



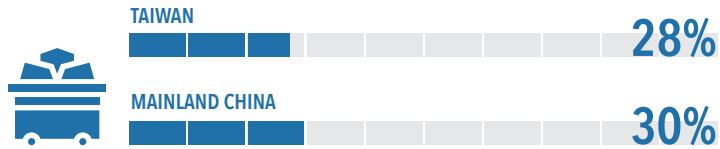
# 03

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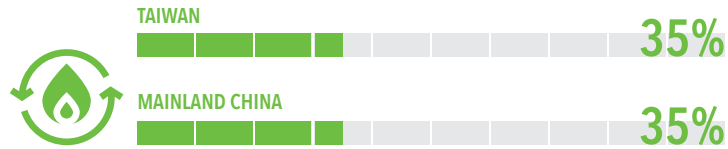
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**TARGETS**

**Ratio of Alternative Raw Materials | 2025**



**The Thermal Substitution Rate (TSR) of Alternative Fuels | 2025**



**Certified to the Highest Level of BS 8001 Circular Economy**

**2022 PERFORMANCE HIGHLIGHTS**

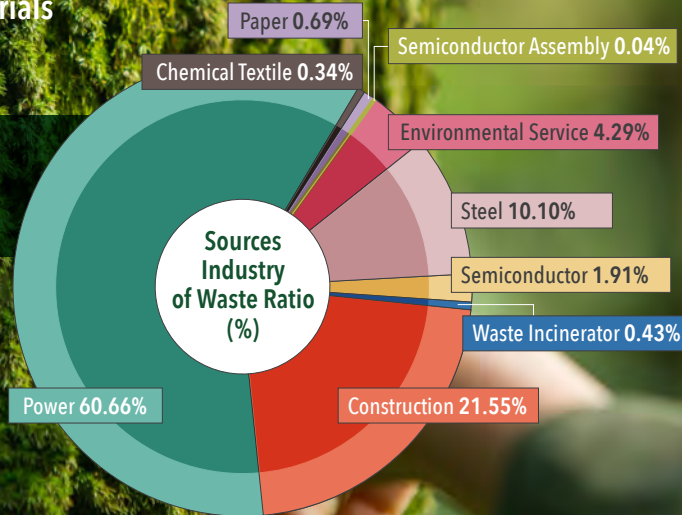
**Resource Recycling**

Reuse per metric ton of cement  
**24.27%**

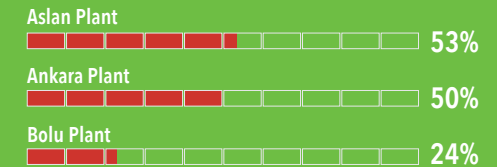
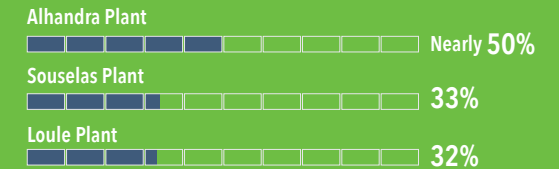
Ratio of alternative raw materials  
**23%**

Total carbon reduced  
**135,573** metric tons CO<sub>2e</sub>

Wastes treated for industries  
**110.1** million metric tons  
Equivalent to the total amount of industrial waste in Taiwan  
**5.3%**



**Thermal substitution rate of alternative fuels**



Recycle with Peace (Hoping) Now!  
Carbon reduction

**1,970.94** KG





### 3.1/ Special Column **TCC DAKA Renewable Resource Recycling Center (RRRC): World-class Iconic Green Building**

#### POLICY

TCC aims to increase resource use efficiency and promote sustainable use of Earth's resources by utilizing environmentally friendly recycled materials.



**a&d** AWARDS  
2021

#### Gold Award of A&D Awards Application for Green Building and Low-carbon Building Certifications

TCC DAKA RRRC received the Gold Award of 2021 A&D Awards with its MIXED USE design of future city, following the contour of the Heping Village ecological valley, with the upper and middle parts of the structure overlapping in an elliptical shape, resembling the movement of celestial bodies in the universe. RRRC shall receive green building and low-carbon building certifications, fostering mutual benefits among the building, environment, and society.

#### Milestone of Circular Economy Co-processing of Domestic Waste with Cement Kilns, First in Taiwan

TCC DAKA Phase II Environmental Landmark Building—TCC DAKA Renewable Resource Recycling Center (hereinafter “RRRC”) is to engage trial run in Q3 of 2023 and officially complete its construction in 2024. RRRC shall address Hualien City's waste crisis and handle 200 metric tons of waste daily. This will prevent methane pollution from garbage piles, which is equivalent to an annual carbon reduction of 40,000 metric tons. The energy generated from processing the waste can also replace

certain portion of fuels, leading to waste and carbon reduction benefits. RRRC will also become the first in Taiwan to use cement kilns for co-processing domestic waste at high temperatures, and achieve carbon reduction through recycling. TCC does not prioritize profit-making and has invested over NT\$40 billion. RRRC has been planned by one of the world's top ten design firms, KPF, and utilizes the most advanced design for the equipment from Kawasaki Heavy Industries in Japan.

**World-class Advanced Technology & Equipment | Enjoy Coffee and the Pacific**

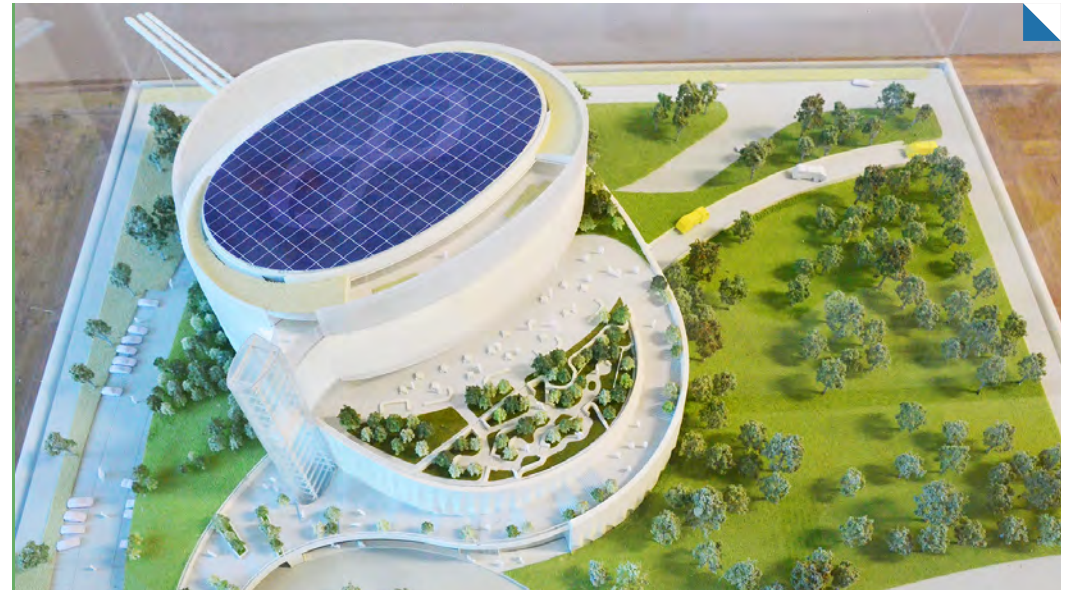
The co-processing of waste in cement kilns is a highly scientific, efficient and environmentally-friendly method. As the kiln reaches 1,300°C at the process, it minimizes residue production and can eliminate toxic substances like dioxin. Through advanced gasification and the unique characteristics of cement kilns, waste materials can be stabilized in cement clinkers. The facility promises zero odor and smell and visitors can enjoy coffee with a view of the Pacific. TCC aims for the garbage processing venue to be in harmony with the environment and welcoming to residents and visitors alike.

**From Protested to Trusted by the Local | Inclusivity and Co-benefit between Industry and Community**

Starting from 2019, TCC has been involved in the "BOO (Build-Own-Operate) Project for Co-processing Waste in Cement Kilns" initiated by the Hualien County Government. TCC attended local forums, briefings, expert group meetings, and environmental impact assessment (EIA) meetings successively as well as communicated with the residents from the villages in the neighborhood through home visit and other forms. Many residents gradually went through the process from protesting and not understanding to consensus and willingness to work with TCC together to build the Heping Village into an iconic green community.



The RRRC project showcases the application breakthroughs of engineering materials performance by using green construction materials and ultra-high-performance concrete (UHPC) produced by TCC. ▲



**TCC DAKA Renewable Resource Recycling Center—World Garden, Mine Rock Garden, and Ferns Garden**

Dr. Cecilia Koo Botanic Conservation Center (KBCC) planned to work with TCC DAKA RRRC to build World Garden, Mine Rock Garden, and Ferns Garden on the platforms of 20 and 35 meters high. Aside from the primary focus of world plants conservation in World Garden, Mine Rock Garden and Ferns Garden will present the biodiversity of plants in mines and serve the function of ex situ conservation.

At present, plants like Taiwan urn orchid (*Bletilla formosana* (Hayata) Schltr.), Formosana begonia (*Begonia formosana* (Hayata) Masam.), and Taiwan hortensia (*Hydrangea longifolia* Hayata) have been included in the cultivation project successively. New sapling nursery has also been created in the mine to care for seedlings in the future. It serves the purpose of sapling production, ex situ conservation, and popular science education as well. It has conserved over 1,000 plants of 30 species thus far and aims to collect over 300 species of plants local to mines in the future. TCC plans to offer guided tours to enable more people to appreciate the natural beauty of mine ecology.



### 3.2 / Alternative Fuels & Raw Materials

**MANAGEMENT APPROACH**

TCC prioritizes natural resource and energy consumption issues by developing alternative fuels and raw materials, and establishing annual product energy consumption indicators for coal and electricity to avoid unnecessary resource consumption.

The Global Cement and Concrete Association (GCCA) pointed out that alternative fuels & raw materials are vital for sustainable transition of cement industry. Through the circular economy model, TCC will not just reduce carbon emissions and natural resource usage, but further resolve waste issues for society and enterprises, bringing about synergy of circular economy.

#### 1,300°C High Temperature of Cement Kiln Core Power of Circular Economy

The co-processing with cement kiln is the core competence of the cement industry. It is hailed as the venous industry of circular economy, which can achieve neutralization and recovery of wastes for reuse. According to the World Business Council for Sustainable Development (WBCSD), the average temperature of over 1,300°C of cement kiln can break down dioxin and turn waste into renewable resources to substitute raw materials and fuels for cement, reducing carbon emissions and fossil fuels.

### TCC Circular Economy Model





Uses of Alternative Fuels at TCC

Alternative Fuel	Status
Waste textiles & used clothes	In use
Discarded Tetra Pak and meal boxes, and waste paper	In use
Waste plastics	In use
Waste wood chips	In use
Construction waste	In use
Spent mushroom compost bulk bag	
To assess the technology of spent mushroom compost bulk bag processing and its economic benefit in alternative fuel	Under assessment
Non-hazardous oil	
Applied for reuse thereof	Preparation in progress
Waste cooking oil	
To clarify if waste cooking oil is fit for use as waste	Under assessment



TCC explores alternative fuels, such as bioenergy, solid recovered fuel (SRF), and application of agricultural residual materials, and studies the transformation of spent mushroom compost, non-hazardous oil, and waste cooking oil into biodiesel in 2022.

In terms of the alternative fuel use in 2022, TCC continued to develop biofuels from agricultural residual materials like waste woodchips, rice husks, and barks, SRF, refuse derived fuel (RDF) from wastes around industries like waste textiles/used clothes, discarded Tetra Pak and meal boxes, and waste paper, waste tires, waste rubber products, etc. as alternative fuels.

In 2023, TCC plans to explore more alternative fuel solutions. For example, TCC will assist the Council of Agriculture with the issues of spent mushroom compost bulk bag as well as CPC Taiwan with oil reuse and assessment of transforming the waste cooking oil from the fast food industry (crude glycerin) into biodiesel.

The substitution rate of biofuels and SRF, take the use rate in weight in Taiwan for example

grew from 0.21% in 2020 to 6.3%

cutting **190,000 METRIC TONS** of coal use volume overall.

It is expected to increase by 2 folds in 2023 compared to 2022.

Clearing Alien Species White Popinac and Assessing the Development of Biofuels

The invasive White Popinac, a top 100 global ecological threat, must be completely removed along with its roots and soil for thorough eradication. However, the shattered remains can be processed and used as a partial alternative fuel. The Hualien County Government, in collaboration with TCC, is implementing a removal project in the Muga River basin and assessing the feasibility of utilizing the removed White Popinac and surrounding soil as alternative fuel.



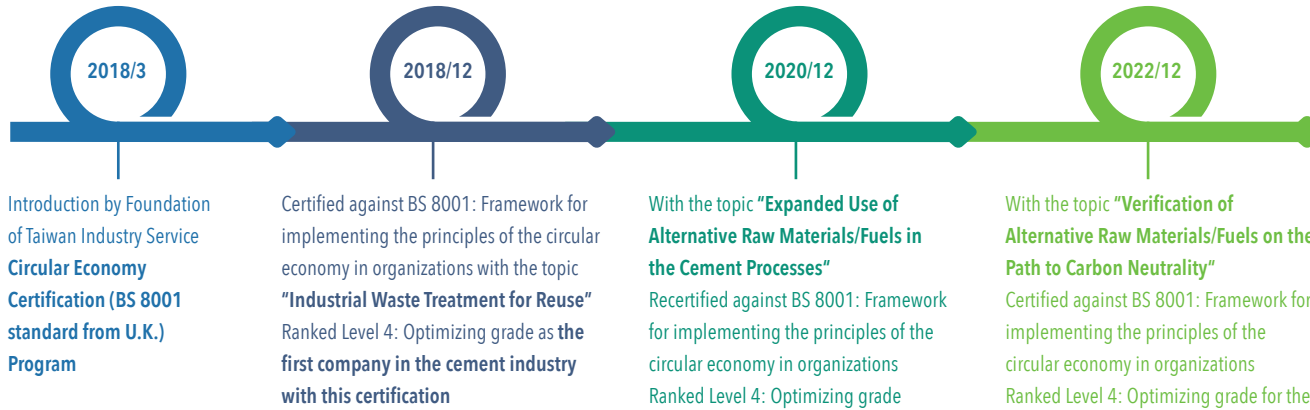
The International Energy Agency (IEA) stated that the cement industry needs to move towards sustainability, with the use of alternative raw materials in cement manufacturing being one direction. Greenpeace emphasized that cement production is a significant source of GHG emissions globally, and that using alternative raw materials can reduce CO2 emissions.

TCC in 2022 assisted industries to treat wastes and develop alternative raw materials for use. The Hoping Plant started to use calcium fluoride sludge as part of the alternative raw materials in March 2022. The Suao Plant has been using engineering or construction waste soil as a substitute for natural clay. The amount of engineering or construction waste soil treated in 2022 was 237,274 metric tons, accounting for 20.9% of the resources reused by both plants in Taiwan.

TCC aims to assist Hualien Distillery in 2023 with the disposal of waste liquor ceramic urns. An estimated 50-60 metric tons of broken urns are expected, and there will be about 10 metric tons of them to be used as alternative raw materials per year, with TCC exploring new sources to maintain a steady supply.

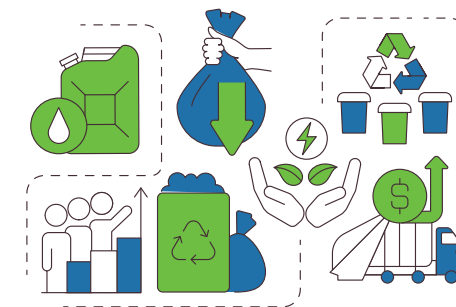
TCC reused almost 4.06 million metric tons of resources as alternative raw materials in the past 4 years, increasing the substitution rate of alternative raw materials in cement from 19% in 2019 to 22% in 2022.

### Verification of TCC on the Path to Carbon Neutrality Highest Level of BS 8001 Circular Economy: Optimizing Certified



#### Alternative Raw Materials/Fuels Used in 2022 (in metric ton)

Resource Reused at TCC (Taiwan)	Alternative Type	Amount in 2022
Calcium Fluoride Sludge	Alternative Raw Material	21,026
MgO-based Desulfurized Inorganic Sludge	Alternative Raw Material	11,291
Coal Ash	Alternative Raw Material	420,886
Desulfurization Gypsum	Alternative Adjunct	247,118
Incinerated Recycled Aggregates	Alternative Raw Material	4,766
Reducing Slag from EAF	Alternative Raw Material	96,324
Construction Waste Soil	Alternative Raw Material	237,274
Waste Compression Molding	Alternative Raw Material	456
Slag	Alternative Raw Material	78,342
Waste Ceramic	Alternative Raw Material	5,275
Spent Refractories	Alternative Raw Material	4,329
Air-cooled Slag	Alternative Clinker	1,965
Blast Furnace Slag	Alternative Clinker	7,638
Wood Chips	Alternative Fuel	43,917
Solid Recovered Fuel (SRF)	Alternative Fuel	3,305
<b>Total Resources Reused</b>		<b>1,183,912</b>



#### "3-in-1 of Port, Power, Cement Plant" at Hoping

for Low-carbon Manufacturing with Zero Waste  
An Average of **33,000 METRIC TONS** of Carbon Reduced Each Year

The circular design at TCC Hoping Plant adopts the highest environmental standard for the processes, negative-pressure totally enclosed storage and conveying system, Low-NOx processes and equipment, and Continuous Emission Monitoring System (CEMS) installed to the stacks. The Hoping Power Plant uses 60,000 metric tons of cement plant-generated limestone annually for eco-friendly desulfurization. An average of up to 420,000 metric tons of coal ash and desulfurization gypsum from power generation wastes are 100% provided to the Hoping Cement Plant as alternative raw materials each year, reducing the use of natural minerals and coal in cement products and replacing clay and gypsum. Furthermore, sea freight shipping reduces carbon emissions by 20 times compared to land transportation.



### 3.3 / Industrial Symbiosis Ecosphere

#### MANAGEMENT APPROACH

TCC proactively develops waste co-processing and partners with industry to build a sustainable ecosphere.

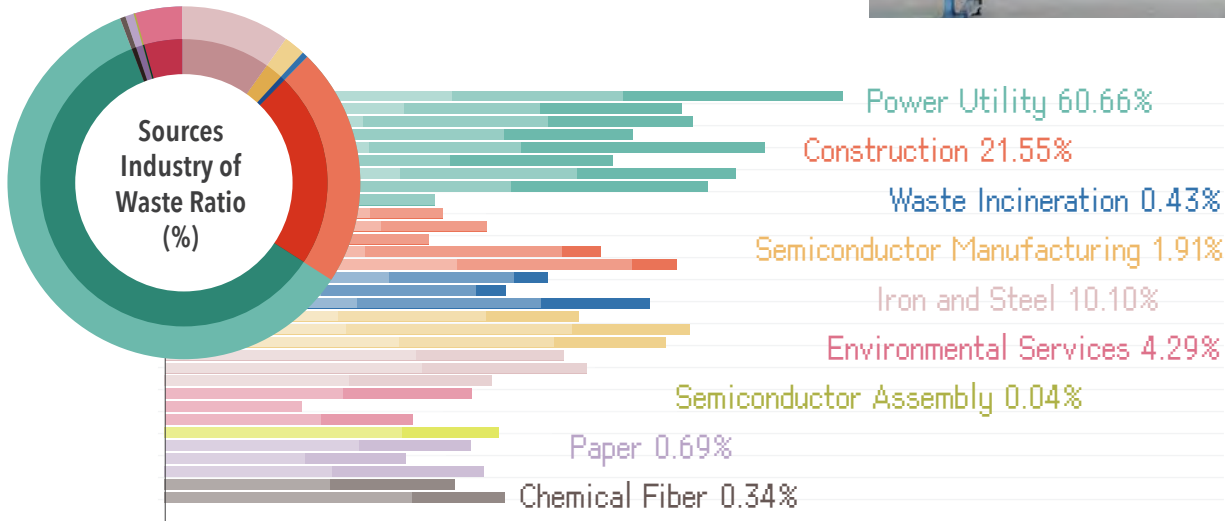
#### Resolving the Issue of Industrial Wastes

TCC committed to circular production, working with industries, governments, cities, and society to foster a circular economy sphere.

TCC helps nine industries manage difficult-to-dispose-of wastes and convert them into alternative cement raw materials and fuels, including power utility, construction, iron and steel, semiconductor manufacturing, semiconductor assembly, chemical fiber, paper, waste incineration, and environmental services.

In 2022, TCC helped dispose of **1.101 MILLION METRIC TONS** of waste which accounted for **5.3%** of all industrial waste in Taiwan.

Note: The source of the total amount of the industrial waste in Taiwan is the data of the monthly report on industrial waste from the Environmental Protection Administration in 2022.



#### Recycle with Peace (Hoping) Now!

TCC DAKA launched "Recycle with Peace (Hoping) Now!" in February 2021, encouraging visitors to recycle PET bottles, cups, and batteries using the "GEMMA smart recycling machine in the park." By collaborating with startups, social enterprises, and welfare groups, the initiative aims to promote waste resource recovery and turn waste into valuable resources such as gemstone. The DAKA Park has recycled PET bottles over the past three years and will transform them into the official shirts for the 2023 Taroko Gorge Marathon.

Gemma is "gem" in Italian, which is pronounced close to "decoding" in Mandarin and "today" in Minnan.

Total Bottles Recycled  
**26,556**





## OYAK & Cimpor Overseas Cement Businesses

TCC expands our business overseas in Europe, Asia, and Africa. In 2018, TCC established a wholly-owned Dutch subsidiary. Together with OYAK, the largest cement company in Turkey, we expanded into the markets in Asia and Europe and set up Taiwan Cement (Dutch) Holdings as TCC European Operation Headquarters. In 2019, TCC and OYAK's joint venture company, JVC, acquired Cimpor, a Portuguese cement company, extending our cement business into Portugal.



### Accumulate Carbon Credits and Elevate Corporate Resilience

The Carbon Border Adjustment Mechanism (CBAM) is planned to be introduced in October 2023 with phased levy from 2026. In the meantime, free carbon allowances will be phased out between 2026-2034, while the introduction of the CBAM will have a significant impact on carbon costs for enterprises.

CBAM will apply the same carbon costs to imported cement into the EU, affecting Cimpor Portugal, TCC's European subsidiary. This may decrease the amount of imported cement and allow TCC to gain market share and improve our overall benefits in the EU market.

Cimpor Portugal has increased its use of alternative fuels, resulting in a reduction of total carbon emissions. Despite using annual carbon allowances, it still maintains a significant amount of allowances. The Alhandra Plant and Souselas Plant have also undergone upgrades and retrofits, further reducing carbon emissions effectively.

In non-EU regions like the Turkish market, the subsidiary OYAK will have limited impact as it has little sales to the EU. Also, the Aslan Plant in Europe has undergone upgrade and retrofitting, setting a benchmark for energy consumption and electricity consumption and becoming a pioneering beacon for the industry in terms of thermal substitution rate (TSR).

### Cimpor Portugal for the Portuguese Market

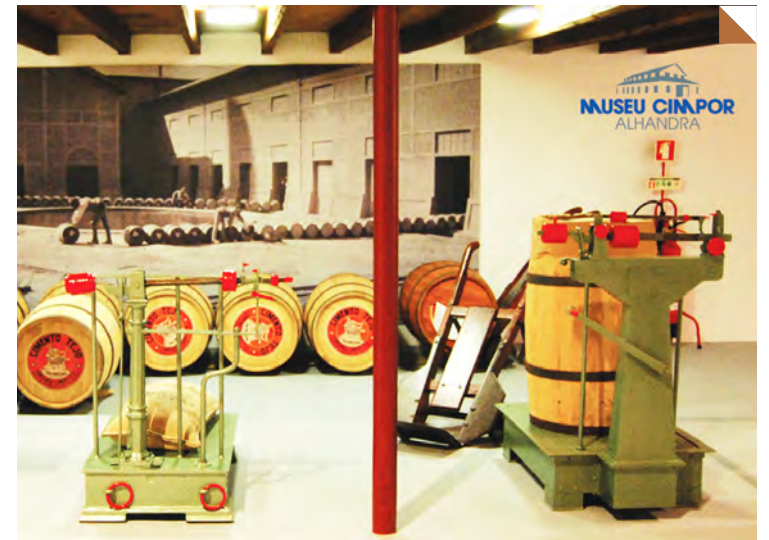
Cimpor Portugal has 3 cement plants with an annual clinker production capacity of nearly 5 million metric tons and a market share of nearly 55%. Also, Cimpor Portugal studied the application of Refuse Derived Fuel (RDF), searched for suitable alternative fuels for the plants collaborated with suppliers on alternative fuel pretreatment. Cimpor Portugal also optimized cement manufacturing processes and upgraded equipment for the Alhandra and Souselas Plants. The total TSR reached 31% in 2022. The Alhandra Plant, with the largest production capacity in Portugal, achieved a close to 50% TSR and underwent an upgrade in 2022 for the clinker production line. Equipment such as the raw mill, preheater, and cooler were replaced to reduce energy and electricity consumption. The Alhandra Plant aims to reach an 80% TSR through overall optimization project completion by 2025.

The Souselas Plant is the second largest production capacity in Portugal. Souselas Plant achieved a TSR of 40% with a new chlorine bypass system in 2022, and plans to add a new alternative fuel feeding system to increase the TSR to 65% by 2024. Loule Plant increased its TSR from 26% to 32% in 2022.



**Côte d'Ivoire (Ivory Coast) Plant**  
**First Calcined Clay Mass Production Base in the World**  
**Certain Clinker Substituted to Reduce 70% of Carbon Emissions**

The plant located in Côte d'Ivoire of West Africa is the world's first calcined clay mass production base. Calcined clay was used to substitute certain clinker to reduce carbon emissions in cement manufacturing. The two low-carbon cement products, Low Carbon CEM II 42.5 (21% < natural calcined pozzolana + Limestone < 35%) and Ultra Low Carbon CEM IV 32.5 (36% < natural calcined pozzolana < 55%), are currently available. Also, TCC plans to introduce this technology to Portugal for next-generation low-carbon cement.



**Cimpor Museum**

The Alhandra Plant was owned by Tejo and is the oldest cement factory in Portugal, built in 1894. The cement museum opened in March 2011, showcasing its historical and cultural significance since the late 19<sup>th</sup> century. It serves as a testimony to the plant's heritage.



**New Plant in Cameroon**  
**Expected to Put into Operation in 2023**

The Cameroon plant is set to begin operations in 2023 and will use different manufacturing technologies than the Côte d'Ivoire plant. During the initial phase of operation, the plant will focus on equipment debugging to achieve optimal performance in the future.



**The Turkish Market with OYAK Group**

OYAK owns 7 cement plants with an annual clinker production capacity of 12 million metric tons. The Aslan Plant has been expanding its alternative fuel pretreatment center, which has improved the plants' TSR performance by using RDF. The Aslan Plant is crucial to our operations in Turkey. In 2022, the average TSR increased to 53%, and kiln head feeding trials were conducted, reaching a daily TSR of 78% in preliminary tests. The feeding system and the dedicated kiln head pretreatment equipment will be added in 2023. The Ankara Plant also raised its TSR to 50%, and even up to 56% in a single day, thanks to the alternative fuel storage and feeding system designed by OYAK itself. In addition, due to energy supply shortages and increased demand for alternative fuels, the Bolu Plant converted chicken farm waste into alternative fuels. This increased the annual average TSR to 24% instead of decreasing.

