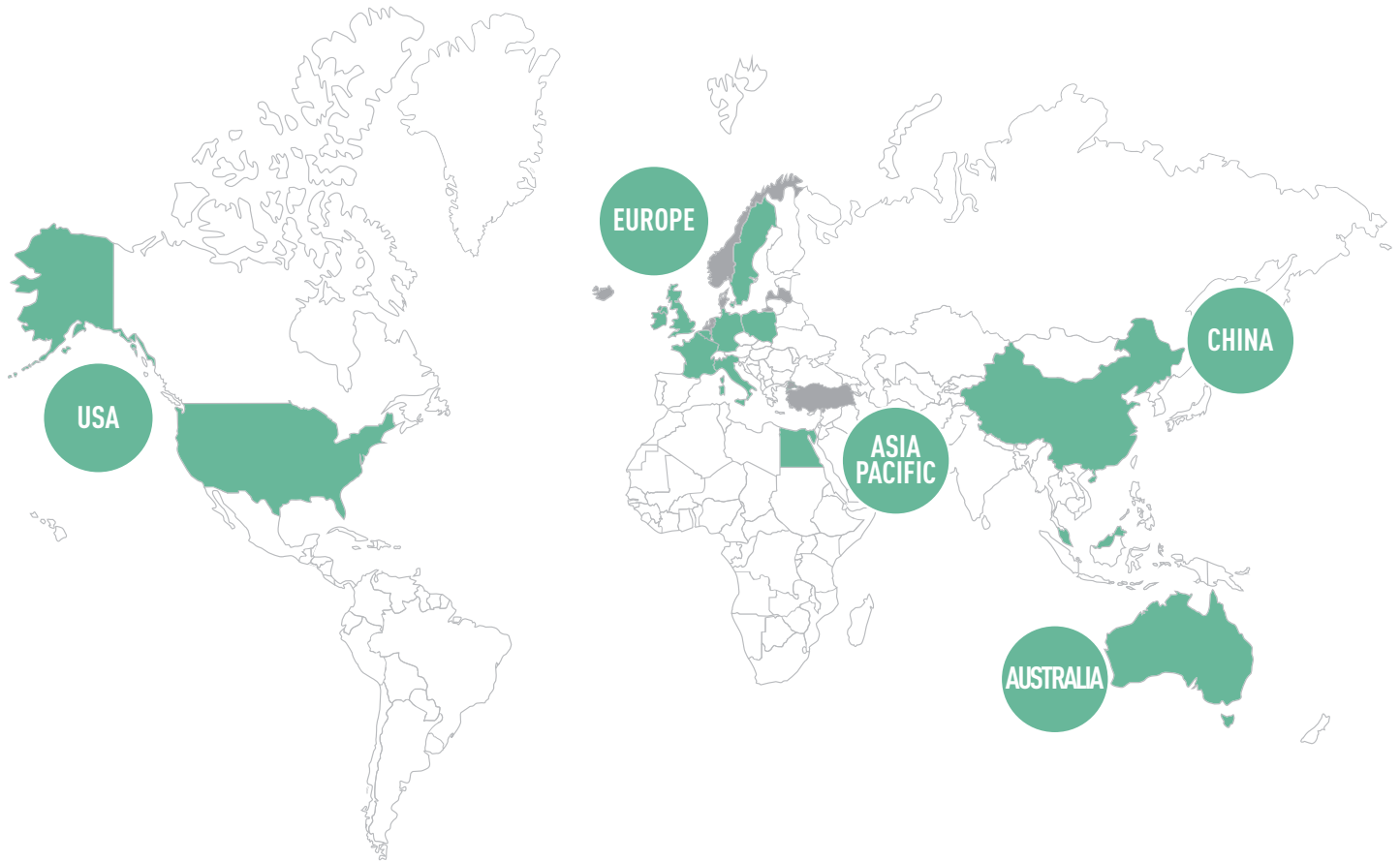


## LEADER IN WHITE CEMENT

The Cementir Group is the world's leading producer and exporter of white cement, with a 27% share of worldwide trade and a production capacity of over 3 million tons. With the Aalborg White® brand we are the leader in China, the United States, Western Europe, Australia, Malaysia and Egypt.



Aalborg White® has always been identified with white cement, throughout the world. It is a pure, high-quality cement that can be found everywhere from Park Avenue skyscrapers in Manhattan, to the London Olympics structures and even the Lindholm Høje Museum in Nørresundby, Denmark<sup>3</sup>.

The distinctive features of white cement are its colour and high levels of performance. The white colour is obtained through the use of highly pure and carefully selected raw materials, the use of complex production processes and an extremely rigorous quality control process which allow this material to be used in complex architectural designs and sophisticated aesthetic applications.

What is special about the limestone used for manufacturing Aalborg White® is the lack of contamination from sand and clay, which makes it very pure and ideal for the production of white cement. The combination of this pure raw material, high-quality sands and kaolin, advanced technology, a specialised workforce and over 100 years of experience have made Aalborg White® cement unique in the world for its properties such as high reflection, high mechanical performance, low alkali content and high resistance to sulphates. As the world leader in the white cement market with the Aalborg White® brand, Cementir offers a wide product range which meet the strictest international standards. Our industrial processes are inspired by the Group's consolidated best practices that guarantee our customers a unique level of quality and reliability over time. Our research quality technical centre (RQT) has a worldwide reputation for international patents, awards and multiple collaborations with prestigious universities.

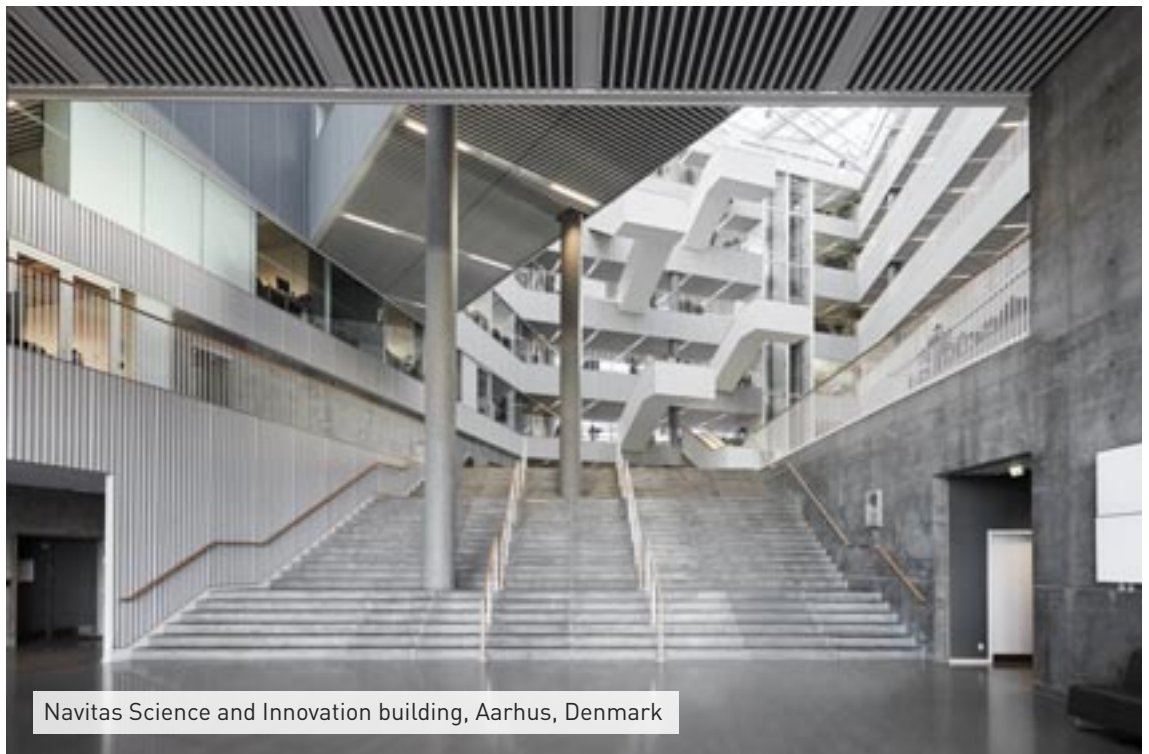
<sup>3</sup>Please see Projects | Cementir Holding N.V. for the main applications of our cements.

## DIFFERENCE BETWEEN GREY AND WHITE CEMENT

White and grey cement are two distinct products, with different applications and production methods. White cement should therefore be viewed as a separate product for the following reasons:

- White cement is mainly used for high-performance applications, dry-mix products, mortars, special products and decorative purposes. Grey cement is widely used in ready mixed concrete as well as precast concrete. White cement supports the development of future sustainable cement-based technologies and products, responding to megatrends in construction such as the circular economy where, among others, enhanced durability, modularisation of construction, reduced work processes and reduced material usage, are essential.
- White cement is a specialty product produced at a limited number of facilities and traded widely across borders inside and outside of the EU, as well as internally within Europe. Grey cement is a commodity which is often used close to the production site.
- White cement applications have a number of benefits related to climate change.
  - The light colour reflects sunlight and thus reduces the 'heat island effect' in cities as well as the need for artificial cooling in buildings. White surfaces also reduce the need for lighting in tunnels.
  - The chemical purity of white cement, as a result of the refined raw materials used and strict production process management, enables the growth of unique, low-carbon concrete solutions and products such as high- and ultra-high-performance concrete and glass fibre-reinforced concrete, where the usage of material is minimised to unprecedented levels (large cladding and structural wall components reduced to as little as 12 to 35 mm in thickness). These technologies are essential for efforts to reduce clinker consumption in buildings, by minimising material consumption.

The many differences are summarised in the table on the next page.



Navitas Science and Innovation building, Aarhus, Denmark

	White cement	Grey cement
Applications (est. % of cement consumption by segment in Europe)	<ul style="list-style-type: none"> <li>• Dry mix/mortars/specialty products (50-70%) <ul style="list-style-type: none"> <li>- Cement-based paint</li> <li>- Plaster</li> <li>- Grout, putty</li> <li>- Decorative concrete panels</li> <li>- Sealing products</li> </ul> </li> <li>• Bricks, blocks and tiles (20-30%) <ul style="list-style-type: none"> <li>- Terrazzo (up to 15% in Mediterranean countries)</li> <li>- Decorative bricks and tiles</li> </ul> </li> <li>• In-situ and pre-cast concrete (10-20%) <ul style="list-style-type: none"> <li>- Facade elements</li> <li>- Iconic buildings and other aesthetic applications</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Ready mixed and pre-cast concrete (55-65%) <ul style="list-style-type: none"> <li>- Mass concrete for infrastructure works: dams, harbours, bridges, tunnels, culverts, road surfaces</li> <li>- Housing and industrial buildings</li> </ul> </li> <li>• Bricks, blocks and tiles (30-40%) <ul style="list-style-type: none"> <li>- Pipes</li> <li>- Paving stones, kerbs</li> <li>- Roofing tiles</li> </ul> </li> <li>• Dry mix/mortars and other applications (5-10%)</li> </ul>
Market position	Niche product	Commodity product
Raw materials	<ul style="list-style-type: none"> <li>• High grade, iron-poor chalk, limestone or marble</li> <li>• Kaolin, bauxite</li> <li>• Iron-poor sand (quartz sand, shifting sand, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• Locally available limestone or marl</li> <li>• Clay, shale, fly ash</li> <li>• Low-grade sand</li> <li>• Iron oxide, pyrite ash</li> </ul>

**Fig. 1:** Examples of grey cement applications.



(a): Concrete pipes



(b): In-situ cast concrete for a road bridge



(c): Pre-cast concrete elements for a multi-storey dwelling

## MARKET DIFFERENTIATION BETWEEN WHITE AND GREY CEMENT



Ultra-high performance concrete, He Fei Wan Ke Cultural Central Park, China

### High and ultra-high-performance concrete, and glass fibre-reinforced concrete

Responding to the megatrends in construction such as fast-rise, mass-customisation, the circular economy, maximised energy efficiency, minimising on-site operations, maximising performance and durability at reduced material consumption, etc., advanced technologies previously regarded as 'unnecessary' are rapidly growing in terms of applications and volumes, providing unique value propositions. These are empowered by the purity and high performance of white cement and bringing solutions to the market with unprecedented performance.



White and coloured mortars

### White and coloured mortars

Cement-based plasters and mortars are used for covering facades, swimming pools and in general to reduce painting requirements, and maximising possibilities in terms of surface texture and expression. Because of its high durability, much less maintenance is needed than painted surfaces. White cement is usually a key ingredient.



Tile adhesive

### Renders, joint fillers and tile adhesives

The complex formulation of these construction materials is usually based on white cement thanks to its high performance.



Exterior facade panels and decorative coating stones, Belgium

### Exterior facade panels and decorative coating stones

White cement is also used in products such as floor tiles, kerbstones and prefabricated stairs, balconies and windowsills. Additionally, applications such as white briquette and white press brick, concrete grids and pool edges are also areas of use.



Works of art and street furniture

### Works of art and street furniture

Concrete sculptures, monuments and the restoration of archaeological sites are usually made or carried out using white cement, leveraging its whiteness as well as high performance.



Pre-cast and concrete elements, Coudrey house, Australia

### Pre-cast and concrete elements

Use of white cement is a more durable alternative than paint in applications where colours are required. Furthermore, white cement, thanks to its high early strengths, allows fast production speed in concrete and prefabricated applications, resulting in costs reductions. It has been used in iconic buildings and remarkable public constructions (bridges, railway stations, stadiums, etc.).



Terrazzo and artificial stones

### Terrazzo and artificial stones

In the production of terrazzo, artificial stones and marble, the external-coloured layer is a fine white cement-based mixture that may have coloured pigments added to it. Bright colours can be achieved only by using white cement and the production of coloured terrazzo would be impossible without it.

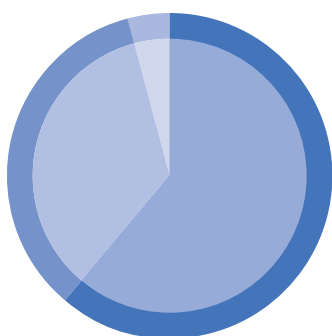
## Markets

The different applications for white and grey cement are reflected in the estimated market segments for the two products (Fig. 2). The product applications are also different within the segments, for example terrazzo being a major component in the 'brick, blocks and tiles' segment for white cement, whereas concrete pipes and paving stones comprise a large portion of the same segment for grey cement.

**Fig. 2:** Estimated market segments for white and grey cement<sup>4</sup>.

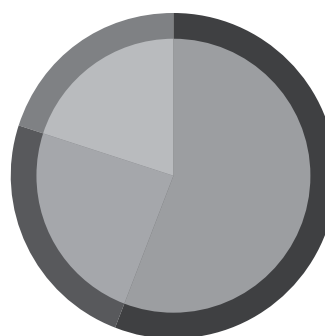
### White

Pre cast concrete  
35% ●  
Ready-mix concrete  
4% ●  
Others  
62% ●



### Grey

Pre cast concrete  
20% ●  
Ready-mix concrete  
56% ●  
Others  
24% ●



## Trade

Grey cement is a commodity product, manufactured at many locations close to the market. On the other hand, white cement is a high-value product which is produced at relatively few, dedicated plants located close to the appropriate raw materials. White cement is therefore traded across borders to a much greater extent than grey.

<sup>4</sup> For white, the dry-mix segment has the lion's share in the 'others' group.

## EFFECT OF WHITE CEMENT ON GLOBAL WARMING AND HUMAN SAFETY

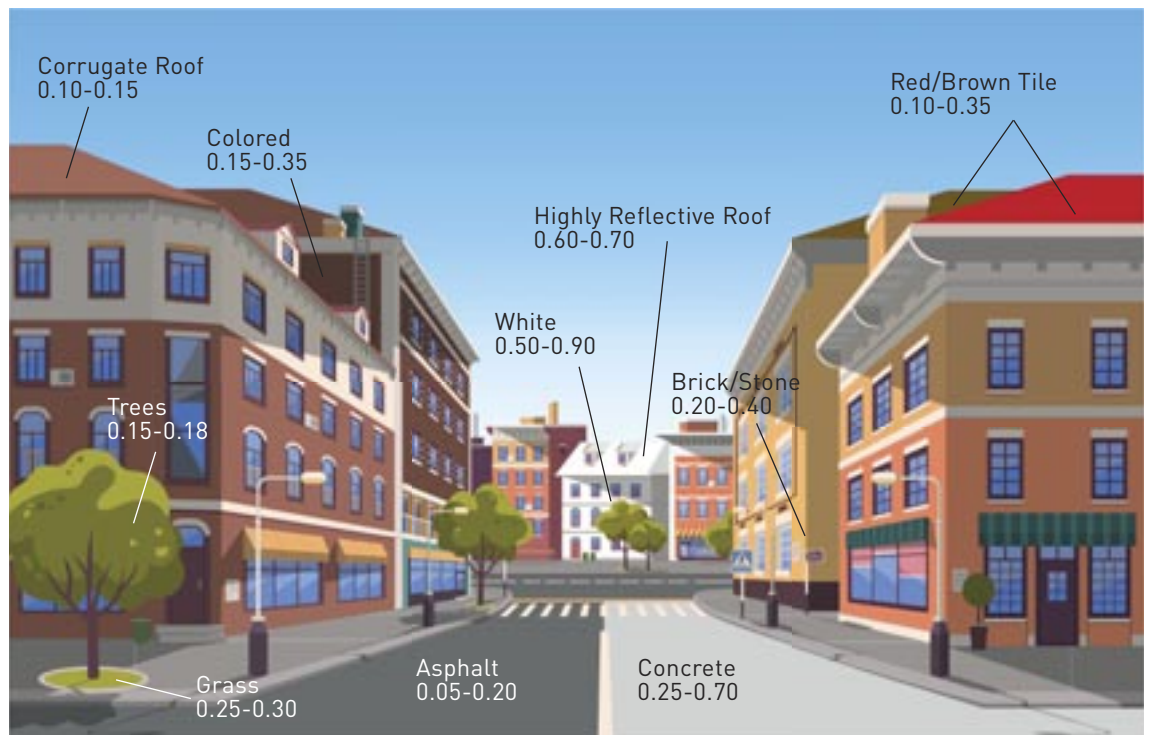
Light-coloured surfaces reflect much more sunlight than dark-coloured surfaces. Providing more reflective surfaces, such as light-coloured roofs, walls and pavements, therefore results in more energy reflected back into space, resulting in less warming.

Locally, this effect is especially significant in cities which tend to become unbearably hot during the summer. Substituting dark roofs, walls and pavements with white ones significantly reduces this 'heat island effect'.

Furthermore, it is estimated that 40% of the total energy consumed around the world is used in building air conditioning. This energy consumption can be reduced significantly by lighter colouration of the facades and roofs of buildings. This way, more solar energy will be reflected and the temperature inside the buildings will drop, reducing the need for air conditioning. Recent studies have shown that an increase in the albedo (measure of the fraction of reflected incident sunlight) of urban surfaces could save, in the US alone, energy with an economic cost up to \$3 billion and reduce the global temperature by 0.01°C each year (Akbari et al., 2006). Applying the same methodology as used in Akbari's study to buildings, the energy consumption of a building according to the colour of the facade can be estimated. The result indicates that the CO<sub>2</sub> savings from using white concrete walls in constructing an office building with the dimensions 15 x 15 x 20 m would be approximately 27 tons annually (see Annex C). Assuming that 28 tons of white cement is used for the building and that the CO<sub>2</sub> emission associated with this production is 1.2 tons CO<sub>2</sub> per ton of white cement, the CO<sub>2</sub> savings will be greater than the emissions associated with the cement production in under two years.

**Providing more reflective surfaces, such as light-coloured roofs, walls and pavements, therefore results in more energy reflected back into space, resulting in less warming**

**Fig. 3:** Illustration of the albedo effect.





Another area where the use of white cement products is beneficial is in tunnels and industrial warehouses, where increased reflection will result in significant energy savings in artificial lighting. White cement plaster, panels or floorings strongly reduce the need for artificial lighting, reducing the need for electricity for this purpose (Fig. 4).



Fig. 4: Application of white cement-based panels reduces need for lighting in an underground tunnel

White cement has an important use in road barriers, sound barriers and other road equipment, where the white colour increases visibility. This is especially significant under wet conditions, where grey concrete road barriers will appear almost black (Fig. 5). Painting grey road barriers white is not a safe option, as the paint will wear off and frequent repainting (which rarely happens) is necessary (Fig. 6).



Fig. 5: Concrete road barriers made using grey and white cement, respectively, illustrating the improved visibility of white concrete under wet conditions



Fig. 6: Grey concrete road barriers painted white. This illustrates the safety hazard and additional costs needed for repainting the road barriers

## GREY CEMENT

Cementir produces and distributes all types of grey cement, which are classified by type (based on the composition of clinker and other constituents such as blast furnace slag, microsilica, pozzolana, ash, calcined shale, limestone and secondary ingredients) and by class based on mechanical compressive strengths.

All the products follow rigorous industrial processes and Group consolidated best practices in order to guarantee consistent quality to our customers over time.

The wide range of cement offered allows customers to fulfil all the requirements for the different durability classes in concrete as well as to meet the needs of their production processes.

Since 2021, Cementir Holding, leveraging on its patented technology – FUTURECEM® has been producing limestone calcined clay cement in Denmark and Belgium, being at the forefront of this innovative technology.

## INWHITE®

The Cementir Group established a global innovation engine for white cement, InWhite®, with the purpose of generating a prioritised and actionable pipeline of high potential customer value proposition global initiatives, bringing new solutions for well-known applications, or completely new applications for white cement-based products, aligned with megatrends detected in society, such as customisation, the circular economy and high-energy efficient solutions. The InWhite® process benefits from the Group's global knowledge on both well-established and emerging applications for white cement and the technical expertise of its internationally acclaimed R&D centre located in Aalborg, Denmark. Aalborg InWhite Solution® has become the umbrella brand for commercialised high-added value and high-performing products like UHPC (Ultra High-Performance Concrete), 3D Concrete Printing and others, identified and developed under InWhite® initiatives, that Cementir Holding will provide to the building industry. Within its innovation pipeline, under InWhite®, in late 2019 the Cementir Group launched innovative UHPC pre-mixes Aalborg Extreme® for infrastructure applications and Aalborg Exce® for more aesthetic and sophisticated applications. In order to meet customer's needs for low-carbon solutions, InBind, a highly customised binder solution for UHPC applications was launched in 2022, while ReCover, UHPC for bridge overlay and for industrial and residential flooring, is planned for launch on the market in 2023/2024.

All InWhite® products are based on FUTURECEM® technology.

## PRODUCTION OF READY-MIXED CONCRETE

In 2022, Cementir Holding produced and distributed 4.8 million cubic metres of ready-mix concrete of all types and classes. Ready-mix concrete is widely used in construction and is made of a mixture of cement and aggregates like sand, gravel, water and any additives. The aggregates serve as bulk, while the cement, reacting chemically with water, serves to bond the other elements. In some cases, admixtures of various kinds are diluted in water and added to obtain specific results or performances, for example greater fluidity or rapid setting.

Ready-mix concrete is made and pre-packed in plants known as concrete mixing plants where the mixture is dosed in special equipment. The mixing stage may take place directly at the plant (using premixers) or during transport using special vehicles (mixer trucks) that continuously mix the product so that it maintains its fluidity, which is essential for building work. When the ready-mix concrete reaches the building site, it is ready for use, i.e., the 'pouring' phase. Often, before being 'poured', the ready-mix concrete is subjected to a special process known as 'pumping'. This consists of a second transport phase through piping, which makes it much easier to reach elevated heights to form floor slabs, tunnels, etc.