



Recycling
of industrial mineral
applications
Contribution
to circular economy
September 2023





RECYCLING RATES

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**INDUSTRIAL MINERALS
CAN BE – AND ARE – RECYCLED!**



Industrial minerals can be – and are – recycled!

Industrial minerals are used in a wide range of applications and products. Recovering these minerals from their manufacturing products would be technically challenging, energy consuming and, ultimately environmentally unsound. However, although the minerals may not be recyclable per se, many of them live second, third, fourth or even an infinite number of

lives thanks to the recycling of the applications they are used in, thus contributing to the circular economy.

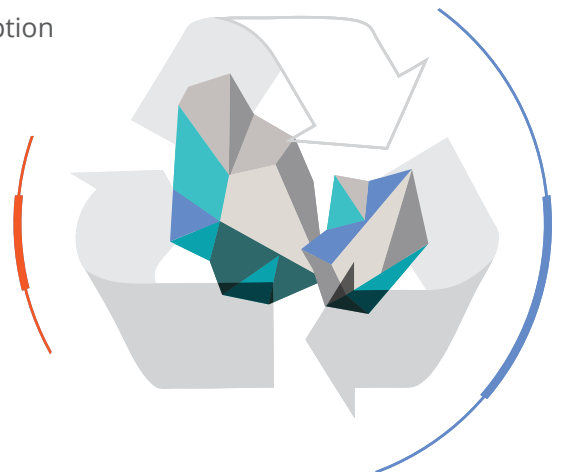
The IMA-Europe Recycling Sheets gather publicly available data on the recycling rate of the main applications and products in which industrial minerals are used as primary raw materials.

For each mineral, we present the consumption by market and the recycling rates of their specific application, showing that, thanks to this recycling,

it is up to

60%

of the industrial minerals that find subsequent uses in our aspirational circular economy.



In this context, recycling should be understood, as defined in the Waste Framework Directive (Directive 2008/98/EC on waste), as: 'recycling' means any recovery operation by which waste materials are re-processed into products, materials or substances whether for the original or other purposes.

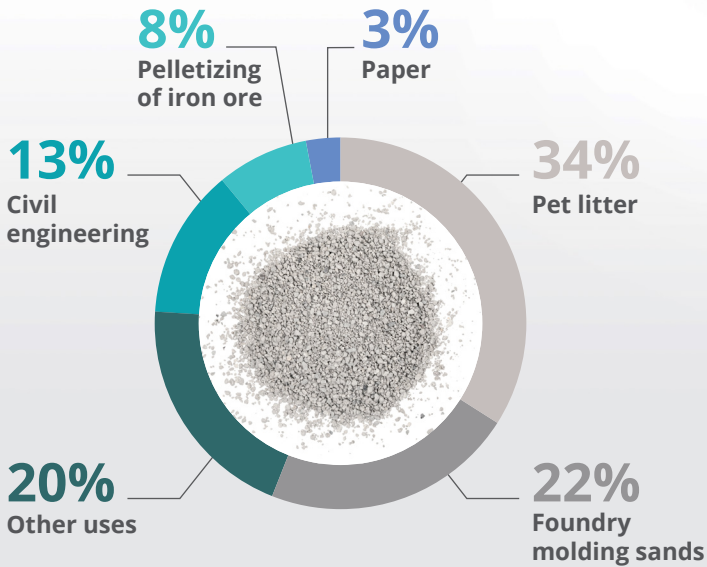
The product recycling is strongly conditioned by the lifetime of different applications: Mobile phone: 1-3 years; car: 10-15 years; house: 30-50 years. The EU recycling rates are average values. EU and national recycling rate can differ.

“Despite the extensive recycling of multiple markets and its continuous improvements over time, there is still a need for more primary industrial minerals to be produced to meet the growing market’s demand.”

BENTONITE

RECYCLING RATES

EUROPEAN BENTONITE CONSUMPTION BY MARKET



European (EU-28) annual consumption of bentonite is estimated at around **2.6 million tonnes**

Bentonite is an industrial name for a rock which contains mainly smectite, the most common form in geological terms being montmorillonite, with particular properties of swelling and water absorption. The special properties of bentonite (hydration, swelling, water absorption, viscosity, thixotropy) make it a valuable material for a wide range of uses and applications. It is frequently used as a binding, sealing, absorbing and lubricating agent.

Bentonite market by use category [IMA Data Collection 2017]

Bentonite recycling rates by application

PET LITTER

The main use in volume of bentonite in Europe is as the active ingredient of pet litter. Each year, nine hundred thousand tonnes of bentonite is used for pet litter, which ends up in municipal waste. In Europe, 27% of the municipal waste is incinerated. Bentonite in the incinerated municipal waste is recovered in the form of fly ash and re-used in different industries, such as the wall board industry.

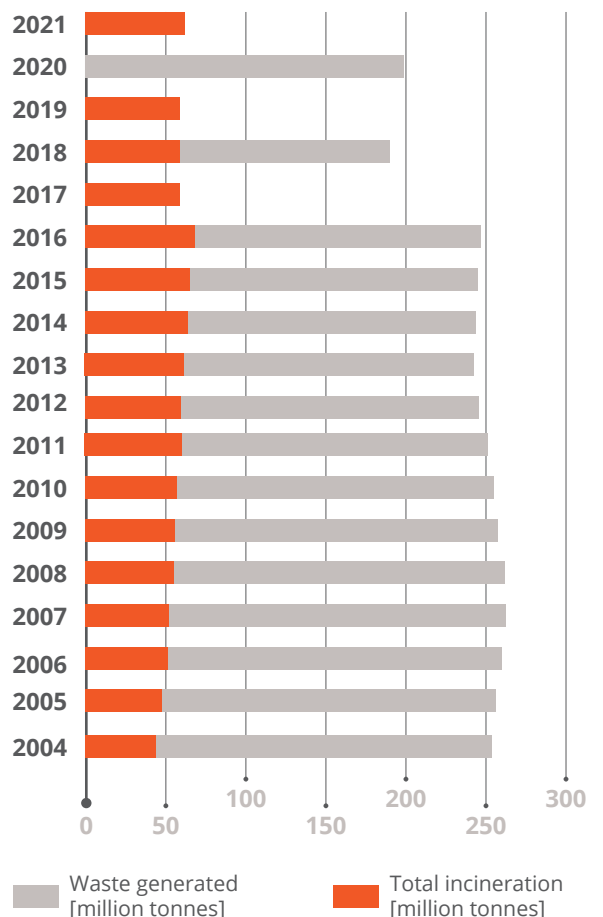
Ref: Generation & treatment of municipal waste [Eurostat 2021]

FOUNDRY MOLDING SANDS

Bentonite is used as a bonding material in the preparation of moulding sand for the production of iron, steel and non-ferrous casting. The unique properties of bentonite yield green sand moulds with good flowability, compactability and thermal stability for the production of high quality castings. Each tonne of foundry sand, containing bentonite after a metal has been cast, is regenerated, after which it is generally given another new life in the foundry and the construction industry. Using the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

Municipal waste incinerated in the EU-27, 2004-2021



CIVIL ENGINEERING

Bentonite in civil engineering applications is traditionally used as a thixotropic, support and lubricant agent in diaphragm walls and foundations, in tunneling, in horizontal directional drilling (HDD) and pipe jacking. Bentonite, due to its viscosity and plasticity, is also used in Portland cement and mortars. Civil engineering applications are recycled principally through the recycling of construction materials. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste, which is estimated to be around 74%.

Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

PELLETIZING OF IRON ORE

8% of bentonite is used for the pelletizing of iron ore. Iron pellets are used to produce iron and steel products. During the production, the majority of bentonite used for pelletizing is transferred in the slag phase which is used in the cement industry. Minimal quantities of iron and aluminium are transferred in the metal phase which is almost 100% recycled, while volatile components like water and CO₂ are transferred into the gaseous phase and are lost. Based on the average content of water, calcium carbonate and other volatile components in bentonite, the recycling rate of bentonite is estimated to exceed 70%.

Ref: *Steel Recycling* [Eurofer 2018]

OTHER USES

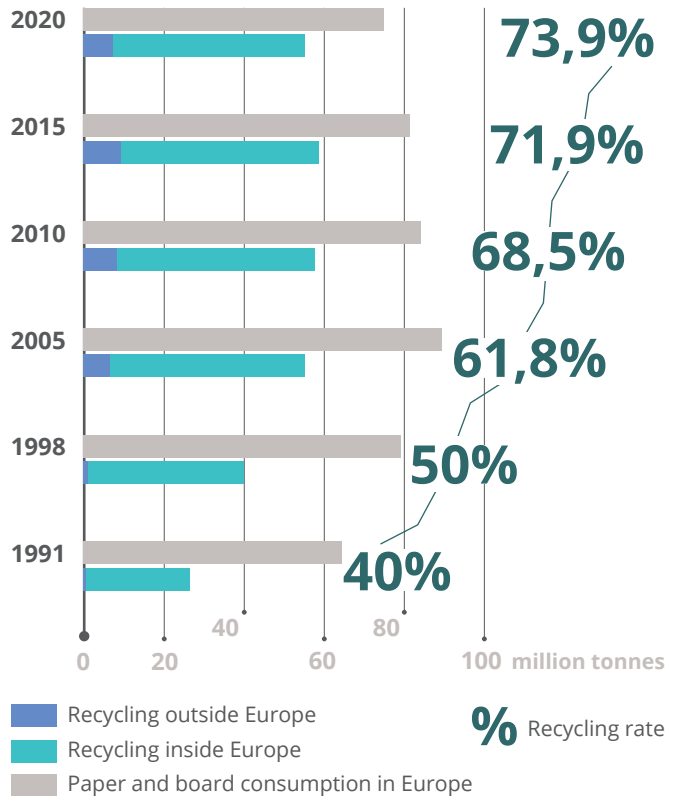
The remaining volume of bentonite is used in other applications, e.g. food and wine production, animal feed additive, drilling fluids for oil and gas, detergents, other specialty applications. These applications are very diverse and it is difficult to obtain recyclability statistics. They have therefore not been factored into results.

PAPER

Bentonite is crucial to paper making, where it is used in pitch control, i.e. absorption of wood resins that tend to obstruct the machines and to improve the efficiency of the conversion of pulp into paper as well as to improve the quality of the paper. Bentonite also offers useful de-inking properties for paper recycling. In Europe, paper fibres are recycled 3.6 times on average, significantly outperforming the world average of 2.4 times. The recycling rate in Europe increased to 73,9% in 2020.

Ref: *Monitoring Report* [Cepi 2020]

Recycling of paper in Europe 1991-2020



Overall recyclability rate of bentonite

“Based on our current market analysis and estimated recycling rates, we can consider that, **about**

44%
of all bentonite used is recycled.

As indicated above, this figure is an EU-wide average figure and regional disparities do exist.”

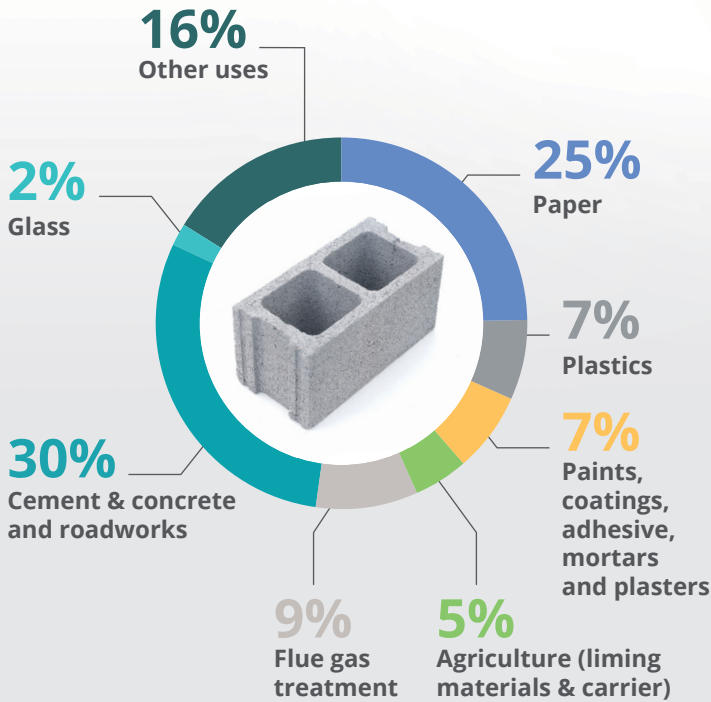
Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

	Bentonite markets	Application recycling rate	Bentonite recycling rate
Pet litter	34%	28%	10%
Foundry molding sands	22%	79%	17%
Civil engineering	13%	74%	9%
Pelletizing of iron ore	8%	70%	6%
Paper	3%	74%	2%
Other uses	20%		0%
Total	100%	65%	44%

CALCIUM CARBONATE

RECYCLING RATES

EUROPEAN CALCIUM CARBONATE CONSUMPTION BY MARKET



European (EU-28) annual consumption of calcium carbonate is estimated at around **53** million tonnes

Calcium carbonate is a multifaceted mineral. The chemical formula CaCO_3 covers a raw material, which is widespread throughout nature, whether dissolved in rivers and oceans, in molten form as "cold" carbonate-lava, or solid as a mineral in the form of stalactites, stalagmites or as the major constituent of whole mountain ranges. Plants and animals need calcium carbonate to form their skeletons and shells. In fact, when considering our lives, modern mankind could hardly imagine existing without calcium carbonate. Almost every product in our daily lives either contains calcium carbonate or has some association with the mineral during its production.

Calcium carbonate market by use category [IMA Data Collection 2017]

Calcium carbonate recycling rates by application

CEMENT & CONCRETE AND ROADWORKS

Calcium carbonate is used in significant volumes within cement and concrete. It is increasingly used as a quality filler in concrete applications, such as concrete wares (paving-stones, tubes, sewer tanks), ready-mixed concrete and prefabricated elements. These will often find an end of life reuse as aggregates used for other construction processes. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]



PAINT, COATINGS, ADHESIVES, MORTARS AND PLASTERS

Recycling rates of interior and exterior paints, which represent 50-60% of the total amount of paint consumed are recycled the most, principally in aggregates and other construction materials. Calcium carbonate is also used significantly in adhesive and sealants, in mortars to improve mechanical properties and in plasters. To calculate the recycling rate of these applications, we can reasonably use the figures of the recycling of construction and demolition waste, which in the EU is estimated to be around 74%.

Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

FLUE GAS TREATMENT

Calcium carbonate is used in significant volumes as a reagent in Flue Gas Treatment where 60-80% of SO₂ precipitated gases reach the end of life as gypsum which is widely reused in construction markets. To calculate the recycling rate of these end applications we can then use the construction and demolition waste rate for the EU, which is around 50%.

Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

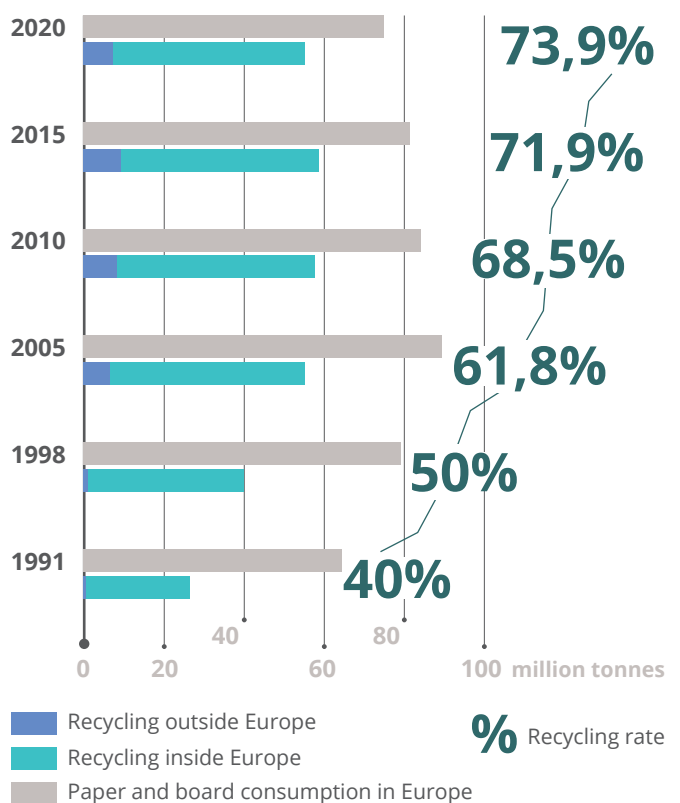


PAPER

Today, calcium carbonate is the most widely used mineral in paper-making. GCC and PCC are used both as a filler and a coating pigment and help produce papers with high whiteness and gloss and good printing properties. In Europe, paper fibres are recycled 3.6 times on average, significantly outperforming the world average of 2.4 times. The recycling rate in Europe increased to 73,9% in 2020.

Ref: *Monitoring Report* [Cepi 2020]

Recycling of paper in Europe 1991-2020



PLASTICS

Calcium carbonate is by far the most important mineral for compounding with polymers. By weight it accounts for more than 60% of the filler and reinforcements market. Main applications include plasticised and rigid PVC, unsaturated polyesters, polypropylene and polyethylene. Other important areas of use include rubber, foamed latex carpet-backings. Most plastics are either recycled or recovered for energy. Industrial film, PET bottles and PVC profiles are recycled the most. The recycling rate of plastics waste in EU in 2019 was 32.5%.

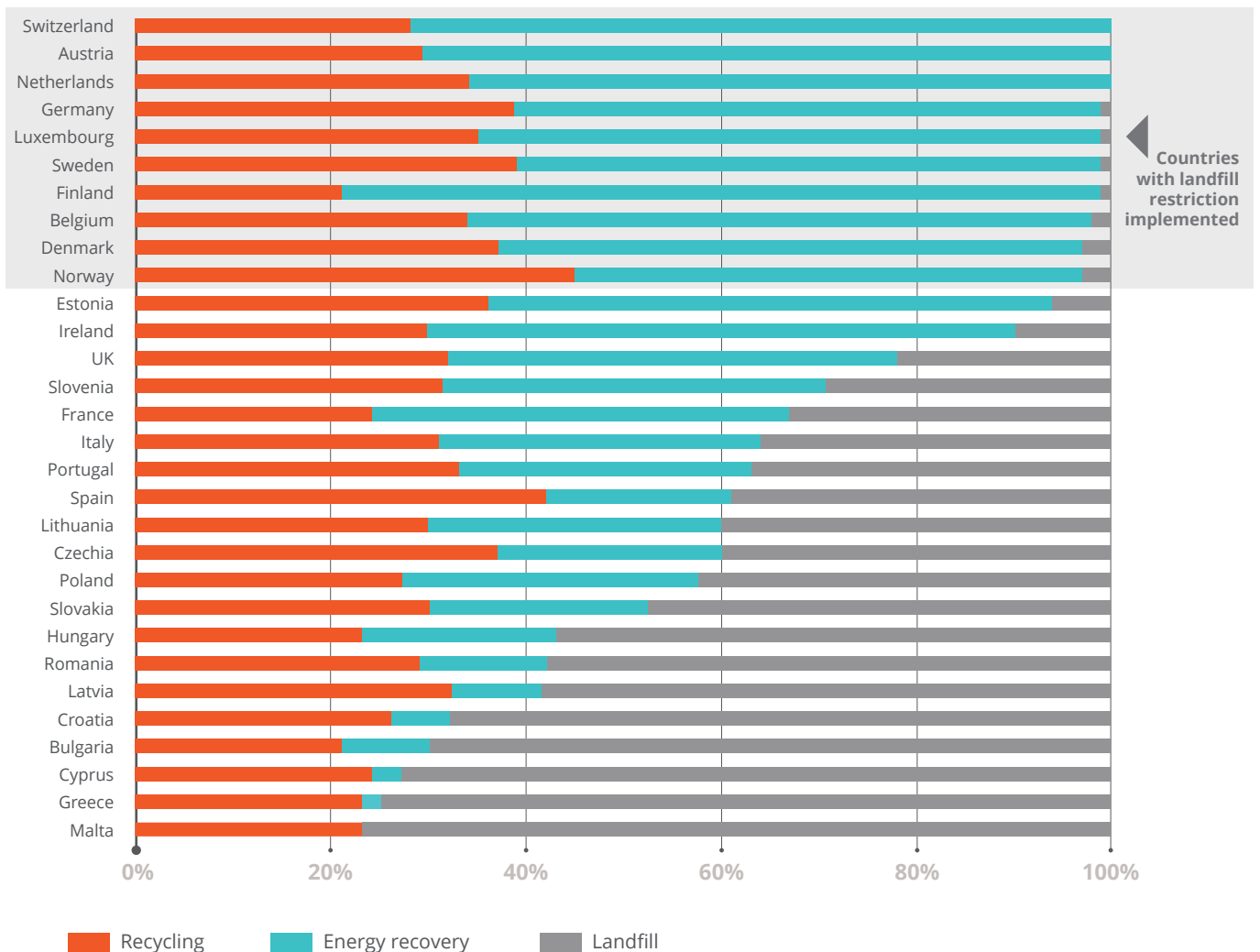
Ref: *Plastics the facts [Plastic Europe 2019]*



AGRICULTURE (LIMING MATERIALS & CARRIER)

Almost 3 million tonnes of calcium carbonate were used in agriculture in 2017. This application usually serves to correct soil acidity, improve plant nutrition and to modify physical properties of soil. It is believed that calcium carbonate in this application has a 100% recycling rate.

European plastic recycling 2019



GLASS

The use of calcium carbonate in glass is well established in all forms of glass (container glass, sheet glass and reinforcement of fiber glass). Nevertheless, the biggest application for calcium carbonate remains the container glass, amounting to two thirds of the market. Therefore, taking into consideration the high recyclability of container glass (78%) and the estimated recycling rate for flat glass (26%), we can reasonably use as a recycling rate for this application a rate of 50%.

Ref: Recycling Statistics [Feve 2019; Glass for Europe 2020]



OTHER USES

Here, calcium carbonate is used for its functional properties, for example in feed and water treatment. It is therefore entirely consumed with the relevant products and returned to nature in the form of salts. These uses have therefore not been factored into results.

Overall recyclability rate of calcium carbonate

“Based on our current market analysis and estimated recycling rates, we can consider that, about

57%

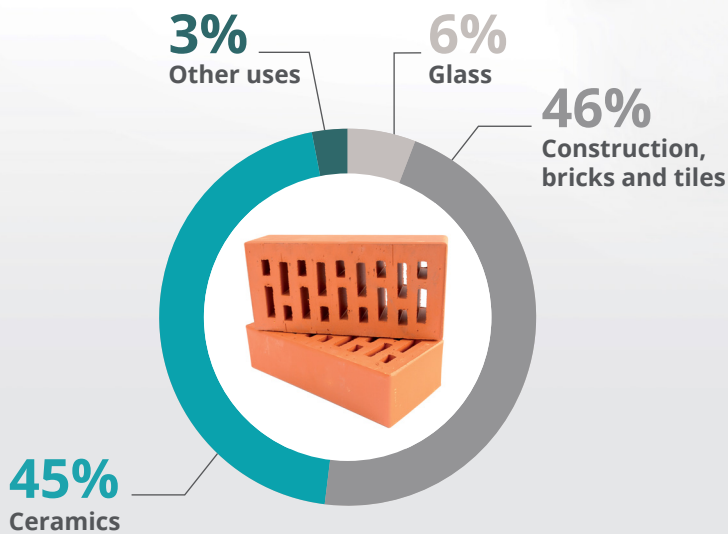
of all calcium carbonate used is recycled.

As indicated above, this figure is an EU-wide average figure and regional disparities do exist.”

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

	Calcium carbonate markets	Application recycling rate	Calcium carbonate recycling rate
Cement & concrete, plaster & mortar roadworks	30%	74%	22%
Paper	25%	74%	18%
Flue gas desulfurisation	9%	50%	4%
Paints, coatings, adhesive	7%	74%	5%
Plastics	7%	33%	2%
Agriculture (liming materials & carrier)	5%	100%	5%
Glass	2%	74%	1%
Other uses	16%		
Total	100%		57%

EUROPEAN FELDSPAR CONSUMPTION BY MARKET



European (EU-28) annual consumption of feldspar is estimated at around **3.2 million tonnes**

Feldspar is by far the most abundant group of minerals in the earth's crust, forming about 50% of terrestrial rocks. Most European deposits offer potassium feldspar as well as sodium feldspar and mixed feldspars. Feldspars are primarily used in industrial applications for their alumina and alkali content. Feldspars play an important role as fluxing agents in ceramics and glass production, and are also used as functional fillers.

Feldspar market by use category [IMA Data Collection 2017]

Feldspar recycling rates by application

CONSTRUCTION, BRICKS AND TILES

Feldspar is used in significant volumes for construction purposes and within bricks and tiles. These applications will often find an end of life reuse as aggregates used for other construction processes. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

CERAMICS

In the manufacture of ceramics, feldspar is the second most important ingredient after clay. Ceramics are currently broken down into aggregates for road works or other civil works. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

GLASS

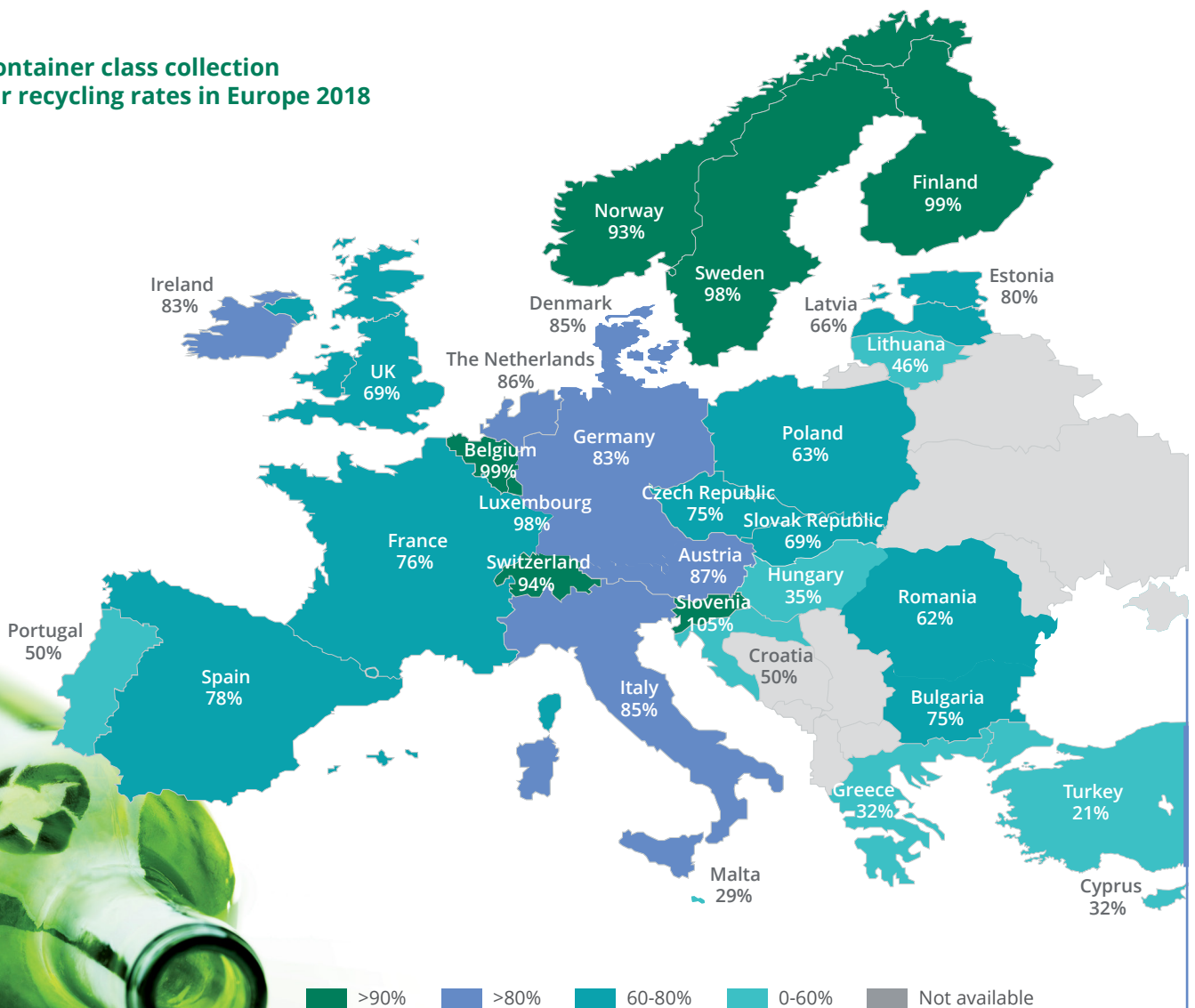
Feldspar is an important ingredient in the manufacture of glass and an important raw material as well, because it acts as a fluxing agent, reducing the melting temperature of quartz and helping to control the viscosity of glass. Glass is one of the most environmentally friendly materials. It is infinitely reusable and recyclable. The recycling rate for coloured container glass (green and brown bottles) is above 90%. For white glass packaging, similar to flat glass, the recycling rate depends heavily on the quality of the container or bottle required. On average, the European container glass industry achieved a record 78% recycling rate in 2018 (EU-28).

Ref: Recycling Statistics [Feve 2019]

OTHER USES

Filler for paint, fluxing agent, refractory. Other applications for feldspar are very diverse and it is very difficult to obtain recyclability statistics for these applications. They have therefore not been factored into results.

Container class collection for recycling rates in Europe 2018



Overall recyclability rate of feldspar

“Based on our current market analysis and estimated recycling rates, we can consider that, about

72%
of all feldspar used is recycled.

As indicated above, this figure is an EU-wide average figure and regional disparities do exist.”

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

	Feldspar markets	Application recycling rate	Feldspar recycling rate
Glass	6%	78%	5%
Construction, bricks and tiles	46%	74%	34%
Ceramics	45%	74%	33%
Other uses	3%		0%
Total	100%	75%	72%

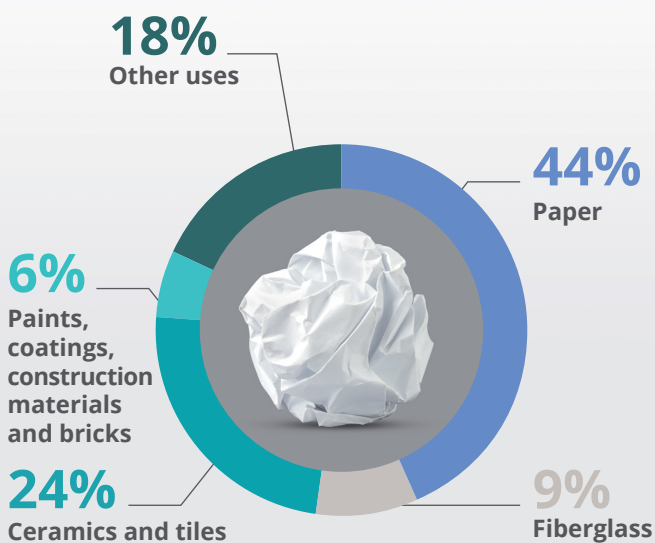
KAOLIN AND CLAY

RECYCLING RATES

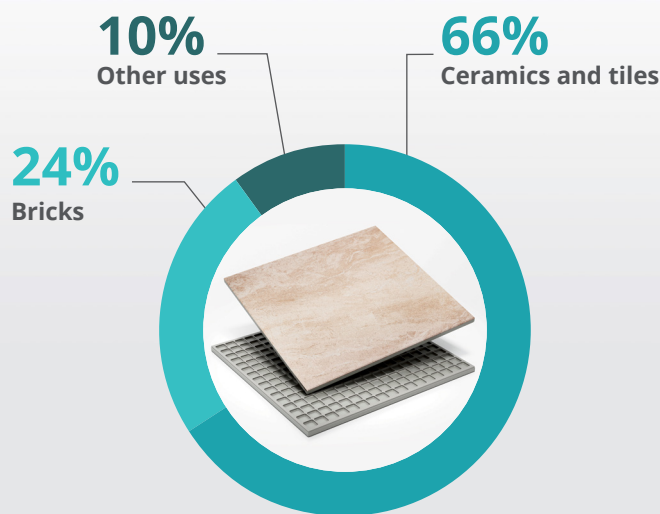
EUROPEAN KAOLIN AND CLAY CONSUMPTION BY MARKET

Kaolin and kaolinitic clays are combinations of very fine-grained minerals. The wide variation both in mineral composition and in the size of the clay particles results in different characteristics. Selection and control of this variation in composition means that the clay can be used in various industries. Kaolin and clays are known to these industries by different names depending on their functional properties. These include China Clay, Kaolin, Kaolinitic Clay, Ball Clay, Plastic Clay, Flint Clay, Fire Clay, Red Clay, Refractory Clay and Ceramic Clay. Kaolin and kaolinitic clays form a vital component in the manufacture of ceramic products, paper and fiberglass which altogether account for about 80% of the total sale volumes in Europe.

European (EU-28) annual consumption of kaolin and clay is estimated at around **13 million tonnes**



Kaolin market by use category [IMA Data Collection 2017]



Clay market by use category [IMA Data Collection 2017]

Kaolin and clay recycling rates by application

CERAMICS AND TILES

Kaolin and clay are used in formulations described as whiterwares, which consists of tableware, sanitaryware, and wall and floor tiles. It provides strength and plasticity in the shaping of these products and reduces the amount of pyroplastic deformation in the process of firing. Therefore, because of physically irreversible processes it is not possible to recycle kaolin and clay in a classical sense. Ceramics are recycled the most, principally in aggregates and other construction materials. Tiles will often find an end of life reuse as aggregates used for other construction processes. Therefore, we can use the figures of the recycling of construction and demolition waste, which is in the EU 74%.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

FIBERGLASS

The fiberglass which is used as a strengthener in a multitude of applications requires the use of kaolin for its manufacture. Kaolin allows for the strengthening of the fibres integrated into the material. It also improves the integration of fibres in products requiring strengthened plastics. The major application industries in Europe are the automotive and transport sector, and the construction one. The recycling rate end-of-life vehicles in the EU is, on average, 90.5% while the recycling of construction and demolition waste in the EU is 74%. The average between these two figures, 82%, can be reasonably use as an estimated fiberglass recycling rate.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]; End-of-life vehicles – reuse, recycling and recovery, totals [Eurostat 2019]; Composites Market Report [AVK 2017]

BRICKS AND CONSTRUCTION MATERIAL

Kaolin and clay are used in significant volumes within bricks and construction material. These applications will often find an end of life reuse as aggregates used for other construction processes. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

PAINTS AND COATINGS

In its hydrous or calcined forms, kaolin can improve the optical, mechanical and rheological properties of a paint. Interior and exterior paints, which represent 50-60% of the total amount of paint consumed, are recycled the most, principally in aggregates and other construction materials. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

OTHER USES

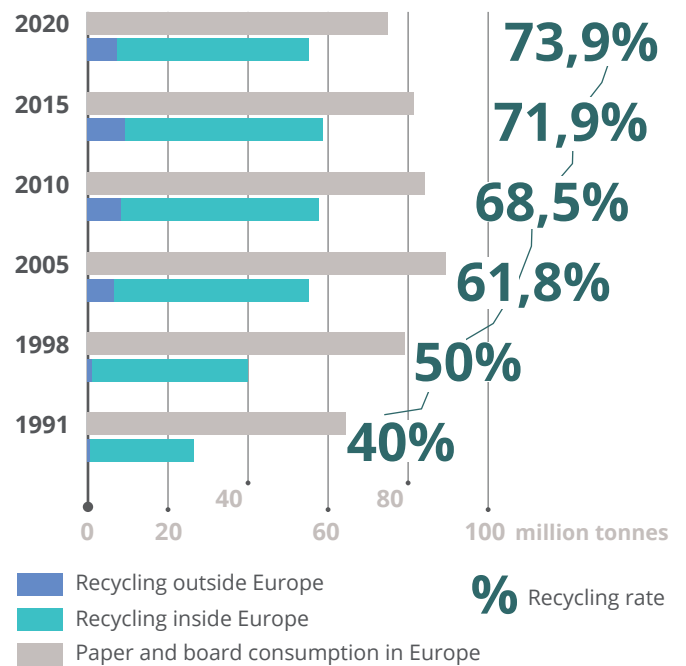
Other uses are diverse and it is difficult to establish recyclability statistics for these markets. These uses have therefore not been factored into results.

PAPER

In this industry, kaolin is used both as a filler in the bulk of the paper and to coat its surface. Kaolin's whiteness, opacity, large surface area and low abrasivity make it an ideal raw material for paper production. The recycling rate in Europe increased to 73,9% in 2020. In a year to year comparison, the total amount of paper collected and recycled in the paper sector increased by 0.9% to 59.5 million tonnes, while consumption of paper decreased by 0.1%.

Ref: *Monitoring Report* [Cepi 2020]

Recycling of paper in Europe 1991-2020



Overall recyclability rate of kaolin and clay

“Based on our current market analysis and estimated recycling rates, we can consider that, **about**

62%

of all kaolin and

67%

of all clay used is recycled.

As indicated above, this figure is an EU-wide average figure and regional disparities do exist.”

Ref: *Emerging Challenges of Waste Management in Europe* [Trinomics 2020]

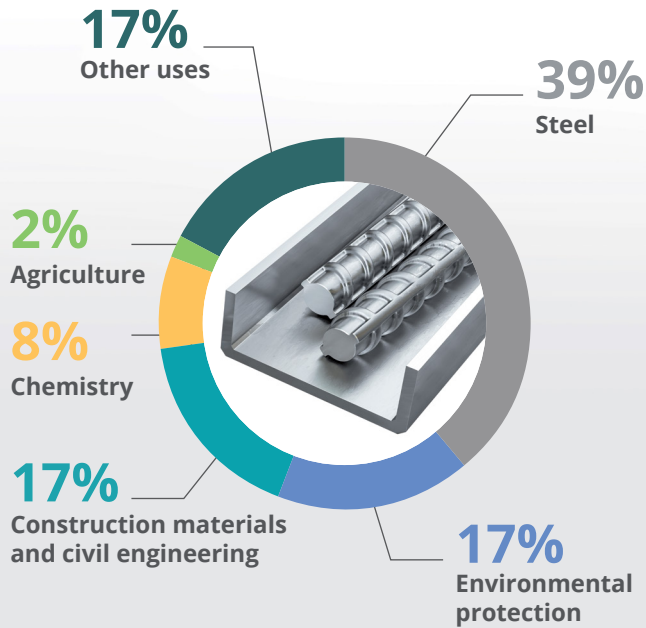
	Kaolin markets	Application recycling rate	Kaolin recycling rate
Paper	44%	74%	32%
Fiberglass (in plastic)	9%	82%	7%
Tiles and ceramics	24%	74%	18%
Paints and coatings, construction materials & bricks	6%	74%	5%
Other uses	18%		0%
Total	100%	76%	62%

	Clay markets	Application recycling rate	Clay recycling rate
Tiles and ceramics	66%	74%	49%
Bricks	24%	74%	18%
Other uses	10%		0%
Total	100%	74%	67%

LIME

RECYCLING RATES

EUROPEAN LIME CONSUMPTION BY MARKET



European (EU-28) annual consumption of lime is estimated at around **24** million tonnes

Lime is a natural product and incomparable – no other chemical compound can do all what lime can: cleaning waste water, preparing our drinking water and absorbing the pollutants from the air. Lime enhances soil quality and is therefore used in agriculture, ensuring a richer harvest. Lime is also used for disinfection in animal husbandry, preventing the outbreak of diseases. Lime is an essential ingredient in the iron and steel industry, in construction (building and civil engineering), agriculture, environmental protection and in numerous chemical manufacturing processes. Its widespread use has supported our civilisation for millennia.

Lime market by use category [IMA Data Collection 2017]

Lime recycling rates by application

STEEL

Lime is most commonly used as a flux in purifying steel in the electric arc furnace (EAF) and basic oxygen furnace (BOF). Lime is particularly effective in removing phosphorus, sulphur, and silica, and to a lesser extent, manganese. Lime also has important uses in secondary refining of steel and in the manufacture of steel products. The lime flux removes impurities and forms a slag that can be separated from the steel and poured from the furnace as a liquid. End of life for lime in these applications in the large majority is as part of the slag, and to a lesser extent as dust. Slags are reused almost completely and dust to a large extent. Steel in cars, for example, is recycled at a rate of more than 95 per cent. And steel packaging is recycled by more than 74% in Europe, which makes steel the most recycled packaging material. Calculating the average between these two figures, the recycling rate for steel – and for lime in steel application – will be 84%.

Ref: Steel Recycling [Eurofer 2018]



ENVIRONMENT PROTECTION

Lime is used to combat acidification and control pH of soil, ground and surface waters. It is used for soil remediation i.e. treatment of soils polluted with hydrocarbons and heavy metals. Systematic liming of rivers and lakes (mainly in Scandinavia) has been carried out for more than 20 years to maintain their rich ecological system. Thus, the recycling rate of lime in environmental applications is estimated to be around 90%.



CONSTRUCTION MATERIAL AND CIVIL ENGINEERING

Builders have made use of the binding properties of lime. For example, lime-based mortars are often used in masonry and in plaster mixes for building facades. In addition, lime is being used increasingly in modern building materials, such as for aerated concrete blocks, for hemp-lime blocks and for sandlime bricks. These materials are highly valued because they have excellent thermal and acoustic insulating properties and they are easy to use.

The addition of lime to clay containing soil improves soil properties (i.e. better densification). Its reaction with water enables it to dry out damp soils. Lime is increasingly used to recycle excavated material from sites in urban areas. Hydrated lime improves the performance of asphalt mixes used for road surfacing. It increases their resistance against stripping, and also against rutting and agehardening. In tunnel

construction, hydrated lime is used to improve the quality of mortars. Quicklime dries out the mud from the excavation and therefore improves its handling. It is also used in the deep soil stabilisation process (lime treated columns) to improve soft soils, reduce settlements and increase stability. Hydrated lime is one of the components used to produce injection binders.

Therefore, to calculate the recycling rate of these application we can reasonably use the figures of the recycling of construction and demolition waste. Considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]



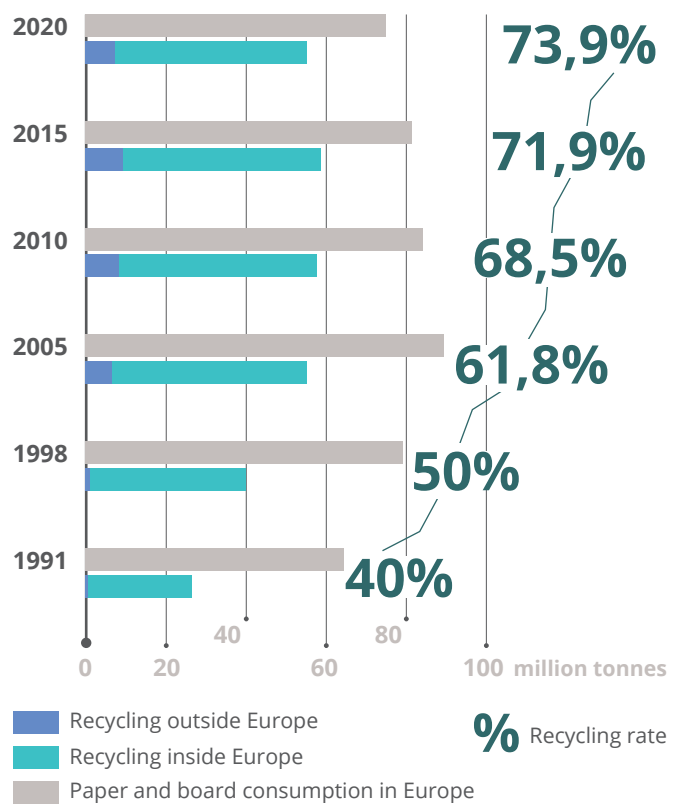
CHEMISTRY

Lime is used in the manufacture of paper pulp, particularly in the production of precipitated calcium carbonate (PCC). Thanks to its exceptional physical and bleaching characteristics, it helps produce high quality paper. Precipitated calcium carbonate (PCC), is used as a whitening agent in the papermaking process. It helps recover caustic soda (white liquor) from paper-mill sludge. In Europe, paper fibres are recycled 3.6 times on average, significantly outperforming the world average of 2.4 times. The recycling rate of paper in Europe increased to 73,9% in 2020.

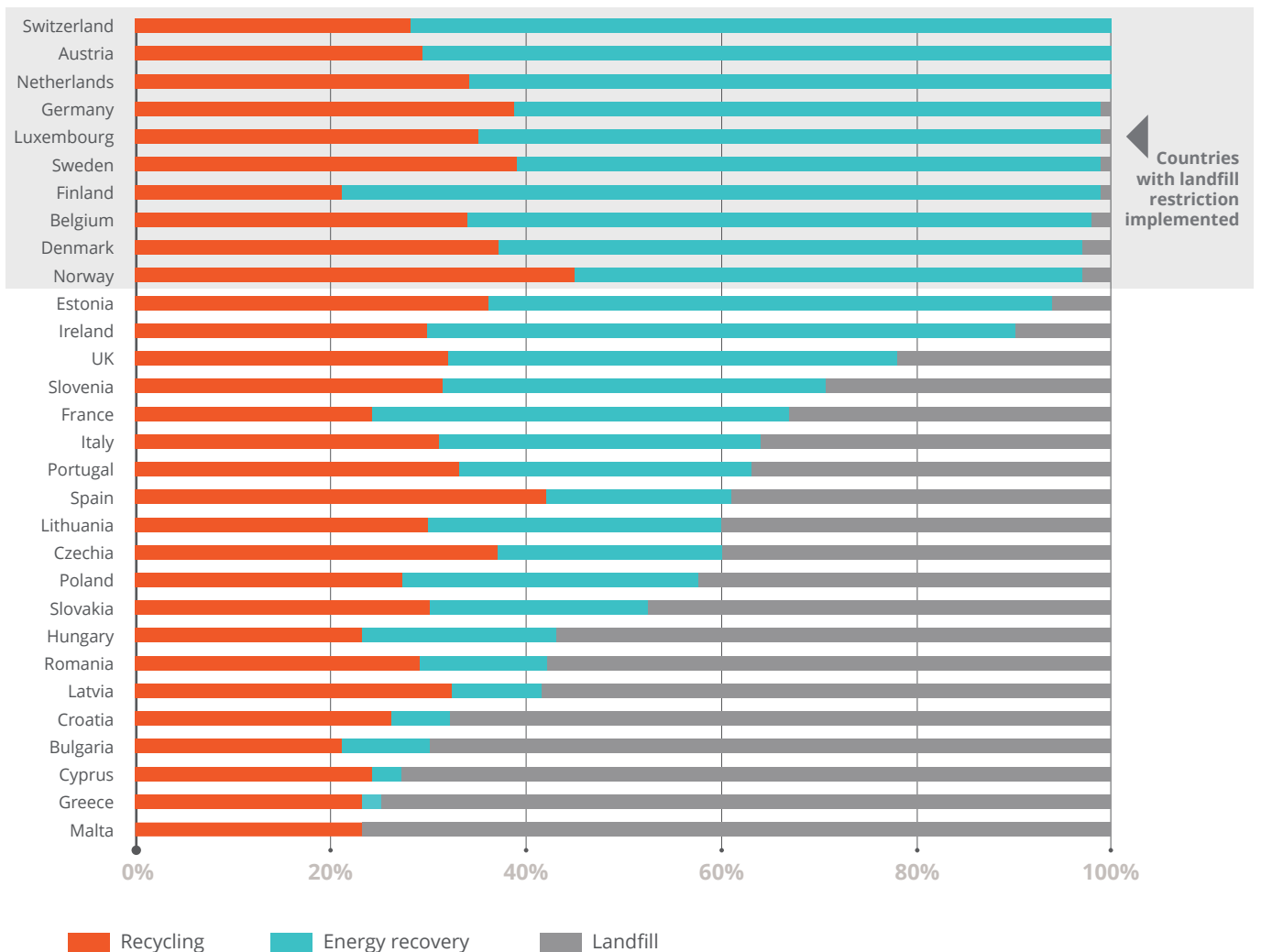
Significant amounts of the processes where lime is used in chemistry have applications in the plastics industry, especially in PVC. The recycling rate of plastics waste in EU in 2019 was 32.5%. Thus, we can calculate the chemistry application recycling rate as the average between the rate of paper and plastic, resulting in 53%.

Ref: Monitoring Report [Cepi 2020],
Plastics the facts [Plastic Europe 2019]

Recycling of paper in Europe 1991-2020



European plastic recycling 2019





AGRICULTURE

Various mixtures of lime, limestone and dolomite are used in agriculture and forestry, both for correcting acidity in the soil and for adding nutrients which contain magnesium and calcium. These nutrients are essential for healthy plant growth and for increasing crop yield. In forestry, dolomite-based products stimulate photosynthesis and, by lowering the degree of acidity in the soil, ensure a better assimilation of nutrients, resulting in a significant increase in forest productivity. It is believed that Lime in this application has a 100% recycling rate.

OTHER USES

Lime is known as the most economical and most widely used alkaline reagent in the chemical industry. It is also used for the glass, leather and sugar industries and as food and feed additives. These applications are very diverse and it is difficult to obtain recyclability statistics. They have therefore not been factored into results.



Overall recyclability rate of lime

“Based on our current market analysis and estimated recycling rates, we can consider that, **about**

67%

of all lime used is recycled.

As indicated above, this figure is an EU-wide average figure and regional disparities do exist.”

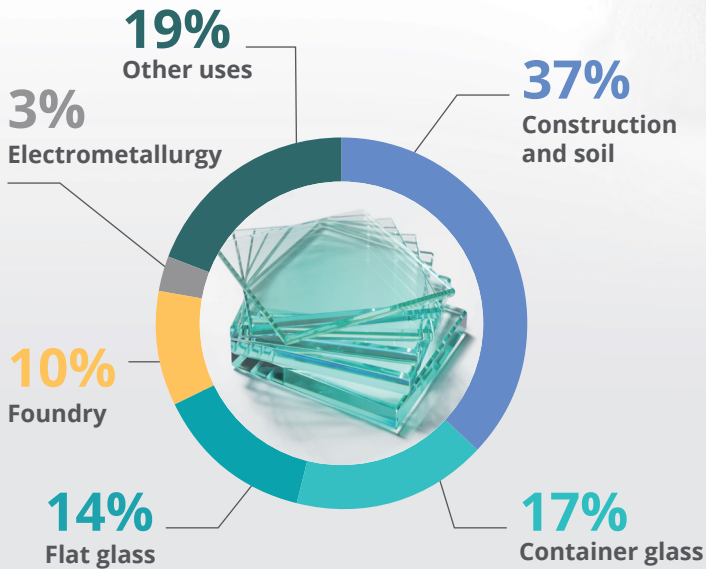
Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

	Lime markets	Application recycling rate	Lime recycling rate
Steel	39%	84%	33%
Environmental applications	17%	90%	15%
Concrete, bricks and mortars and soil stabilisation	17%	74%	13%
Chemistry	8%	53%	4%
Agriculture	2%	100%	2%
Other uses	17%		0%
Total	100%	80%	67%

SILICA

RECYCLING RATES

EUROPEAN SILICA CONSUMPTION BY MARKET



European (EU-28) annual consumption of silica is estimated at around **32 million tonnes**

High grade silica is usually sold as calibrated silica sand (predominantly composed of quartz) but can also be ground into silica flour or converted into cristobalite. Silica is hard, chemically inert and has a high melting point because of the strength of the bonds between the atoms. These are valorised qualities in various industrial uses.

Silica market by use category [IMA Data Collection 2017]

Silica recycling rates by application

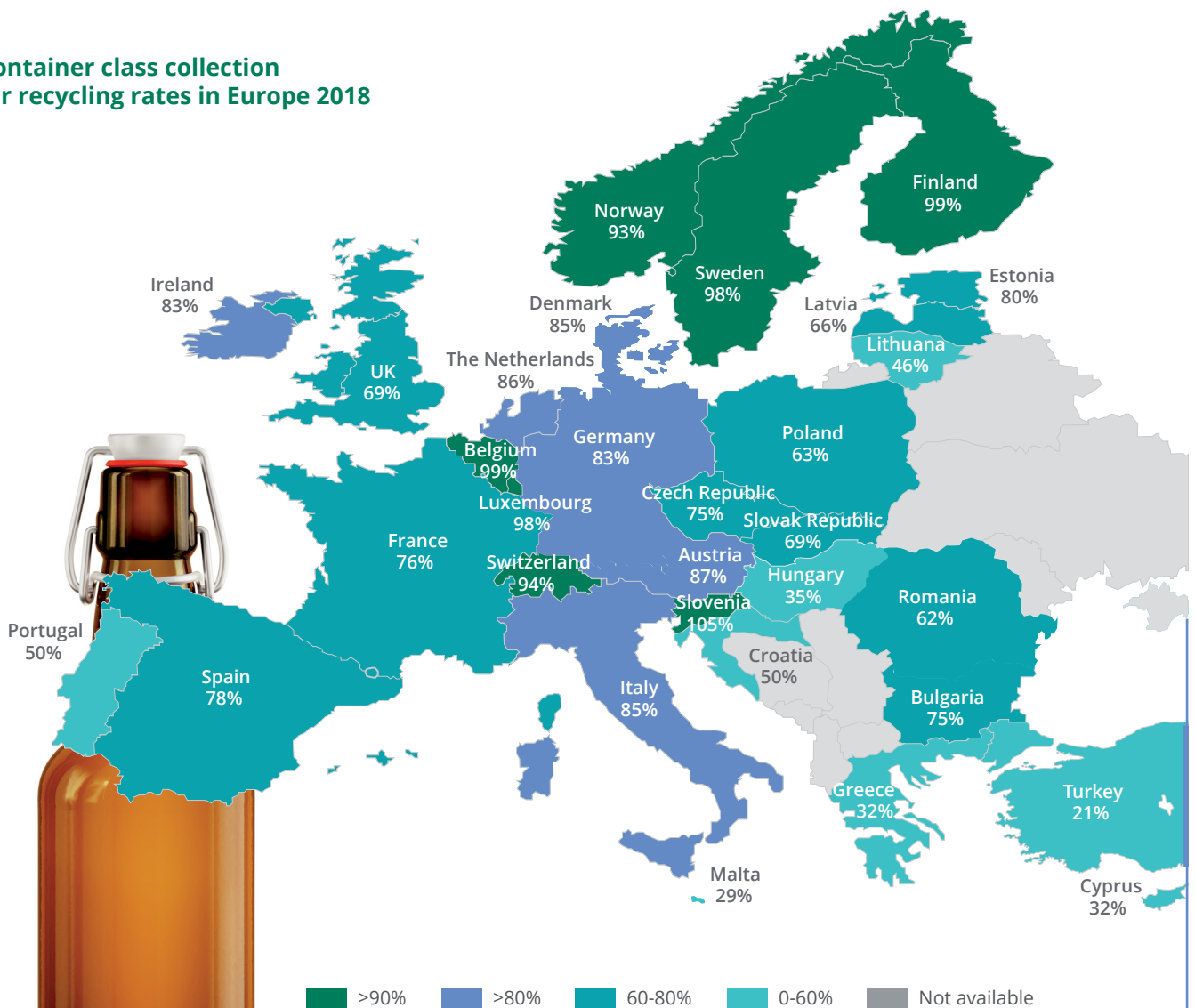
CONSTRUCTION AND SOIL

In the last 4 years, high-end construction or soil application became the leading application for silica sand. The total construction sub-group accounts for 37% of all silica sand applications. This includes both high quality niches and low-end by-products. High quality niches include special mortar mixes, high-end concrete, composite “granite- or marble look” kitchen tops, equestrian surfaces and sports soils. Taken together, these applications constitute a considerable share of the silica sand market, although they are only a small part of the diverse EU “construction sand and aggregates” market consumption. Lower quality silica sand by-products are used in asphalt & road construction. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste containing silica.

Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]



Container class collection for recycling rates in Europe 2018



Ref: Recycling Statistics [Feve 2020]

FLAT GLASS

The quality requirements for flat glass for building, automotive and mirror applications are extremely high. Highly-recyclable end-of-life building glass is almost never recycled into an equivalent value product, despite being a highly valuable material in construction and demolition waste. The variety of building glass and building types creates a major complexity; also, the fact that this type of glass is usually part of a framed window and not a 'stand-alone' product makes separation more difficult. The total recycling rate of flat glass is it therefore estimated at 26%.

Ref: Glass for Europe 2020

CONTAINER GLASS

Silica is the major ingredient in virtually all types of glass which is one of the most environmentally friendly materials. It is infinitely reusable and recyclable. The recycling rate for coloured container glass (green and brown bottles) is above 90%. For white glass packaging, similar to flat glass, the recycling rate depends heavily on the quality of the container or bottle required. On average, the European container glass industry achieved a record 78% recycling rate in 2018 (EU-28).

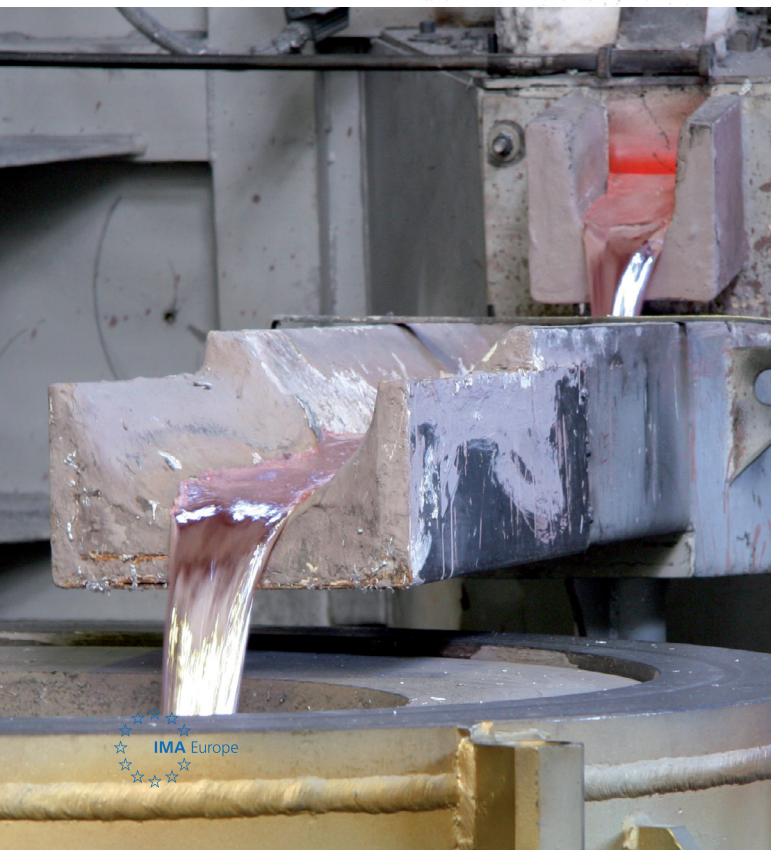
Ref: Feve 2020



FOUNDRY

Crystalline silica has a higher melting point than iron, copper and aluminium. This enables iron, steel or aluminium castings to be produced by pouring molten metal into moulds made out of silica sand and a binder. These end applications are highly recyclable, and therefore their EU recycling rate is estimated around 79%.

*Ref: Steel Recycling [Eurofer 2018],
Recycling Brochure [European Aluminium 2016]*



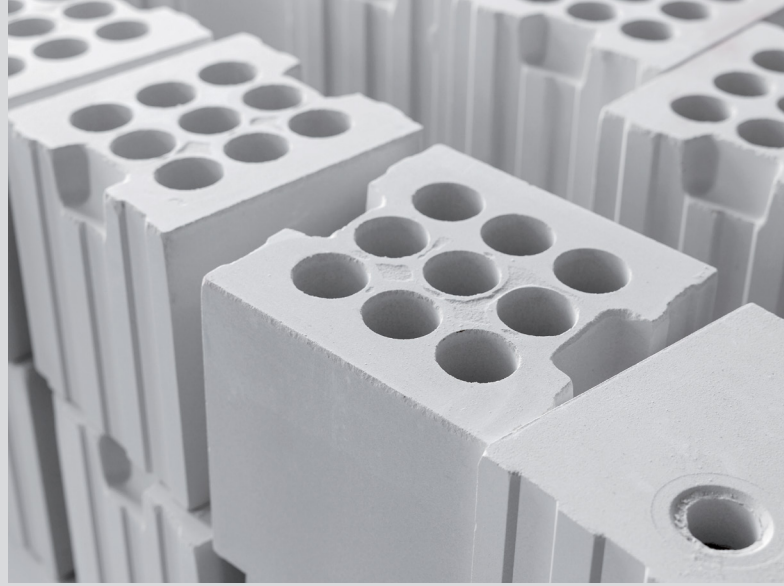
ELECTROMETALLURGY

A considerable amount of silica is used in the electrometallurgy market as raw material for silicon and ferrosilicon production. Nevertheless, we can calculate the recycling rate of only the part used in aluminium and not the total amount of Silica used in metallurgy. The recycling rate of applications containing synthetic amorphous silica or silicon is in fact unknown. Europe enjoys high end of life aluminium recycling rates: over 90% in the construction and automotive sectors and 76% in the packaging sector. From this we can calculate an aluminium average recycling rate of 83%.

*Ref: Recommendations on the Circular Economy package
[European Aluminium 2019]*

OTHER USES

Other uses embrace a broad spectrum of higher value applications such as silicate production, filtration sand, refractory materials, fluidised bed incineration, fillers in paint and plastics, silicon carbide and many more. Because the corresponding tonnage in many of these niche applications is limited, and because quality requirements for these applications are very high, the recycling rate of silica is also limited and a second life is not always possible. Silica in sodium silicate which is transformed into synthetic zeolite used in washing powders or silica flour used in paint formulations cannot be recovered as such but is recycled in the construction industry. These uses have therefore not been factored into results.



Overall recyclability rate of silica

“Based on our current market analysis and estimated recycling rates, we can consider that, **about**

54%

of all silica used is recycled.

As indicated above, this figure is an EU-wide average figure and regional disparities do exist.”

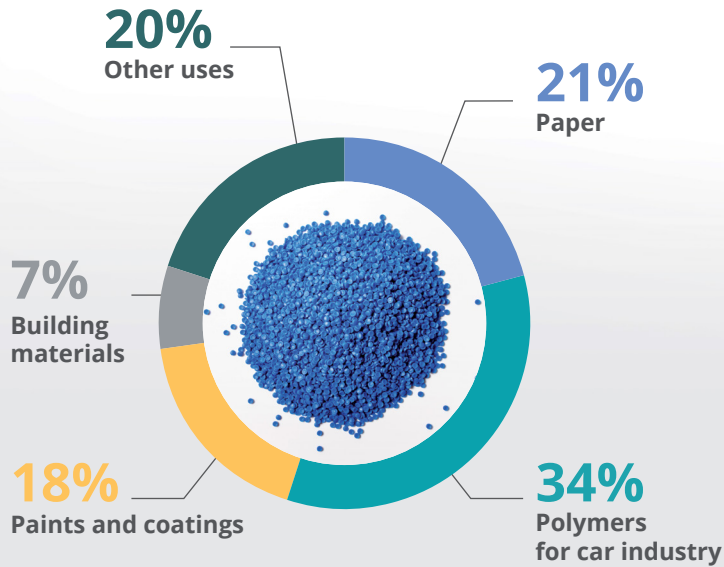
Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

	Silica markets	Application recycling rate	Silica recycling rate
Construction and soil	37%	74%	27%
Container glass	17%	78%	13%
Flat glass	14%	26%	4%
Foundry	10%	79%	8%
Electrometallurgy	3%	83%	2%
Other uses	19%		0%
Total	100%	68%	54%



RECYCLING RATES

EUROPEAN TALC CONSUMPTION BY MARKET



European (EU-28) annual consumption of talc is estimated at around **1.1 million tonnes**

Talc is a hydrated magnesium silicate. It is the world's softest mineral. Talc's properties – platyness, chemical inertness, softness, water repellency and an affinity for organic substances – provide specific functions in a myriad of products and processes. The magazines we read, the plastics in our cars and houses, the paints we use and the floor tiles we walk on are just some of the products that talc brings to life.

Talc market by use category [IMA Data Collection 2017]

Talc recycling rates by application

POLYMERS FOR CAR INDUSTRY

The main polymer market for talc is the automotive sector. Today, most automotive applications comply with EU End-of Life-Vehicle (ELV) Legislation which requires that 95% of vehicle weight must be reused or recycled. Recycled plastics are mainly used for under-the-bonnet automotive parts, arch liners, cable harness plugs, water and sewage pipes, furniture feet, chair arm rests and electric motor housings. Thus, to calculate the talc recycling rate in this application we can use the average recycling rate of end-of-life vehicles in the EU, which is 90%.

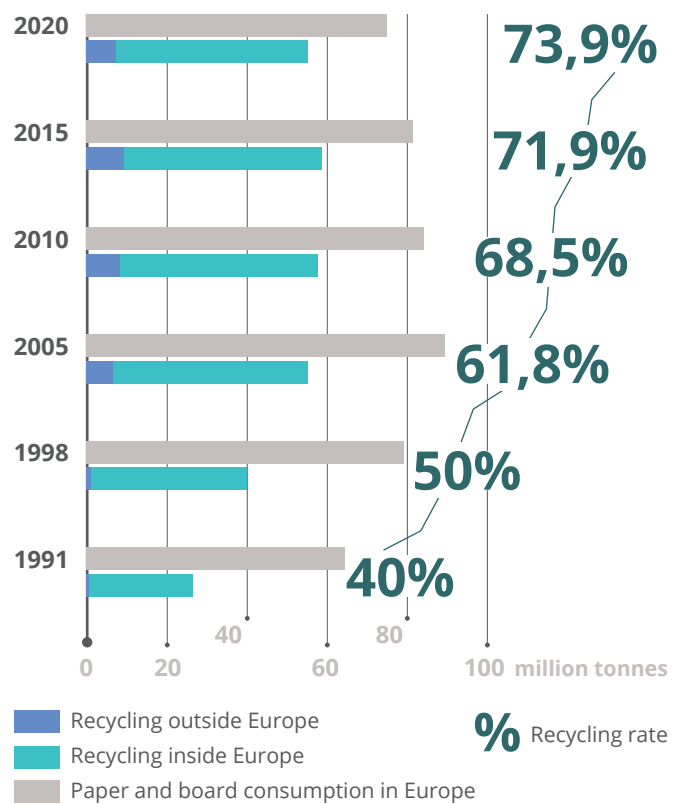
Ref: End-of-life vehicles – reuse, recycling and recovery, totals [Eurostat 2019]

PAPER

Talcs are used in both uncoated and coated rotogravure papers where they enhance printability and reduce surface friction, improving productivity at the paper mill and print house. They also improve mattness and reduce ink scuff in offset papers. In Europe, paper fibres are recycled 3.6 times on average, significantly outperforming the world average of 2.4 times. The recycling rate in Europe increased to 73,9% in 2020.

Ref: Monitoring Report [Cepi 2020]

Recycling of paper in Europe 1991-2020





PAINTS AND COATINGS

Talcs confer a whole range of benefits to coatings. In interior and exterior decorative paints, they act as extenders to improve hiding power and titanium dioxide efficiency. Talc's lamellar platelets make paint easier to apply and improve cracking resistance and sagging. They also enhance matting. Interior and exterior paints, which represent 50-60% of the total amount of paint consumed, are recycled the most, principally in aggregates and other construction materials. Therefore, we can reasonably use the figures of the recycling of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: EU Construction and Demolition Waste Protocol [European Commission 2016], Emerging Challenges of Waste Management in Europe [Trinomics 2020]

OTHER USES

Other uses for talc are diverse and it is difficult to establish recyclability figures. For instance, talc is used for its functional properties as an additive in food or feed, cosmetics, pharmaceuticals or fertilizers. It is therefore entirely consumed with the relevant products and ultimately returned to nature. These uses have therefore not been factored into results.

BUILDING MATERIALS

Talc is a phyllosilicate which imparts a wide range of functions to floor and wall tiles, sanitary-ware, tableware, refractories and technical ceramics. In traditional building ceramics (tiles and sanitaryware), it is used essentially as a flux, enabling firing temperatures and cycles to be reduced. Building material applications are recycled principally through the recycling of construction and demolition materials. Therefore, we can reasonably use the figures of construction and demolition waste and, considering the large disparities in recycling rates in EU countries, an average recycling rate of 74% can be taken for construction and demolition waste.

Ref: EU Construction and Demolition Waste Protocol [European Commission 2016], Emerging Challenges of Waste Management in Europe [Trinomics 2020]

Overall recyclability rate of talc

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Ref: Emerging Challenges of Waste Management in Europe [Trinomics 2020]

	Talcs markets	Application recycling rate	Talcs recycling rate
Paper	21%	74%	16%
Polymer for car industry	34%	90%	31%
Paint and coatings	18%	74%	13%
Building material	7%	74%	5%
Other uses	20%		0%
Total	100%	78%	65%



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