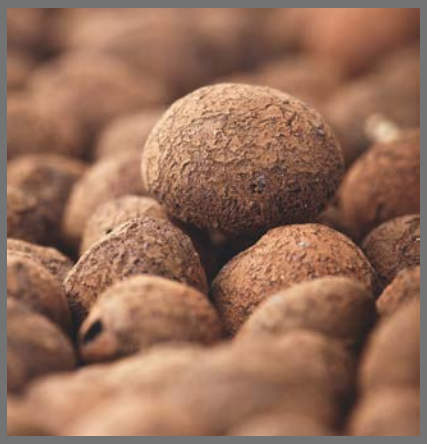
Cerame-Unie The European Ceramic Industry Association



CIRCULAR ECONOMY & SUSTAINABILITY

BEST PRACTICES FROM THE CERAMIC INDUSTRY

Cerame-Unie Aisbl (CU) is the European Ceramic Industry Association. Based in Brussels since 1962, it is the voice of the European ceramic industry to the EU institutions. The European ceramic industry accounts for a total annual turnover of €31 billion and generates over 200,000 direct jobs. The European ceramic industry covers a wide range of products including bricks & roof tiles, clay pipes, wall & floor tiles, refractories, sanitaryware, table- & ornamentalware, technical ceramics, expanded clay and flower pots.

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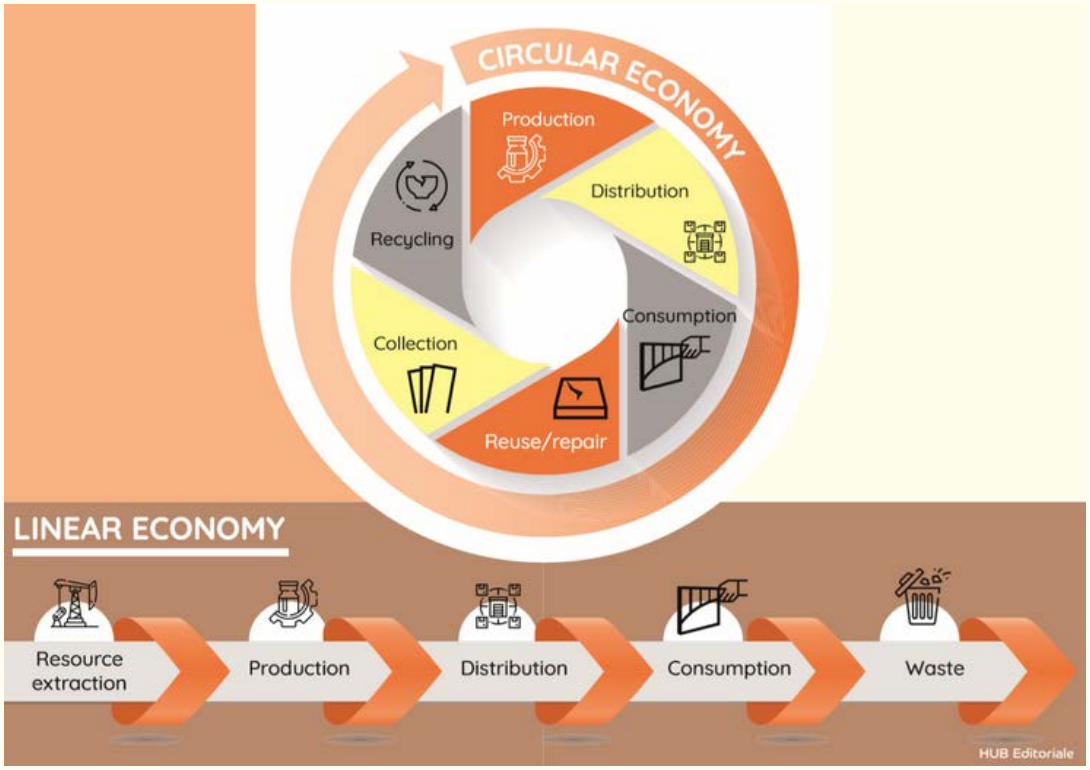
Introduction

The transition from a linear 'produce, use, waste' model to a circular model where resources and materials are reused, recycled or recovered is a high priority topic on the EU political agenda with the adoption of the new Circular Economy Action Plan by the European Commission. **This transition also calls for new business models and encourages the development of innovative solutions in the industry**. Cerame-Unie highlights in this brochure how the ceramic industry contributes to the shift towards circular economy through innovative production processes and sustainable products, However, it is important to mention that **the chemical transformation of clay to ceramics does not allow for a 100% closed loop recycling but rather provides a valuable input for an open loop one**.

Circular Economy in the Ceramic Industry

Resource efficiency is not only about 'using less', but also 'using better'. **Clay is a widely, endless available raw material. Ceramic products are resource efficient and stand out with their high durability thanks to their long lifespan. After the end-of-life stage, ceramic products can be reused, recycled, or recovered.** The ceramic industry has developed innovative solutions with the aim of minimising the raw material consumption and waste generation during the production process, through the reuse of waste from other industrial processes, an optimised raw material selection and product design, and supply chain cooperation in the case of recycling. This brochure features the best practices from each ceramic sector provided by Cerame-Unie members.



BEST PRACTICES IN EACH CERAMIC SECTOR:

BRICKS, TILES, and CLAY PAVERS

Bricks & Clay Blocks

In most European countries, **the use of internal production residues from brick production as a substitute for raw materials is common practice.**
Manufacturers are reintroducing scrap material, such as the dust generated from the grinding of clay blocks, into the raw material mixture for the production of new clay blocks. Some of the pore-forming agents used to optimise thermal insulation properties are secondary raw materials from external organic sources, such as saw dust, rice husks or sunflower seed shells.
Waste content from ash products, hydrocarbons, industrial minerals and minerals can be also recycled into the production process as secondary raw materials.
Broken clay blocks can also be crushed to a defined grain size distribution and used as a light weight aggregate in the production of concrete blocks.

Dry stack systems for facing bricks have also been developed. As the walls can be easily dismantled, main benefit provided by this system is that **bricks are reusable**. Bricks can also be reused when using lime mortar for the brickwork. Brick manufacturers have also developed hanging systems where bricks or brick slips glued on panels are detachably connected to an underlying frame to be easily reused.

Rooftiles

Rooftiles are easy to disassemble and have a very long service life. After the end of life, roofing tiles can be reused as such or recycled in other areas: backfilling in pits and quarries, water-bound cover layer, aggregate for substructure or surface layer in road construction, cover layer of tennis courts and sports fields, vegetation substrate, roofing substrates for green roofs...

Clay Pavers

Ceramic pavers are almost always reused and they even increase in economic value. Clay pavers have a **reuse percentage of at least 90%** and an **average lifespan of 125 years**.

WALL AND FLOOR TILES

A project gathering Spanish manufacturers of ceramic tiles aims at achieving zero-waste in the manufacture of ceramic tiles. A new type of ceramic tile for outdoor application has been developed, incorporating high content of ceramic waste in the body and glaze. Other energy-intensive process wastes (from power plants or glass manufacturing) are also considered. In addition to that, a highly sustainable body preparation process for manufacturing the ceramic tiles has been designed, based on dry milling technologies, capable of recycling all type of ceramic wastes. Achieved results were **20% reduction of waste disposal, 65% saving in water consumption, 30% saving in energy input and 30% reduction in CO2 emissions**.

A project gathering Italian tile manufacturers aims to develop **ceramic tiles made from over 70% and up to 85% recycled materials from urban and industrial wastes** (e.g soda lime glass cullet waste, green scrap tiles generated during the industrial process) in substitution of natural raw materials. The combination of these different wastes enables the production of ceramic tiles with similar or improved mechanical properties with respect to the traditional ones.

A Portuguese manufacturer has created a porcelain stoneware flooring for interior areas, designed following sustainability criteria. This **ceramic tile is removable and reusable** and does not need any glues, cement or specialised workmanship. As the ceramic tile can be reused, the **life span has been extended, leading to less waste production**. It also does not need any complementary products of application by implying reduction of material.

REFRACTORIES

Refractories *are materials designed to withstand very high temperatures. Refractory products are a vital element in all high-temperature processes, such as metals making, the production of cement, petrochemical processes, glass and ceramics.*

In the refractory industry, manufacturers can produce **monolithic refractories and refractory bricks that contain between 20% and 80% of recycled material. Virgin refractory materials can be substituted by recycled material coming from various industries** (e.g iron, steel, metallurgical industries, alumina, ceramic, cement). Materials are then sorted, crushed, dried and possibly milled. These products are tailored to the installation method as well as the application conditions of customers.

As an example, one manufacturer produces refractory bricks for the cement industry that contain up to 55% of recycled material. Based on this composition, a high resistance against alkali attack is achieved, which is often a major issue in the cement manufacturing process. Recycled materials play an important role in the research and development of these products as they have a significant impact on the behaviour and performance of the corresponding monolithic and brick refractories.

SANITARYWARE

In the sanitaryware industry, porcelain shards can be used as by-product materials by the feldspar extractive industry. Porcelain shards are crushed and grinded before being dispatched. Plaster moulds can also be used as by-products by the gypsum extractive industry for quarry restoration or in the production of aggregates. **These processes reduce the use of primary raw materials, decrease pollutants released into the environment due to the extraction of raw materials and save costs**.

A manufacturer from Portugal has created a new material with high incorporation of waste that competes with common stoneware. **This unique material is formulated to reintegrate all the resulting waste from its own processing, as well as part of the waste produced during the processing of chinaware**. Moreover, no additional treatment is required before integration in the sanitary ceramic manufacturing process circuit, since it uses the same means from the preparation of raw material to the final firing, keeping up with the ongoing chinaware workpieces in the production chain.

TABLEWARE

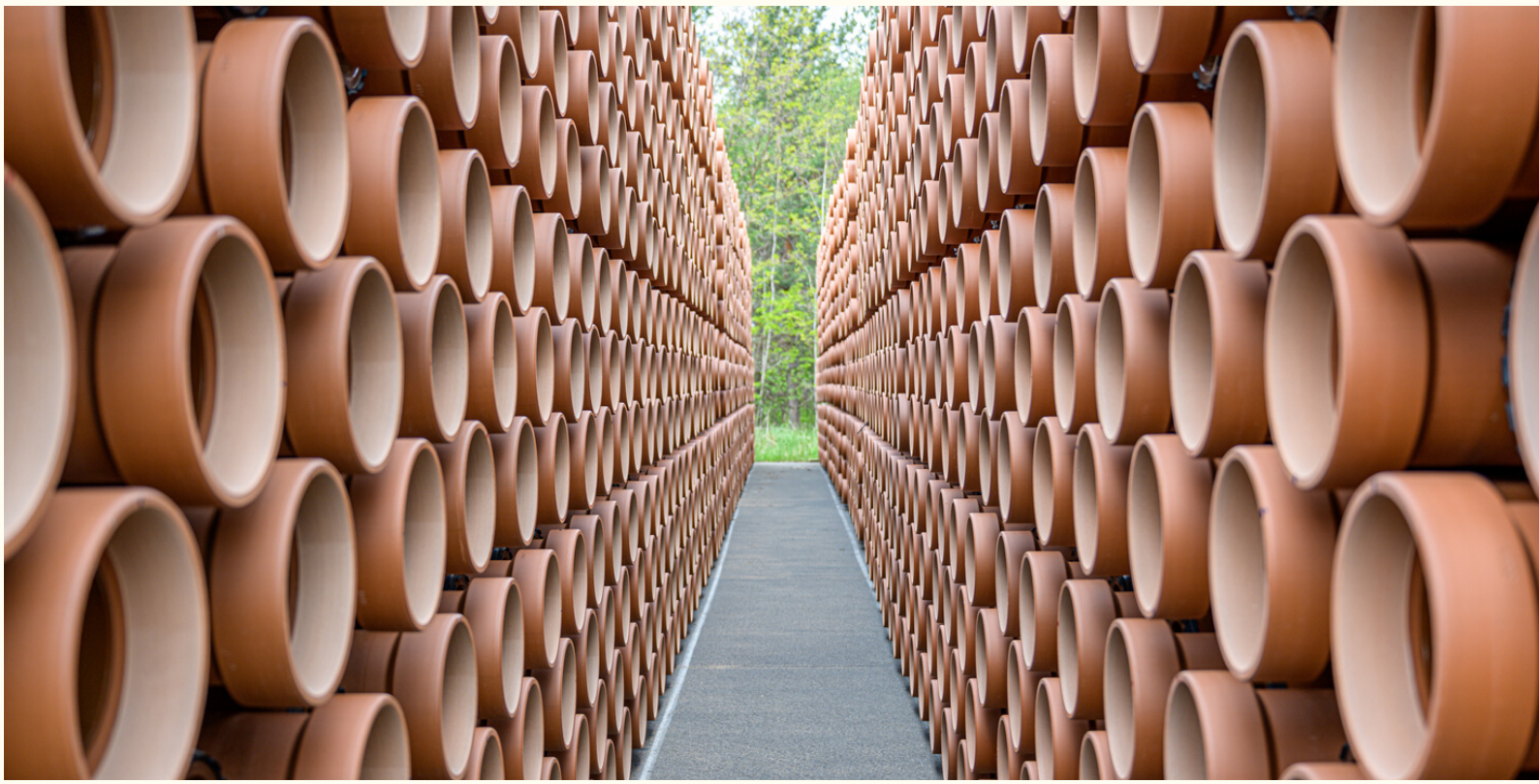
Porcelain tableware of high quality is a durable product that can be used effortlessly for decades. As ceramic is inert at temperatures below 200° C, ceramic tableware products can be washed for a very high number of times without any visible changes. Due to their specific properties (e.g. hand-painted porcelain, porcelain with precious metals), artistically high quality tableware products should be washed more gently by hand.

In the tableware industry, **most manufacturers are developing solutions to reintroduce processed water and material residue in the production process**. A French manufacturer is producing recycled household goods made from a natural paste formed by treating mineral materials and manufacturing sludge, recycling up to 25% of their industrial residue. A manufacturer from Germany recovers up to 98% of solid material residue (unfired and fired porcelain mass), reintroduced as secondary raw material in the porcelain production process. Water used in the manufacturing process is also treated and reincorporated in the production process by using a combination of process optimisation measures and sewage treatment systems. As shown in the figure on the left, a manufacturer from Italy is following this practice as processed water and material waste are reused to produce their tableware. Material waste that cannot be recycled is delivered to an external recycling plant. A Spanish manufacturer is also recycling ceramic food packaging products to powder that can be used for road and pathway construction among other. The ceramic food packaging can also be used for other purposes (e.g. table- and kitchen-ware, pencil cubes or flower pots).

EXPANDED CLAY

Expanded clay *is a lightweight aggregate that is produced from natural clay. It is suitable for a wide range of applications in the construction sector, such as housing and infrastructure. It can be used in green applications such as in hydro-culture and technological applications (water treatments, roofgardens).*

In the expanded clay industry, up to 90% of the product can be reused. It is also resource efficient as 1m³ of natural clay will result in about 4m³ of expanded clay. **Up to 100% of expansion clay additives and 10-15% of virgin clay can be replaced by alternative materials** derived from other industry sectors. Manufacturers of expanded clay use waste as additives or fuels, hence reducing the need for virgin raw material. As an example, a Belgian manufacturer uses iron oxides coming from the steel industry as additives. This iron oxide is needed in the bloating process as the boom clay does not have chemical properties that could make the expansion possible as well as providing support to reduce the energy in the overall process. Such additives come from oil refineries, vegetable oil producers, bio-diesel, steel production or treatment, industrial and municipal waste water cleaning, mineral wool and other types of wastes.



CLAY PIPES

In the vitrified clay pipes industry, a manufacturer is producing **clay pipes which are 100% recyclable, consist of about 40% secondary raw materials on average and have a service life of more than 100 years**. The minimum share of external recycled content in the raw materials used has been increased, on average, over 20%. Scrapped content from other clay productions such as tiles and sanitaryware can be used as secondary raw materials. The internal recycled content from scrap and auxiliary materials leads to a total recycled content of over 60% at maximum. The non-conform products (scrap) that didn´t pass the quality check at the dryer or the kiln are crushed and used as raw material again. This also applies for auxiliary ceramic materials that used to support the pipes in the kiln and for cut-off material. **The use of secondary raw materials leads to less scrap during the production due to an increased resilience and also reduces energy consumption in production**. The circularity of the process from mining clay to recycling of vitrified clay has also been optimised with the cradle-to-cradle® certification process.

GLOSSARY

- **Aggregate -** A material or structure formed from a mass of fragments or particles loosely compacted together
- **Auxiliary materials -** Auxiliary materials are used for production maintenance needs and are not part of production output
- **Ceramics -** Inorganic materials, made out of non-metallic components, not all including clay, and which become permanent after a firing process
- **Circular Economy -** A circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste
- **Cradle-to-cradle® -** During the design process everything is planned from the start to ensure that nothing ends up as garbage. Each component continues its service, becoming a raw material for another new product in a system that profits industry, the economy and consumers alike
- **Feldspar -** a mineral containing varying amounts of potassium, sodium and calcium. In ceramics, it acts as a flux and provides the vitreous luster of chinaware and ceramic tiles
- **Manufacturing sludge -** waste from water and/or run-off that originates from the manufacturing process
- **Monolithic Refractories -** All unshaped refractory products, these heat-resistant materials can be molded or can be given any shape as per requirement
- **Porcelain Shards -** piece or fragment of porcelain
- **Quarry Restoration -** The extraction of clay is a temporary land use. Once quarrying has finished the land can be 'recycled' or reused through restoration. Restoration involves returning the land to its original use. New land uses can also be created.
- **Raw Materials -** Basic substance used as an input to a production process for subsequent modification or transformation into a finished product. In the ceramic industry, clay is used as raw material
- **Scrap -** piece or fragment
- **Secondary Raw Materials -** Secondary raw materials are recycled materials that can be used in manufacturing processes instead of or alongside virgin raw materials. The use of secondary raw materials presents a number of advantages, including reduced material and energy use, reduced impacts on the climate and the environment

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