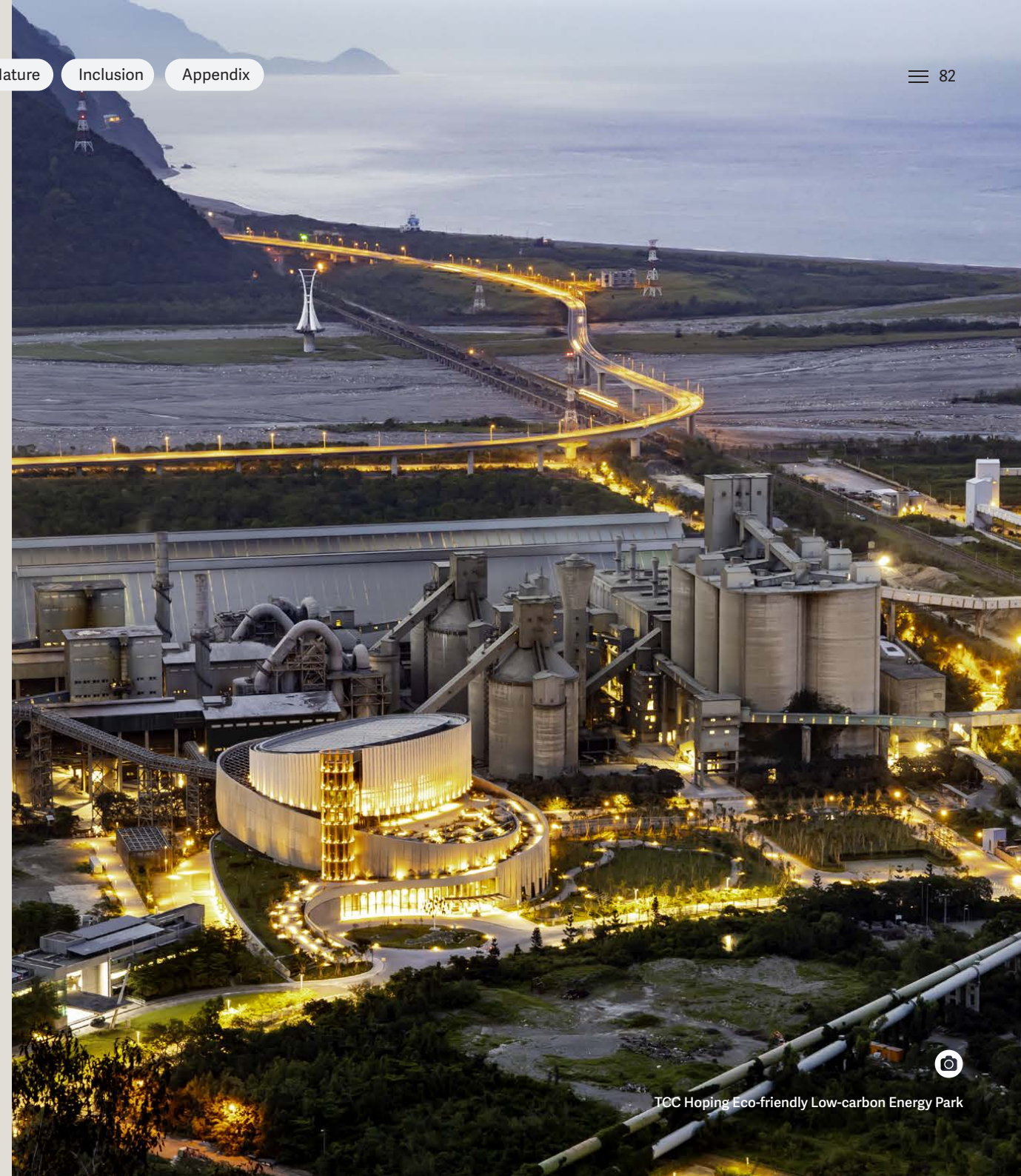
chapter 2

Carbon Reduction

6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Corresponding SDGs



TCC Hoping Eco-friendly Low-carbon Energy Park

2.1

Low-Carbon Construction Materials

TCC's products sold in Africa, Europe, Central Asia, and in Taiwan and Mainland China have all achieved the "low-carbon" rating from the Global Cement and Concrete Association (GCCA). TCC is the only company in Taiwan whose cement and concrete products have met third-party certified low-carbon standards.
--Chairman Nelson An-ping Chang

TCC is the Only Company to be Listed in Both Global Cement and Concrete Low-Carbon Ratings

In April 2025, the GCCA released the world's first Low Carbon Rating (LCR) standards for cement and concrete. TCC is Taiwan's sole construction materials manufacturer whose cement and concrete products meet these GCCA low-carbon standards. Our low-carbon products made in Mainland China, Türkiye, Portugal, and West Africa also fully comply.
However, unlike Europe's 20% clinker and 80% additive allowance, Taiwan's 50-year-old regulations still govern its cement industry, resulting in TCC's Taiwan-produced cement having the highest carbon emissions regionally. Despite being Taiwan's only compliant company, it only achieves GCCA's basic 'F' grade. Therefore, TCC continues to communicate with the government, suggesting they reference European experience to relax relevant regulations, thereby jointly driving the domestic cement industry to accelerate its green transformation.

Global Cement and Concrete Association LCR standards

TCC Low-carbon Cement Products		TCC Low-carbon Concrete Products
	Near Zero AA	
	A	
	B	
OYAK CEMENT CEM III 32,5N **OYAK CEMENT** CEM VI 32,5N	C	**Taiwan** Portland Limestone (IL) Cement Concrete 3000-6000psi
OYAK CEMENT CEM II 32,5N **OYAK CEMENT** CEM V 32,5N	D	**Taiwan** Portland Type I Cement Concrete 3000-6000psi
OYAK CEMENT CEM II 42,5R **OYAK CEMENT** CEM V 32,5R **CIMPOR** CEM II 32,5N	E	
Suao & Hoping Plant – Portland Limestone (IL) Cement **Yingde & Jurong Plant** – PO 42.5R	F	

TCC

TCC will exclusively produce and sell low-carbon cement and concrete

CIMPOR

Sales proportion in the Portuguese market will increase to 90%, with export share reaching 30%

By 2030, CIMPOR will reduce the clinker ratio in cement production to below 65%

OYAK CEMENT

- The proportion of CEM-I in gray cement sales will decrease from 23.4% to 12.2%
- The clinker ratio in cement production will decrease to 73%

Low-Carbon Products - Reducing Carbon Without Compromising Strength

The UN's 2050 Global Buildings Net Zero Pathway calls for over a 40% reduction in embodied carbon from construction materials in new buildings by 2030. The 2024 Emissions Gap Report adds that using low-carbon cement with clinker alternatives like limestone could cut global CO_2e emissions by 400 million metric tons by 2035.

Cement

- Carbon reduction
- Low heat of hydration
- Highly resistant to environmental impacts
- High workability
- High sulfate resistance

CO_2e −23.8%

TCC Branded Cement
Portland Limestone (IL) Cement
Higher early strength; suitable for general construction and engineering
Carbon footprint 754.82 kg CO_2e per metric ton of cement

Mainland China
PO 42.5R
Better workability and higher durability compared to PC type. Can be used for general construction and engineering

OYAK CEMENT
CEM II 32,5 N
Suitable for sewage treatment plant engineering

OYAK CEMENT
CEM III 32,5 N
Suitable for foundation improvement, coastal and port structures, and offshore structure engineering projects

OYAK CEMENT
CEM V 32,5 R
Suitable for sewage treatment plant engineering

OYAK CEMENT
CEM VI 32,5 N
Suitable for sewage treatment plant engineering

CIMPOR
CEM II 32,5 N
Suitable for various mortars and general construction projects

Concrete

TCC Low-Carbon Concrete | Portland Limestone (IL) Concrete

- Consistent slump and excellent workability
- Higher early strength
- Strong workability and better carbon reduction
- Excellent durability
- For general construction and engineering

Action Spotlight

Portland Limestone Cement Concrete User Manual

During the initial introduction of limestone cement concrete in Taiwan, due to ready-mixed producers' early application concerns, TCC, Taiwan Construction Research Institute and Taiwan Concrete Institute to jointly compile this manual. It provides a reference guide for project authorities, design and construction units, construction companies, and ready-mixed concrete industries, offering concrete guidance for green construction. The manual covers limestone cement characteristics, application benefits, mix design, construction precautions, and quality management. It aims to ensure engineering quality and promote proper Portland limestone cement concrete use.

Sustainable and Innovative Low-Carbon New Construction
Ultra-High Performance Concrete (UHPC)

What is UHPC ?

Ultra-High Performance Concrete (UHPC) is a new concrete developed in recent decades. Its discontinuous pore structure inhibits harmful substance penetration (e.g., chlorides), surpassing traditional concrete in mechanical properties and durability. As UHPC excels over traditional concrete in structural form, constructability, and aesthetics, its global use is expanding. Applied in over 400 US highway bridges, it also shows amazing sculptural plasticity in international landmarks like France's Mucem Museum and Shanghai Grand Opera House. UHPC achieves comprehensive breakthroughs from structural strength to architectural aesthetics, redefining modern construction material possibilities.

Carbon emissions in construction originate from component manufacturing, and differ based on architectural design, logistics, and equipment usage. UHPC's lifecycle can reach 100 years, with less material consumption than traditional concrete. Replacing ordinary reinforced concrete with UHPC reduces component thickness, material quantity, weight, and carbon emissions. TCC's UHPC team, not limited to precast methods, developed cast-in-place formulations. The team further integrated 3D printing, fully expanding market applications. Learn more at TCC Sustainable E-Newsletter.

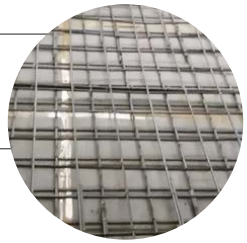
UHPC KT Slab (Precast K-Truss Slab)

- Precast product, eliminating the need for formworkers and floor supports
- Reduce structural net load
- Reduced number of steel bar tying workers & low carbon emissions
- Shortened construction time

VS

Traditional Slabs

- Depression, water accumulation
- Insufficient carrying capacity



UHPC Bricks

- **Grass pavers**
  With resistance to heavy pressure and high durability, allowing the land to breathe
- **Paving bricks**
  High compressive and flexural strengths

VS

Traditional grass pavers & paving bricks

- Depression, water accumulation
- Insufficient load-bearing capacity
- Uneven surfaces & prone to loosening

TCC UHPC Applications

TCC DAKA RRRC Curtain Wall

- TCC DAKA RRRC Curtain Wall
- UHPC EnergyArk
- National Highway Bureau, Zhongli Engineering Office - Roof Waterproofing Project:
  520 square meters of 2 cm thick UHPC was cast on-site, highlighting the material's superior compactness and mechanical properties, replacing traditional base concrete.

Low-Carbon Construction Materials: Key to Reducing Building Embodied Carbon

TCC Actively Engages Industry, Government, Academia

According to UN estimates, 68% of the population will be urban by 2050, with city buildings and public works causing 43% of global carbon emissions. Embodied carbon, from materials, transport, construction, renovation, and disposal, accounts for roughly 35% of this. TCC's low-carbon construction material product line—low-carbon cement, concrete, and UHPC—integrates R&D, process, and application innovations to offer sustainable material solutions. Concurrently, TCC actively dialogues with regulators to drive construction industry decarbonization, accelerating the cement industry's green transformation.

Communication Unit	Key Engagement Focus Areas
European Cement Research Academy (ECRA)	Exchanging latest cement and concrete technology knowledge and research findings, committed to industry sustainability and innovation.
CarbonZero	CIMPOR CTO Berkan introduced CIMPOR's deOHclay innovation to reduce cement manufacturing carbon, aiding 2050 net-zero goals.
Bureau of Energy, Ministry of Economic Affairs	Introduced TK cement industry tech applications with experts, accelerating cement industry energy and resource efficiency.
Industrial Development Bureau, Ministry of Economic Affairs	Shared TCC's net-zero pathway and related industrial applications, helping industries turn challenges into net-zero opportunities.
Building Research Institute, Ministry of the Interior	Discussed mineral admixture use in cement and concrete design and evaluated incorporating low-carbon sustainability goals.
Industrial Development Bureau, Ministry of Economic Affairs	Shared TCC's low-carbon production experience, exchanging views on cement's 2050 net-zero outlook and international energy reduction issues.
Ministry of the Interior	Showcased UHPC products at the low-carbon recycled materials ceremony to promote them to potential customers.

Prioritizing Customer & Market Needs

Share Sustainable Construction Materials Applications

TCC promotes sustainable construction materials applications through "market communication" and "customer promotion," extending to overseas subsidiaries to boost global brand influence. TCC actively joins seminars and sharing sessions, collaborating with government, academia, and low-carbon certification personnel to discuss low-carbon material tech and market trends. We also tailor diverse promotion strategies for clients, proactively briefing group construction firms, large export plants, and renowned local builders. We liaise with supervision units on specifications, aiding client understanding of low-carbon cement's compliance and applications, boosting adoption confidence. TCC actively participates in construction alliances and briefings, sharing success stories to enhance market awareness of low-carbon cement performance and international trends, integrating low-carbon solutions from the design stage to accelerate material adoption.

Invited to the Ministry of Environment's Growth Alliance

The Ministry of Environment plans to introduce a carbon pricing system integrated with the cap-and-trade system. To learn from international experience, the Ministry established the Green Growth Alliance in April 2025, inviting businesses and relevant ministries. TCC was the sole cement company representative invited in the first wave.

Action Spotlight

CIMPOR Participates in Tektónica International Building Exhibition

CIMPOR attended the Tektónica International Building Exhibition in Lisbon, Portugal, in April 2025. The Portuguese Minister of Economy visited its booth. Through an interactive display, CIMPOR showcased its latest innovations and low-carbon solutions, strengthening customer and partner relationships.

Innovative R&D Capacity:
TAF Certified Sustainability R&D Center

To bolster technical capability and competitive advantage in low-carbon construction materials, the Sustainability R&D Center was established in January 2023. It features TAF-certified labs for cement and civil engineering materials, analyzing components, controlling quality, and continuously developing new low-carbon materials, technologies, and products. The R&D Center also expanded third-party certification for Portland limestone (IL) cement, securing CNS 15286 testing capability in Feb 2024. Type IL cement holds carbon footprint certification, with 2025 plans for Ministry of Environment carbon label and Type III EPD. Long-term durability and hydration heat tests are ongoing for future public works. Focus also extends to forward-looking research like 3D printing. Facing labor shortages and stricter environmental rules, the construction industry seeks innovative methods like 3D concrete printing for its efficiency and flexibility. It aims to simplify processes, shorten construction times, reduce labor, and cut mold consumables, lessening environmental and human reliance. CIMPOR also invests in innovative R&D. For details, please refer to Overseas Cement Business.

3D Printing

CIMPOR plans to install large-scale 3D equipment at its Alhandra Plant in Portugal in 2025, developing low-carbon slurry combining calcined clay, slag, white cement, and recycled materials. The standard mortar formula was completed in 2024; more recycled raw materials will be introduced to promote circular economy.

Hoping Plant and NHOA.TCC Jurong UHPC Production Base

TCC's UHPC Production Center demonstrates comprehensive application capabilities. The Hoping Plant applies UHPC technology to building facades, grass pavers, and EnergyArk products. Also, the Jurong UHPC Production Base has begun trial production, capable of mass producing EnergyArk casings. The UHPC Production Center boasts advanced R&D and integrated production capacity, achieving seamless transition from lab innovation to industrial manufacturing.


UHPC Production Center at Hoping Plant

Industrial Academic Publications

Journal	Publication Highlights
Journal of the Chinese Institute of Engineers Vol.97 No.2	**Circular Economy in Cement Industry** The cement industry uses kilns to co-process waste as alternative raw materials and fuels, cutting process carbon emissions and advancing the circular economy. The article outlines domestic and international trends in alternative raw materials and fuels, as well as waste treatment's current status, also briefly detailing TCC Group's co-processing situation.
Journal of Concrete Technology Vol.18 No.2	**UHPC Application in 3D Printing Technology Development** The article introduces basic properties of TCC's independently developed 3D printing UHPC materials, showcasing art installations and products made using 3D printing technology, thus enhancing UHPC's application value.

2.2

Low-Carbon Production Management

TCC is committed to reducing the environmental impact of its product manufacturing processes, actively implementing full lifecycle management and introducing international management systems. Environmental education and training for employees are conducted through certification guidance courses, TCC Lyceum, new employee training, and Town Hall Meetings. These cover topics including energy efficiency, water resource efficiency, and waste reduction. This extends to the TCC Carbon Academy to enhance employees' sustainability awareness and management efforts.

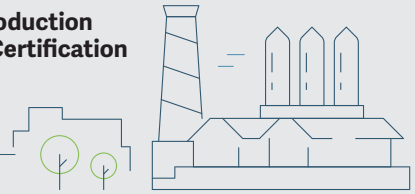
TCC KEY FACTS

100% ISO 14001 Certification Obtained

Environmental Protection Policy

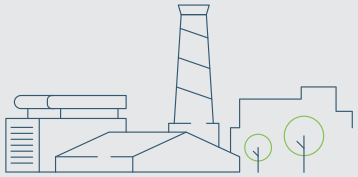
Cement Plants

- ISO 14001 — **Environmental Management**: Taiwan, Mainland China, OYAK CEMENT and CIMPOR
- ISO 14046 — **Water Footprint**: Taiwan, Mainland China
- ISO 14064 — **Greenhouse Gas Inventory**: Taiwan, Mainland China
- ISO 14067 — **Carbon Footprint**: Taiwan
- ISO 46001 — **Water Efficiency Management**: Taiwan
- ISO 50001 — **Energy Management**: Taiwan, Mainland China, OYAK CEMENT CIMPOR (In Progress)
- Alliance for Water Stewardship — **Water Management Platinum Level**: Taiwan
- BS 8001 — **Circular Economy**: Taiwan
- 綠色工廠 Green Factory — **Green Factory Label** / **Clean Production System Certification**: Taiwan



RMC Plants Taiwan

ISO 14001 | ISO 14046 | ISO 14064 | ISO 14067 | ISO 46001 | ISO 50001



Clean Production System of Green Factory Certification: 綠色工廠 Green Factory; BS 8001

Office Taiwan

ISO 14001 | ISO 50001

Environment Management Process

Step 1 /
Conduct Management System Audits & Identify Opportunities

Implement ISO system audits to identify performance improvement opportunities, leveraging international management systems like ISO 50001, ISO 46001, ISO 14001, ISO 14046, and ISO 14064 to pinpoint key enhancement areas.

Step 2 /
Environmental Management Goal Setting

Establish clear goals across key environmental areas, including Energy Efficiency, Water Resource Efficiency, Waste Reduction, Air Pollution Reduction, and Greenhouse Gas Reduction.

Energy
Cement Plants (Taiwan & Mainland China): Join EP100, aiming to increase energy productivity by 50% by 2040 (2016 baseline).

Operational Headquarters: Achieve a 1% annual electricity saving.

Water Resources
Cement Plants (Taiwan & Mainland China): Reduce water withdrawal intensity to 0.000248 million liters/metric ton of cementitious materials by 2030; reduce water withdrawal by 1.2% annually for plants in water-stressed areas.

Taiwan RMC Plants: Reduce freshwater withdrawal intensity for concrete by 0.5% by 2025, 1.5% by 2030, and 3.5% by 2050 (2023 baseline).

CIMPOR: Reduce water withdrawal intensity to 0.0002 million liters/metric ton of cement by 2030.

Waste
Cement & RMC Plants (Taiwan & Mainland China): Achieve a 0.5% annual reduction in household waste.

Step 3 /
Develop and Implement Action Plans

Develop specific action plans for each goal area. Key actions include:

- **Energy & GHG**: Implement energy-saving actions, use clean or renewable energy, and invest in innovation and R&D to reduce energy consumption.
- **Water Resources**: Execute water-saving programs, promote water recycling and reuse, and implement water recycling technology.
- **Waste**: Implement waste reduction actions and recycling programs, and invest in innovative technologies.

Step 4 /
Enhance Employee Capability

Build employee capacity and awareness through targeted programs:

- **Training Courses**: Offer ISO System Certification Training and TCC Carbon Academy to deepen professional knowledge and align with international standards.
- **Awareness Programs:** Utilize platforms like the TCC Lyceum and New Employee Training to deepen sustainability awareness and integrate it into daily work.
- **Leadership Communication**: Conduct Town Hall Meetings, chaired by the Chairman, to communicate the company's sustainability strategy directly to employees.

Step 5 /
Engage with Stakeholders

Communicate environmental policies, requirements, and progress to all internal and external stakeholders. This is achieved through multiple channels, such as:

- **Sustainability Newsletter**
- **Supplier Conference**
- **Product Promotion Events and Conferences**

Note 1: For targets related to greenhouse gases, air pollution, water consumption, CIMPOR energy and waste, please refer to Sustainability Goals and Tracking.

Internal Carbon Pricing & Internal Carbon Trading

In response to the EU CBAM and Taiwan's carbon fee, TCC is implementing an internal carbon pricing system to conduct cost-benefit analysis. The system anticipates carbon cost impacts on operations and investments and is an economic incentive to drive low-carbon investments, enhancing risk awareness for capital expenditure, operational decisions, and reduction initiatives. Additionally, TCC launched an internal carbon trading platform in 2024. By calculating site-specific emission allowances and effectiveness, this platform will strengthen responsibility, foster collaboration, and encourage technological innovation. Also, CIMPOR and OYAK CEMENT established internal carbon pricing based on forecasts from the European Cement Association (CEMBUREAU), IEA, and BNEF. For their 2025 investment sensitivity analysis, both use a projected 2030 external carbon price of EUR 150 per metric ton CO_2e.

TCC is also piloting a water pricing system. From 2025, cement operations in Taiwan and Mainland China will use a water cost model based on each unit's water intensity, regional water risks, and price trends. The goal is to drive water conservation actions through economic incentives. The pricing for Taiwan and Mainland China is (local water price + NTD 3) and (local water price + CNY 0.75) respectively, per m^3 of water withdrawal. For more information on greenhouse gas management, please refer to the Carbon Competitiveness and CH 2.3.

Internal Carbon Pricing	Taiwan	Mainland China
GHG Scopes Covered	100% of cement business's Scope 1 + Scope 2 (including cement plants, RMC plants, and grinding stations)	
Type of Internal Carbon Price	Shadow price	
Pricing Method	Set with reference to recommendations from the 5th Carbon Fee Review Committee in 2024	Set based on IEA's World Energy Outlook Report STEPS scenario and local carbon market prices
Carbon pricing for 2025	NT$500 per Metric Ton CO_2e	CNY 105 per Metric Ton CO_2e

Respond to Green Office Practices and Implement Daily Low-Carbon Management

To implement green office practices and daily low-carbon management, TCC integrates net-zero concepts into daily operations, from procurement and equipment management to office habits. Taiwan and Mainland China offices promote the reduction of single-use items, with priority given to purchasing eco-labeled and FSC-certified materials. Smart energy monitoring and energy-saving facility upgrades are also being implemented. These management processes will be replicated overseas to deepen employees' green awareness.

Key Focus Actions for 2024:

- Strengthening copier control and sending monthly paper usage comparison reports
- Installing smart systems in meeting rooms
- Replacing paper cups with glass cups to reduce single-use items
- Reducing the number of trash cans to decrease the use of garbage bags and plastic consumables
- Installing hand dryers in restrooms to reduce paper towel usage


Outdoor Office Area, TCC C. F. Koo Building

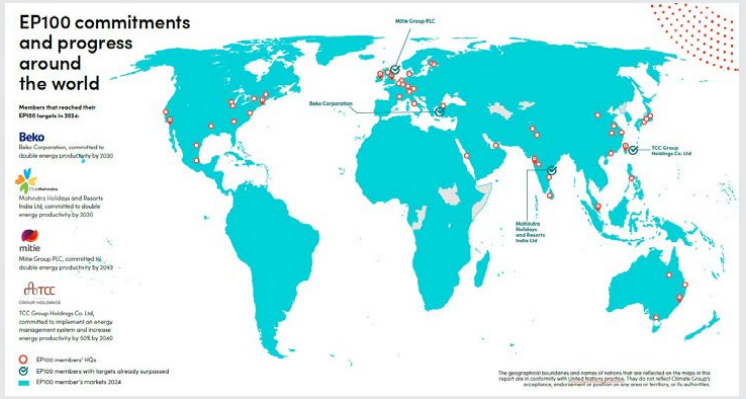
Energy Efficiency Management

All cement plants in Taiwan and Mainland China have implemented the ISO 50001 energy management system, integrated with smart systems, to identify opportunities for improving energy performance and evaluate equipment enhancement plans (please refer to CH 6.1). TCC actively optimizes energy efficiency and autonomous power management, improving energy use through process conservation, energy storage systems, and both self-generated and purchased renewable energy. Furthermore, the installation of waste heat recovery systems and the introduction of flash evaporation technology have enhanced heat and power generation efficiency, reducing external manufacturing power purchases by 20-30%.

	Power Generation by Waste Heat Recovery (million kWh)	Equivalent to Purchased Electricity for Manufacturing Process
Taiwan	79	18%
Mainland China	858	44%

Exceeding Targets!
TCC Listed on EP100 Surpass Map

The EP100 initiative's April 2025 annual report urged businesses to harness energy efficiency's potential. Since joining in 2022, TCC has met its targets for two consecutive years and was listed on the annual Surpass Map. This demonstrates TCC's energy efficiency surpasses international benchmarks, affirming the effectiveness of its sustained investment in energy conservation and governance.



CLIMATE GROUP EP100

Action Spotlight

Suao Plant's Waste Heat Recovery Upgrade Boosts Power Generation by Over 100%

Following renovation completion and grid connection in February 2025, power generation per metric ton of clinker, under normal operation, increased from 14.89 to 32.33 kWh/ton. Control parameters are continuously optimized to minimize purchased electricity.

Self-Generation and Consumption of Renewable Energy to Fulfill Obligations as an Energy Heavy Industry

Rather than relying solely on purchasing renewable energy certificates, TCC pursues a dual strategy of on-site generation and external green power procurement. Globally, TCC is installing solar power systems on rooftops and unused areas at its operational headquarters, plants, and subsidiaries. Concurrently, the company supports the green power market by strategically increasing external procurement annually. In 2024, on-site generation at Taiwan's cement sites totaled 5,736,025 kWh, or 1.2% of their total consumption. The Hoping and Suao plants, designated 'obligated renewable energy users,' fulfilled these requirements ahead of schedule in 2023. In Mainland China, on-site generation reached 20,517,710 kWh. The combined renewable energy usage of TCC's cement operations in Taiwan and Mainland China accounted for 2.1% of total electricity consumption.

Enhancing Energy Resilience and Efficiency with Integrated Solar and Storage

TCC is actively deploying energy storage systems to support on-site power demands and participate in the electricity trading market by regulating peak and off-peak power. During events such as natural disasters or outages, these storage systems can immediately discharge to provide backup power, maintaining the electricity required for essential production processes. In parallel, cement plants in Mainland China and CIMPOR's operations in Portugal are prioritizing a "solar + storage" integration strategy.

By the end of 2025, the total installed energy storage capacity is projected to reach 335.04 MWh across TCC's cement plants in Taiwan and Mainland China, its RMC plants in Taiwan, and the operations of CIMPOR. This includes commissioning behind-the-meter systems at the Hoping (28 MWh) and Suao (11 MWh) plants, featuring black start capability to provide backup power for emergency material discharge into the kiln during sudden outages.

TCC KEY FACTS

Yingde and Guigang Plant
Energy Storage System Capacity 140.96MWh

Annual Operating Costs
Saving
NT$880 million

Green Power Procurement Targets

Since 2025
Taiwan-
Additional 100,000 kWh annually
Mainland China-
Additional 10 million kWh annually

Action Spotlight

CIMPOR Secures EU Funding for On-Site Solar Project in Portugal

CIMPOR received funding from the EU's NextGeneration EU program, via the Portuguese Recovery and Resilience Facility (RRF), for its on-site solar generation project at the Maia commercial center in Portugal. The installation will generate approximately 1,300 MWh annually, cutting CO_2e emissions by 450 metric tons and achieving a 40% power self-sufficiency rate for the site.

Water Resource Management

Although the cement industry is not considered water-intensive, TCC proactively strengthens its water management. Following the Task Force on Nature-related Financial Disclosures (TNFD) framework, TCC identifies its dependencies on surface and groundwater, water flow, and water quality to comprehensively understand resource risks.

In 2024, a priority assessment was conducted on Taiwan's quarry and cement sites. Using the WRI Aqueduct Water Risk Atlas, TCC assessed all locations in Taiwan and Mainland China, identifying three cement plants—Anshun, Guigang, and Huaying—as being in high-risk, water-stressed regions. Key risks for these plants include potential production halts from water shortages (physical risk) and stricter discharge regulations (transition risk). Violations could lead to fines or stoppages with maximum daily losses of up to NT$10.98 million (approx. US$366,000). Poor management could also impact local community and agricultural water supplies.

As this assessment expands to CIMPOR and OYAK CEMENT locations in 2025, TCC will further set risk mitigation targets, implement tiered resource management at its production sites, and begin promoting low-water-impact products.

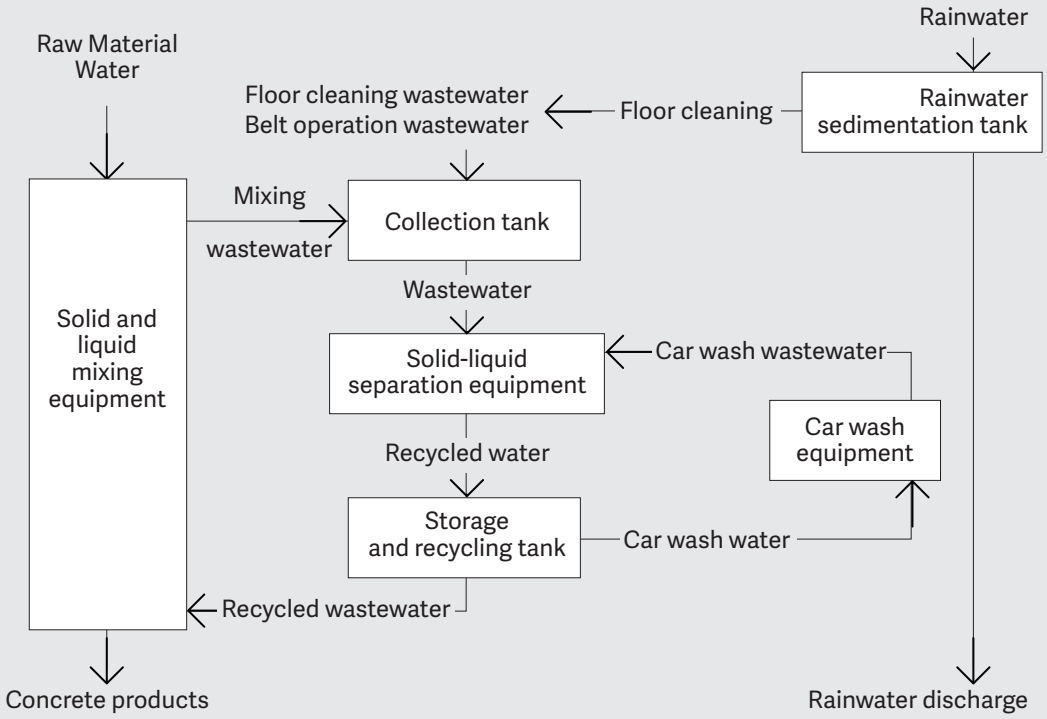
	Scope	Quarries	Plants
Dependencies Ecosystem Services	1 Surface water	HIGH	VERY HIGH
	2 Ground water	HIGH	VERY HIGH
	3 Water flow maintenance	HIGH	
	4 Water quality		LOW

VERY HIGH HIGH MODERATE LOW VERY LOW

Closed-Loop System Achieves Zero Wastewater Discharge in Concrete Production

At TCC's RMC plants, all process water—from mixing, floor cleaning, and belt washing—is treated through sedimentation and separation for reuse in production and equipment cleaning. Rainwater collection facilities are also installed for floor cleaning, with the resulting runoff directed into the same recycling system. This closed-loop approach achieves 100% water resource recycling and reduces dependence on tap water and groundwater.

Water Balance Diagram of RMC Plants



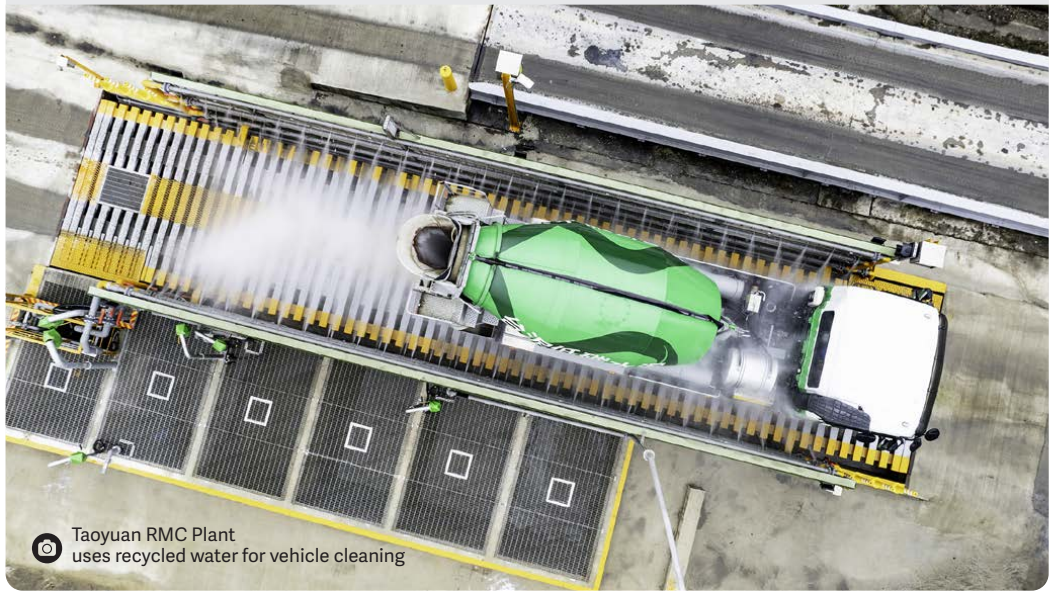
RMC Plant Water Balance Diagram

Water Resource Smart Management

Since 2022, TCC has strengthened water management across its Taiwan and Mainland China cement plants using a dedicated footprint platform. This system monitors water supply, consumption, recycling, and discharge, providing real-time recycling rates. In 2024, Taiwan cement plants surpassed the Water Resources Agency's 30-80% industry benchmark for water recycling rates. Taiwan plants also monitor intake water quality; for example, Hoping Plant sets quality standards for cooling water from the industrial zone and annually tests groundwater. TCC's conservation efforts include rainwater recycling systems and regular maintenance. In Portugal, CIMPOR sites reduce freshwater consumption by using dry cleaning methods and developing water-saving dry-mix mortar alternatives.

To enhance water recycling and pollution prevention, TCC implements localized and digital water management solutions at its plants. Key examples include:

- **Hoping Plant**: Uses a Membrane Bioreactor (MBR) to treat domestic wastewater for reuse in irrigation and site cleaning.
- **Taoyuan RMC Plant**: Deploys a self-developed system that recycles car wash water, removing mortar and solids for reuse in vehicle and site cleaning.
- **CIMPOR Loulé Plant (Portugal)**:
  - Operates a facility that recycles treated domestic wastewater and filtered rainwater for cooling and washing operations.
  - Future plans involve a large-scale pipe replacement and implementing new IoT water meters and abnormal monitoring systems. This will enhance water management efficiency and response capabilities by enabling real-time monitoring and rapid leak detection.



Taoyuan RMC Plant uses recycled water for vehicle cleaning

Wastewater Management

TCC's cement and RMC plants have established water pollution management systems with regular internal and external testing for indicators like COD, SS, and pH to ensure compliance with discharge standards. At cement plants, wastewater from process cooling and domestic sewage is centrally treated to meet Ministry of Environment standards. Compliance is verified through internal monitoring and regulatory inspections to prevent harm to ecosystems and communities. Cement plants in Mainland China achieve 100% zero process wastewater discharge, while plants in Portugal and Türkiye are also fully equipped with treatment facilities. RMC plants operate a closed-loop system where wash water from trucks and equipment is collected, aggregates are separated, and the water is reused in the process. All global operations comply with their respective regional environmental standards.

Incident Response and System Enhancement

Corrective Actions for the Tainan RMC Plant Water Overflow

Following a late-2024 overflow incident at the Tainan RMC Plant, where heavy rain caused suspended solids to exceed standards, TCC immediately reported the event, initiated response protocols, and completed cleanup. By Q1 2025, initial improvements like retention ponds and pre-treatment facilities were completed, followed by comprehensive actions including upgrading the water treatment system, extending risk assessments to other plants, and strengthening early warning capabilities.

Waste Management

TCC's waste management is based on the ISO 14001 environmental system. For in-plant treatment, bottom ash, waste oil, and waste refractory materials are fed into rotary kilns as alternative raw materials and fuels. Shredded employee domestic waste, plastics, rubber, and paper are also utilized as alternative fuels. Off-site, qualified contractors recycle valuable metals like scrap iron for reuse in steel plants. Based on these management regulations, TCC's global operations are setting their own waste reduction targets to enhance group-wide resource recycling efficiency.

OYAK CEMENT Obtained Türkiye's Zero Waste Certification

Nine OYAK CEMENT-managed cement plants and one RMC plant have earned zero waste certification from Turkish authorities by implementing comprehensive waste management. This includes on-site sorting, tracking, and recycling, alongside employee education and source reduction initiatives like packaging redesign and material substitution. These efforts maximize reuse and minimize outsourced waste disposal.

E One Moli Corporation Plans to Implement UL 2799 Zero Waste to Landfill Certification

To achieve UL 2799 certification, which emphasizes waste transparency and recycling rates, the E One Moli Corporation (Tainan Plant) will first inventory waste sources, classify materials, and establish recycling indicators. Subsequently, these classifications and recycling paths will be optimized to progressively achieve the goal of zero waste to landfill.

Action Spotlight

INVESTMENT IN INNOVATION TO MINIMIZE WASTE

Food Waste Processing Center

Yingde Plant

The Yingde Plant operates an integrated center that processes 8.7 metric tons of food waste from its employee cafeteria each month. This process yields three main products: solid matter is fermented into 1.25 metric tons of granular organic fertilizer; wastewater is processed into liquid fertilizer for greening the plant and its quarry; and recovered oil is refined to make soap, hand wash, and crayons. Beyond its internal operations, the center also recycles food waste from nearby villages, providing fertilizer back to the community, thereby addressing both waste reduction and social inclusion.

Food Waste Becomes Nutritional Fertilizer for Happy Farm

Hoping Plant

In 2021, the Hoping Plant installed food waste processing equipment to recycle waste from TCC DAKA and nearby food stalls. Using bacterial decomposition, the waste is converted into soil improvement materials and provided free of charge to local villagers for agriculture or gardening. The plant established the 'Happy Farm,' inviting local families to plant crops and experience the results of this recycling firsthand. This hands-on initiative teaches residents about the circular economy and environmental sustainability. From 2020 to the end of 2024, the project received a cumulative investment of NT$24.35 million.

Air Emissions Management

TCC employs a range of advanced technologies across its global operations to manage and control air pollutants. Key measures include:

Gaseous Pollutant Management

- Installation of Selective Non-Catalytic Reduction (SNCR) denitrification equipment across sites in Taiwan, Mainland China, OYAK CEMENT, and CIMPOR Portugal.
- Utilization of low-sulfur coal in Taiwan and Mainland China to reduce sulfur oxide emissions.
- Deployment of Low-NOx burners in Taiwan, Mainland China, and at CIMPOR sites in Portugal and Ivory Coast.
- Use of multi-stage combustion equipment in Taiwan, Mainland China, and CIMPOR Portugal.

Particulate Pollutant Management

- Continuous optimization of bag filters to enhance dust collection efficiency in Taiwan, Mainland China, and OYAK CEMENT.
- Implementation of enclosed transport systems to minimize fugitive dust emissions in Taiwan, Mainland China, and CIMPOR Ivory Coast.
- Ongoing optimization of hybrid systems combining bag filters and electrostatic precipitators for kilns in Taiwan and Mainland China.
- Installation of highefficiency electrostatic precipitators at OYAK CEMENT.

Continuous Automatic Monitoring of Air Pollutants

TCC has installed Continuous Emission Monitoring Systems (CEMS) at its cement plants in Taiwan, Mainland China, OYAK CEMENT, and at CIMPOR sites in Portugal and Ivory Coast. To enhance transparency, the CEMS in Taiwan and Mainland China are linked in real-time to local environmental agencies for comprehensive stack monitoring.

Air quality stations are established in surrounding communities in Taiwan, Mainland China, and OYAK CEMENT (Türkiye) to enable rapid emergency response. Independent verification is also conducted via quarterly third-party air quality testing and semi-annual environmental impact assessments to ensure full regulatory compliance.

Enclosed Corridors, Hoping Plant

Hilltop Platform Mining Combined with Enclosed Corridors to Reduce Dust Dispersion

The Hoping Plant extracts limestone using a hilltop platform mining method combined with a vertical shaft transport system. Both crushing and transportation within the mine occur inside tunnels, preventing noise and dust pollution, significantly reducing environmental impact, and ensuring the safety of transport personnel. After being processed by the vertical shaft and crusher, the limestone is transported directly to the plant via enclosed corridors, which reduces approximately 1,600 diesel truck trips daily and cuts annual carbon emissions by about 23,000 metric tons.

Transportation Management

First Company in Taiwan to Use Electric Tractors for Cement Transportation to Reduce Scope 3 Carbon Emissions

TCC and its subsidiary, Taiwan Transport & Storage, began using electric tractors for cement delivery in April 2024, expecting a 32% carbon reduction. Its ready-mix concrete plants and subsidiary Feng Sheng are replacing diesel mixers with eco-friendly models, reaching 92% and 57% adoption respectively by the end of 2024. TCC continues to expand its green fleet, currently operating 2 electric tractors, 2 electric heavy-duty trucks, and 1 patented electric compressor truck, with plans to add 10 more electric tractors and 4 electric trucks by 2025.

Action Spotlight

Fully Adopt Electric Tractors by 2025

Guigang Terminal

Through offering 'priority delivery rights', Guigang Plant encourages suppliers to participate in electrification by introducing 60 electric tractors on the 38-kilometer delivery route from plant to terminal. This has reduced costs by 15% and achieved an 87% annual carbon reduction per vehicle compared to diesel vehicles.

Baisha Port, Guangxi

Actively Responding to the International Maritime Organization's (IMO) Emission Strategy

Ta-Ho Maritime Targets 40% Carbon Reduction by 2030

TCC subsidiary Ta-Ho Maritime exceeds IMO requirements by equipping all cement vessels with shore power. The upcoming TAHO COMPLIANCE eco-vessel (2025) is estimated to achieve a 23.7% carbon reduction below EEDI Phase I using an intelligent management system and enclosed technology. The bulk carrier fleet also surpasses IMO's EEXI and CII standards, with 86% achieving A-grade. Ta-Ho continually reduces EEOI carbon intensity via AI shore power and smart routing. Full compliance with the Ballast Water Management Convention protects marine ecosystems, leading to the sterilization of 2.367 million metric tons of ballast water and offloading of 611 metric tons of waste oil to qualified facilities.

- Carbon reduction for cement vessels exceeded 2,300 metric tons.
- Installing Propeller Boss Cap Fins (PBCF), optimizing hull design, and route planning achieved over 2% fuel savings.
- Retrofitting 2 bulk carriers with high-power LED lighting saved over 208,000 kWh of electricity.
- During dry-dock maintenance, 6 vessels were fully coated with 11,304 liters of new AFS-compliant, energy-saving paint. Free of organotin, the paint prevents marine bio-adhesion, reducing navigation resistance for a 3% fuel saving.

Patented Electric Compressor Truck Deployed

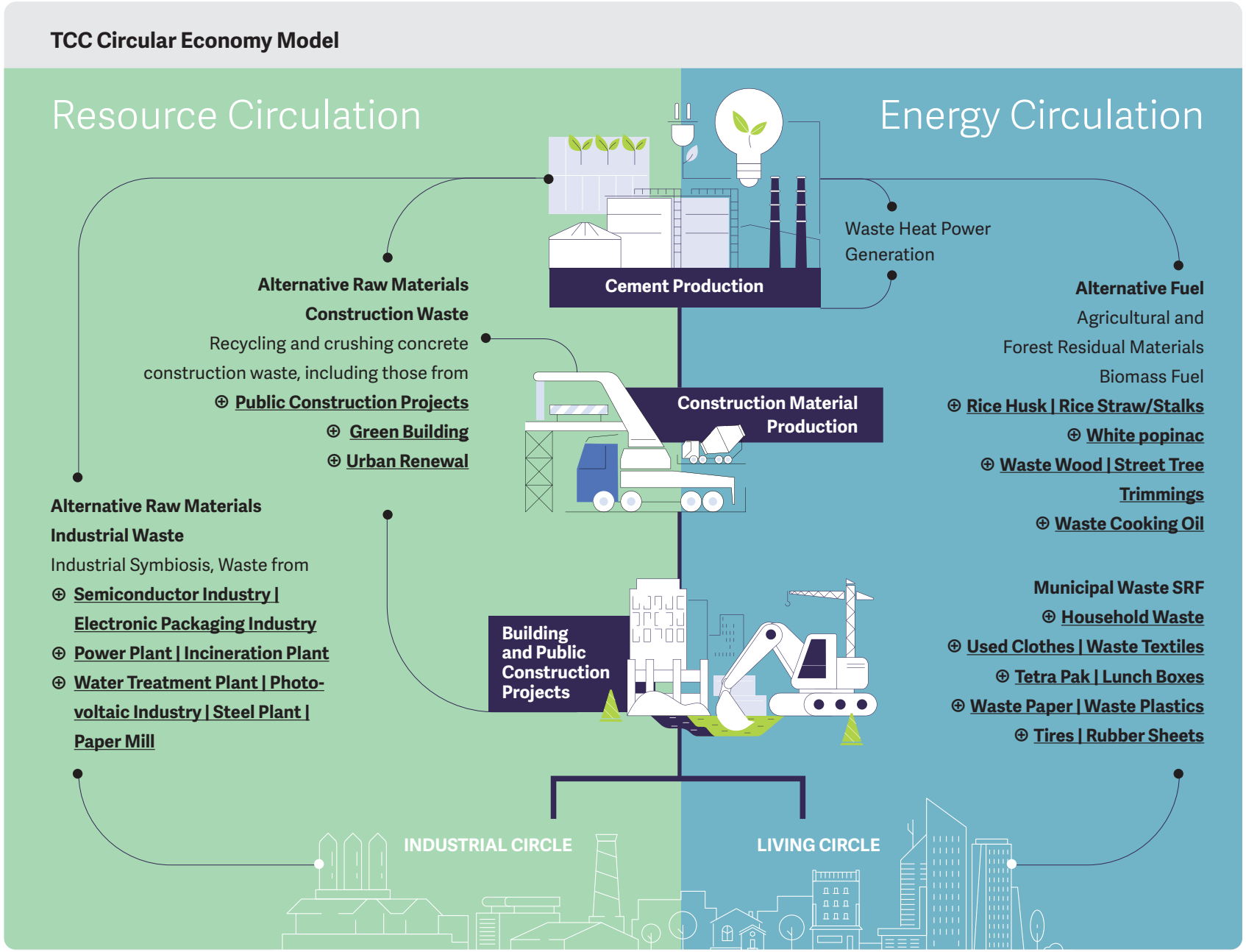
TCC's subsidiary, Taiwan Transport & Storage, developed a patented electric compressor truck, licensed in 2024, which uses an independent permanent magnet synchronous motor (PMSM) to power its compressor. It now transports SRF (Solid Recovered Fuel) for the Hoping Plant and external clients.

2.3

Resource Recycling

The co-processing technology used in cement kilns, known as the venous industry, detoxifies waste and enables the circular use of resources. According to a research report by the WBCSD, cement kilns, with an average temperature above 1,300˚C, can break down dioxins that incinerators are unable to process. They can also convert most human-generated waste into renewable resources that substitute for cement raw materials and fuels, thereby reducing both carbon emissions and fossil fuel consumption.

TCC Circular Economy Model



Alternative Raw Materials, Fuels, and Clinker

The GCCA states that alternative raw materials and fuels are fundamental to the cement industry's transformation, enabling a circular production model that reduces natural resource consumption. Utilizing these materials is a key method for reducing carbon emissions in clinker and cement manufacturing. TCC actively develops and applies diverse alternative materials, considering the geographical characteristics, industrial, and regulatory structure of each plant location, and collaborates with local governments and enterprises to secure stable material sources for trials. Furthermore, reports from the IEA and WBCSD identify reducing the clinker-to-cement ratio as another key decarbonization strategy

Accordingly, TCC incorporates materials like limestone, volcanic ash, and kaolin into cement products, guided by local regulations, permits, and market demand. For 2024 usage data in Taiwan, Mainland China, and at our CIMPOR and OYAK CEMENT subsidiaries, please refer to CH6.1 ESG Data Sheet. However, our cement plant sites in Taiwan must adhere to CNS 61, where chloride ion limits are stricter than global cement standards. These regulations hinder efforts to effectively raise the thermal substitution rate for alternative fuels or expand their use. Consequently, while developing material sources, TCC actively engages with regulatory bodies to discuss the feasibility of adjusting these CNS 61 chloride limits.

Low-carbon and Circular Economy Engagement Initiatives

- Adjustment of the chloride ion limit in the CNS 61 Portland Cement standards issued by the Bureau of Standards, Metrology and Inspection.
- Revision of the Public Construction Commission's Construction Specification.
- Matters related to the use of alternative fuels in coordination with the Ministry of Environment.
- Participate in discussions with the Ministry of Environment's Climate Change Agency to provide a definition for low-carbon cement.
- Participated in review meetings for draft amendments to the Environmental Protection Administration, Executive Yuan Guidelines for the Promotion of Carbon Footprint of Product Management.
- Supported the establishment of Green Factory Evaluation Criteria by the Industrial Development Administration, MOEA.

Action Spotlight

Alternative Raw Material

Waste Glass Fiber

Waste glass fibers from PCB manufacturing cannot be directly recycled as glass raw materials due to their irregular dimensions and surface contaminants. To address this, TCC is collaborating with PCB manufacturers to develop technology for using this waste fiber as an alternative raw material, with the goal of applying for reuse permits by year-end 2025.

Glass Powder

To mitigate potential shortages of common supplementary cementitious materials (SCMs) like fly ash and slag powder, developing new materials is crucial. Recycled and ground glass, a silico-aluminate material, can function as a pozzolanic SCM. TCC secured the related patents in 2025.

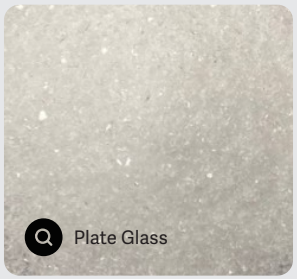


Plate Glass


Waste Container Glass

To address resource scarcity, TCC implements a circular economy. Materials rich in silicon, aluminum, iron, and calcium can be potential raw materials for cement production; therefore, waste from other industries can be reused. In concrete, we also substitute cement with slag and fly ash, reducing both material use and carbon emissions.

Extensive testing is required to stabilize alternative fuels due to their varying characteristics like calorific value and moisture. Suao Plant and the Industrial Technology Research Institute jointly completed the construction of a "Cement Kiln High Calorific Value SRF Co-firing and Clean Integration System" in 2023. This system is now undergoing performance verification. Successful SRF/wood chip tests in March 2025 defined an optimal mixing ratio.

TCC is actively developing clinker alternatives. The Cape Verde plant has abundant local pozzolanic volcanic ash. This resource enables the production of CEM II 42.5 cement, which replaces traditional clinker and its 750–800 kg/metric ton of CO_2 emissions, achieving carbon reduction without compromising strength. The enduring strength of the ancient Roman Pantheon built in 128 CE, suggests pozzolanic volcanic ash is a key to concrete's longevity. Additionally, kaolinite from Ghana serves as a clinker substitute that also improves energy efficiency, as it can be calcined at lower temperatures. The Ghana plant is scheduled to commence production by year-end 2025.

In 2025, TCC's Taiwan plants will also assess building a slag powder storage system to ensure stable supply and utilization. For products developed using alternative clinker, please refer to Carbon Competitiveness and CH2.1.

TCC KEY FACTS

2024 Alternative Fuel Usage Status	
Waste textiles	In continued use
Waste paper	
Waste plastics	
Waste wood	
Construction waste	
Rubber sheet	
Leucaena wood waste	
Non-hazardous oil sludge	Obtained case-by-case reuse application

2024 Alternative Clinker Usage Status	Plant/Facility
Limestone	Taiwan/Mainland China
Fly ash	Taiwan/Mainland China
Furnace slag powder	Taiwan
Calcined clay	Mainland China/Ivory Coast /Cameroon
Volcanic ash	Cape Verde
Kaolinite (requires calcination at 700-900°C)	Ghana Quarry

Action Spotlight


Chlorinated Ash Washing System At Guangan Plant

Alternative Raw Material

In 2024, the Guangan Plant implemented a fly ash washing system to remove water-soluble chloride ions. The washed ash is reused as an alternative raw material in raw meal, while the process yields sodium and potassium chloride by-products, maximizing resource use. Since 2021, the Jurong Plant has also utilized its "Fly Ash Water-washing for Dechlorination (FWD) with Zero Liquid Discharge and Salt Separation" technology to process municipal waste incineration fly ash for local power plants.

Alternative Fuel Fire Control

Rising global wildfires, intensified by drought and high temperatures, threaten ecosystems and industrial operations. For the cement industry, which heavily relies on biomass and solid recovered fuels (SRF) as alternative fuels, this escalates the risk of fire or spontaneous combustion, particularly when exposed to high temperatures, low humidity, or electrical anomalies. TCC mitigates this with rigorous fire protection standards, implementing temperature monitoring, water spray cooling, and automatic extinguishing systems from intake to feeding. For immediate detection, twelve plants in Mainland China and Taiwan's Suao Plant use infrared monitoring and sensors integrated with automatic sprinklers.

Cross-Industry Circular Symbiotic Network

Supporting Waste Resource Utilization Across Various Industries

Cement kilns feature high temperatures, long retention times, and high turbulence, ensuring complete combustion of materials without residue or dioxin formation. Leveraging these characteristics, TCC offers co-processing services to help various industries manage hard-to-treat waste. These industries include power, construction, steel, semiconductor manufacturing and packaging, chemical fiber, paper, waste incineration, and environmental recycling. By co-processing waste as alternative raw materials and fuels, TCC collaborates with industry, government, and local communities to build a circular economy. In 2024, TCC co-processed industrial waste in Taiwan, Mainland China, Türkiye, Europe, and Cameroon. For details, please refer to CH 6.1 Data Table.

TCC KEY FACTS

Total industrial waste treatment volume reached

9,157,049.3 metric tons

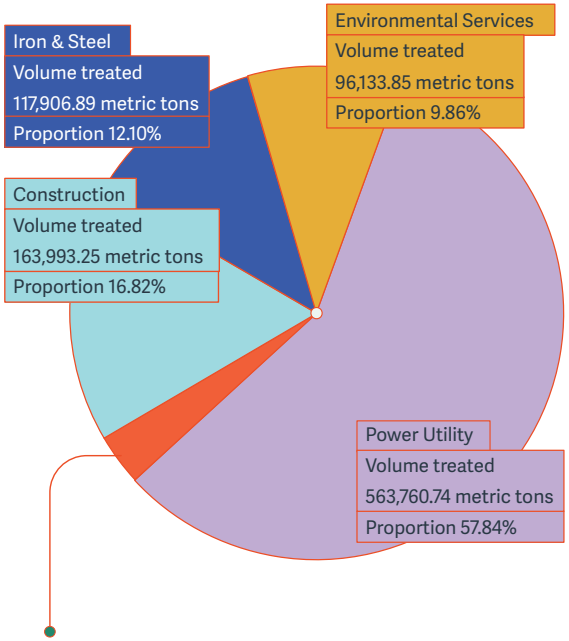
Taiwan plants processed a total of 974,744.29 metric tons

Mainland China processed a total of 7,475,785.32 metric tons

OYAK CEMENT & CIMPOR
processed a total of 706,520 metric tons

Taiwan — Source of Waste

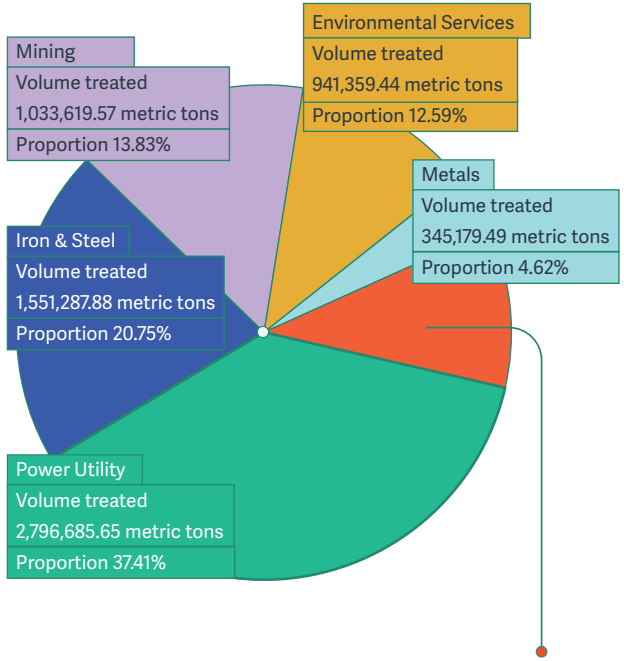
Industry Proportion %



Source Industry of Wastes	Volume treated (metric ton)	Proportion
Semiconductor	14,379.35	1.48%
Waste Incineration	5,671.55	0.58%
Self-treated	4,079.71	0.42%
Petrochemical	3,744.87	0.38%
Metals	2,782.59	0.29%
Paper	1,957.86	0.20%
Semiconductor Assembly	214.92	0.02%
Water Treatment Plant	118.71	0.01%

Mainland China — Source of Waste

Industry Proportion %



Source Industry of Wastes	Volume treated (metric ton)	Proportion
Chemical	307,392.28	4.11%
Construction	294,514.90	3.94%
Paper	172,163.00	2.30%
Tire	33,063.35	0.44%
Agroforestry	519.76	0.01%

Urban Sustainability Solution -
Household Waste Resource Utilization

Cities face two major waste challenges on the path to net-zero: construction and household waste. A 2021 National Oceanic and Atmospheric Administration report showed the largest atmospheric methane increase in 40 years. Methane's warming potential is 27.9 times that of carbon dioxide. Over 150 countries have signed the Global Methane Pledge, acknowledging landfills as a major methane source. In 2023, TCC launched TCC DAKA RRRC, Taiwan's first facility combining a cement kiln and gasifier to process local waste. It helps Hualien County process up to 200 metric tons of household waste daily, with the generated heat replacing some kiln fuel. The residual ash from gasification is also reused as a raw material in cement. TCC's cement plants in Mainland China collectively process over 600 metric tons of waste daily. TCC also uses its core cement expertise to provide waste treatment services that help local governments address methane pollution from landfills. To strengthen its material supply chain and cost control, TCC established a dedicated environmental technology business in Mainland China to secure material sources.

TCC KEY FACTS

2024 TCC Household Waste Co-processing Status (Unit: metric ton)

Plant/Facility	Household Waste Co-processing Volume	Reduced Methane Emissions
TCC DAKA RRRC	41,420.77	2,071.04
Shaoguan Plant, Guangdong	6,771.35	338.57
Anshun Plant, Guizhou	62,788.80	3,139.44
Jingzhou Plant, Hunan	41,828.10	2,091.41
Total	152,809.02	7,640.46

Action Spotlight

Household Waste Disposal Expanding Alternative Fuel Applications

Jingzhou Plant

The household waste treatment equipment at the Jingzhou Plant in Hunan was commissioned in September 2022, collecting household waste from townships around Huaihua City through a professional fleet. To further enhance the efficiency of waste resource utilization, plans are underway to introduce screening equipment in 2025, employing cyclone separation technology to efficiently extract combustible materials for use as alternative fuels. During the initial construction phase, the Jingzhou Plant reserved additional processing capacity to enable future expansion of its service areas to include municipal waste from Tongdao County and Huitong County.

Full Life Cycle Service for Buildings — Construction Waste Solutions

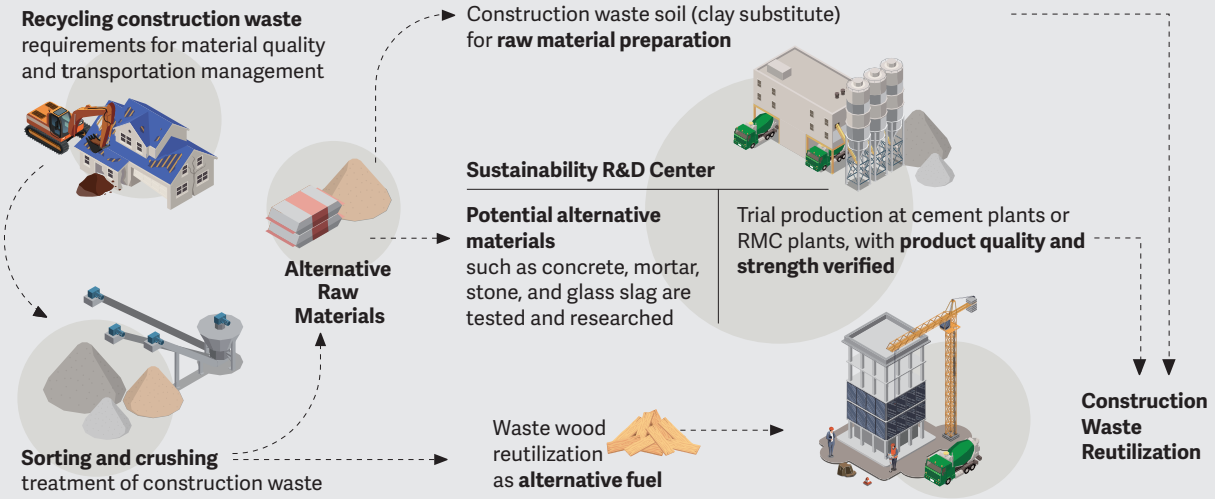
"We are currently dealing with astronomical figures in handling construction waste after demolition, and the handling is not adequate. In the future, what we hope to do is to recycle and reuse all the ready-mixed concrete after building demolition, which will not only reduce carbon emissions but also will not affect the strength quality."
--Chairman Nelson An-ping Chang

Taiwan generates over 2.1 million metric tons of construction waste annually (2022), with many recyclers unlicensed, making legal disposal a government priority. TCC addresses this by reusing construction waste (e.g., soil, wood) as alternative materials and fuels in its Taiwan and Mainland China plants. In 2023, TCC launched a new treatment project in Taiwan, completing trials by late 2024 and receiving approval for 12,000 metric tons/month, pending final permit. Also in 2024, Yingde Plant partnered with its municipal government to recycle urban renovation waste into materials for cement and roads through sorting, crushing, and analysis—establishing a circular model meeting all quality, strength, and emission standards.

Permeable concrete

Note 2: Reference: PTS News (2023)
https://news.pts.org.tw/article/668911

Construction Waste Disposal Process



OYAK CEMENT and CIMPOR Construction Waste Research and Development

After the magnitude 7.8 earthquake in 2023 that collapsed 300,000 buildings, Türkiye's Ministry of Environment invested in crushing and screening facilities for reconstruction. In 2024, OYAK CEMENT added auxiliary equipment to enhance processing efficiency, aiming to use 100% recycled aggregates from construction waste in concrete production, with full operations by end-2025.

CIMPOR's central laboratory in Portugal is developing technologies to turn construction waste into recycled concrete matching traditional performance. It's also advancing Prior Carbonation of concrete fines and by-products to create carbon sinks. Successful large-scale validation will accelerate recycling innovations in concrete, SCMs, and artificial aggregates.

TCC KEY FACTS

Construction Waste Processing Volume

Excluding existing alternative raw materials and fuels such as construction waste soil and waste wood

Taiwan Trial
3,500 metric tons

Yingde Plant (Guangdong)
21,832 metric tons