimated 5,000 operators of refining and remelting facilities, compared to a raw aluminium production totalling 1,151,000 tonnes). ●

PACKAGING:
Environmental Changes in Waste Management

by **Paola Ficco**

In recent years, the legislation regarding management of aluminium packaging waste has not undergone significant changes.
However, just as all sectors related to ecosystems' protection and management, the aluminium packaging's has also been affected by a series of crucial rules that are relevant to the sectors of waste management and the AIA (Integrated Environmental Authorization). As for packaging, although Law 29th July 2015 n. 115 ("European Law 2014") has to be mentioned, Law 68/2015 on environmental crimes stands out above all others.

Law 29th July 2015 n. 115, "European Law 2014", www.reteambiente.it/normativa/22596/

The aims of this paper are:
- identifying new aspects about packaging, waste management and the AIA;
- listing some particularities of the new Law 68/2015, as well as those found in the new Part VI a of the Legislative Decree 152/2006 ("Environmental Code") introduced by the above mentioned Law 68/2015. This new Part VI a is indeed crucial for managing litigation avoidance in the so-called "environmental" sectors – including the one considered here – because it introduces a new system for the prescription of crimes as provided for by the other sections of the aforementioned "Environmental Code".

Packaging

Since 18th August 2015, Law 29th July 2015 n. 115, or "European Law 2014", has been in force. It directly affects Italian law by conforming it to the European legal framework, in order to respond to the infringement procedures adopted by the European Commission against Italy. Among the "environmental" provisions, we would like to highlight changes to packaging control included in Legislative Decree 152/2006. Under these provisions, the rules of the "Environmental Code" now apply also to packaging produced in Italy, but destined to the European market.

Waste

1) Since 1st June 2015:
- important changes have occurred regarding classification of waste. Since that date, it has been possible to apply Decision 955/2014/EC, which modifies the European list of waste and – as specified by Italian Ministry of the Enviroment in its note of 28th September 2015 – replaces attachment D, Part IV, of Legislative Decree 152/2006;
- Regulation (EU) 1357/2014 has replaced attachment III to Directive 2008/98/EC (Attachment I to Legislative Decree 152/2006). Therefore, attachment I, Part IV, is no longer in force, since it is replaced by the attachment to Regulation (EU) 1357/2014;
- the new provisions established by regulation 2015/830/EU for filling in safety data sheets of chemical substances have come into force. This measure has replaced Attachment II to regulation "Reach" (1907/2006/EC), in order to adjust the provisions according to the fifth revision of GHS rules (Globally Harmonised System of Classification and Labelling of Chemicals).

Paola Ficco is an environmental legal specialist, lawyer, publicist, and professor. She is a former member of the Italian EMAS Committee for Ecolabel Ecoaudit, as well as legal expert for the Italian Ministry of Industry and the Environment, and member of the Italian Register of Environmental Operators. She has been an expert on environmental issues for the broadsheet *Il Sole 24 Ore* since 1990 and editor in chief of *Rifiuti – Bollettino di informazione normativa* since 1994. She coordinates the organization of the legislative activity of SUSDEF (Foundation for Sustainable Development) as well as the author of many titles and publications for *Il Sole 24 Ore*, Buffetti, Maggioli, Utet and Edizioni Ambiente. For the latter, she is also in charge of the rules and regulations section and lifelong education on waste.

1. Since there was not enough time to pass Decree Law 92/2015, its provisions were "transferred" into Law 125/2015, with no modification, passing Decree Law 78/2015. Decree Law 92/2015 was not passed, yet the legal effects while it was in force were preserved by the above mentioned Law 125/2015.

2) Since 4th July 2015, Decree Law 92/2015[1] has affected the "Environmental Code", by modifying the concepts of "original waste producer", "collection" and "temporary storage".

In particular:
- the concept of "original waste producer" (article 183, paragraph 1, letter f of Legislative Decree 152/2006) now includes also any party legally connected to waste production;
- as for waste "collection" (letter o), the Decree Law states that "storage" – already included into the former with "sorting" – is to be intended as "preceding the collection" only;
- as well as indicating blending or mixing of waste, "temporary storage" (letters bb) now also includes "storage preceding collection for transport to a waste treatment facility".

Furthermore, the definition "place of waste generation" is to be understood as "the whole area where the activity generating waste is undertaken".

3) Law 6th August 2015, n. 125, passing Decree Law 78/2015, states that the cost items setting the price of TARI (Tax on Waste) must include the lost revenues due to bad debts with reference to pre-existing systems (TIA 1, TIA 2 and TARES).

4) Ministerial Decree 24th June 2015 (effective since the 11th September 2015) amended the provisions contained in Ministerial Decree 27th September 2015 regarding the criteria of waste eligibility in landfills. Among the changes, we highlight the newly-introduced evaluation of the neutralizing capacity of stable non-reactive hazardous waste's acid, in order to dispose of them in non-hazardous waste landfills.

AIA (Integrated Environmental Authorization)

Companies that have been working in compliance with the AIA prior to 7th July 2015 can carry on with their activity beyond that date, while waiting for the relevant authorities to update their AIA. Already included in Decree Law 92/2015 – that was not passed into law, the provision has been transferred into Law 125/2015, passing Decree Law 78/2015, without modifications. The companies can keep up their activity, provided that, if necessary, the relevant authorities take care of suitably updating their authorizations and that all the amendments proposed in the adjusting applications are fully implemented.

Environmental Crimes

Law 68/2015 adds Title VI b, "Crimes against the Environment", to the criminal code. It has been in force since 29th May 2015 and cannot apply to the proceedings before that date.

The most significant crimes are:
- "environmental pollution" (article 452 a), punished with imprisonment from two to six years and a fine from €10,000 to €100,000. If it causes deaths or bodily harm, sentences are harsher (article 452 b);
- "environmental disaster" (article 452 c), punished with imprisonment from five to fifteen years.

Negligent crimes carry a sentence reduced by one to two thirds. If there is a risk of environmental pollution or disaster, sentences are reduced by another third (article 452 d). The sentence is increased by up to one third if the pollution incident in a protected natural area, a zone within landscape, environmental, historic, artistic, architectural or archaeological restriction, or if endangered animal or plant species are harmed.

By means of Title VI a of the criminal code, Law 68/2015 also states the following environmental crimes: trafficking and abandonment of high radioactivity material (article 452 e), punished with imprisonment from two to six years and a fine from €10,000 to €50,000; hindrance to inspections (article 452 f), punished with imprisonment from six months to three years. Article 452 g features specific aggravating factors for crimes of association designated within articles 416 and 416 a of the Criminal Code. Failure to reclaim polluted areas (article 452 n) is punished with imprisonment from one to four years and a fine from €20,000 to €80,000. Ineligibility to enter into a contract with the government extends to those convicted of intentional environmental pollution and disaster, trafficking and abandonment of high radioactivity material and hindrance to inspections, as well as to those convicted of illegal waste trafficking. The new Law introduces the institution of voluntary disclosure. This acts as a mitigating factor on behalf of those who, before the first hearing starts, respectively avoid the illegal activity from leading to further consequences, taking care of securing, reclaiming or restoring places to their original state, or cooperate

actively in re-enacting events and finding the culprits. Reclaiming polluted areas can mitigate punishments but cannot extinguish crime.
In fact, voluntary disclosure does not feature among the causes of immunity for environmental crimes (unlike infringements, according to the new paragraph 4, article 257 of Legislative Decree 152/2006). Therefore, regarding environmental crimes, it seems that repentance is unlikely to assure the disclosure of offences or encourage reclamation of polluted areas.
Law 68/2015 adds environmental crimes to article 25 l of Legislative Decree 231/2001 as new offences. This assumption implies companies' responsibility.
Article 452 g of the criminal code carries an aggravating factor for crimes of association, including both criminal conspiracy (as laid down in article 416 of the criminal code) and Mafia association (as laid down in article 416 a of the criminal code). The sentence is increased by up to one third (in compliance with article 64 of the Criminal Code) and from one third to one half if public officers or people in charge of public services carrying out environmental tasks or functions have participated in the association.
Article 452 l, paragraph 1 of the Criminal Code states the mandatory seizure of items which have been produced by, earned through or used for committing the crime – unless they belong to people not guilty of the crime – in case of conviction or plea bargain for crimes of environmental pollution or disaster, trafficking and abandonment of high radioactivity material, hindrance to inspections and crimes of association with aggravating factors.
Seizure is extended to the crime provided for by article 260 of Legislative Decree 152/2006.

Article 1, paragraph 9 of Law 68/2015 adds the new Part VI a to Legislative Decree 152/2006 ("Environmental Code"), thus introducing a "sentencing control for administrative and criminal offences regarding environmental protection". The brand new Part VI a consists of seven articles – from 318 a to 318 g – and introduces a procedure similar to the one for safety at work, provided for by articles from 20 onwards of Legislative Decree 758/1994, although its adoption is more complicated with respect to environmental issues.
As for the infringements included in the "Environmental Code", Law 68/2015 introduces a process for extinguishing crime through its regularisation, provided the infringement has not "caused damage or posed existing, actual risk of damaging protected environmental, urban or landscape resources".
The new article 318 c of Legislative Decree 152/2006 states that, when provisions are followed, "the supervisory authority allows the transgressor to pay [...] one fourth of the maximum fine imposed for the infringement committed". Therefore, the new provisions apply only to infringements provided for by the "Environmental Code" and, among these, only to those punished with a fine imposed with or without imprisonment. With respect to waste, for example, the provisions do not apply to the offence punished under article 255 paragraph 3, carrying only a sentence of imprisonment for failure to comply with the mayor's order in case of abandonment.
Or, with regard to waters, they do not apply to the offence provided for by article 137, paragraph 11, carrying a sentence of imprisonment for up to three years in case of failure to observe the "no dumping" prohibition.
In other words, for the new system to be applied, fines must show among the penalties provided for by the Environmental Code.
However, it seems rather peculiar that infringements included in other environmental regulations (e.g. those concerning landfills or Seveso) are not considered. ●