TCC

THE FUTURE IS WORTH IT

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2021 TCC

THE TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

2021
TCC
-
The Task Force on
Climate-Related
Financial
Disclosures

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This year has been a year of dark clouds enveloping the world, whether it is the outbreak of Russo-Ukrainian war in Europe, the COVID-19 surge in Asia and Taiwan, or the disruption of the supply chain of commodities all over the world, resulting in food shortages, and the highest inflation in the past two to three decades. This has inevitably caused uncertainty and pessimism about the future. It was also a year of immense challenges for TCC over the past decade or so. On the one hand, the exponential growth of energy prices and the rapid decrease in cement consumption in Mainland China have caused severe business pressure. However, all dark clouds will have a silver lining as long as we move in the right direction. Above the clouds, the sunlight will always radiate through the cracks of the clouds and give us a ray of optimism for the future.

Living in the 21st century, we are encountering a world of unknown uncertainties, no less risky than in the fifteenth century during the Age of Discovery. Although, today, we know much more about the world.

But an unjustified war has caused the death of countless innocent people and plunged the world into resource and energy shortages. This, coupled with a worldwide outbreak of infectious diseases has taken the lives of millions over the past three years, as well as adding to the ubiquity of waste plastics. The sudden shortage of energy has also worsened carbon emissions, leading to further global warming and other problems that pose a great threat to the future survival of mankind.

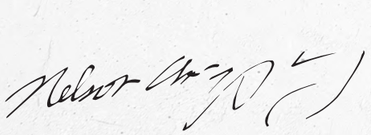
In fact, the reason why the human world has gone astray today is all of our own making because we have made a series of unjustifiable decisions. The only way to find the real answer is to turn to ourselves and change our thinking and behavior.

In this era, we need to awaken to a sense of coexistence on the scale of the entire planet, a globalization of the mind, a re-creation of keywords that each person uses to think in the face of the epidemic, in the face of climate change, and the face of a more ideal and just society. That is, we should no longer think in terms of "I", but "we".

WE, in full capitalized letters,
is an essential step toward a sustainable future for humanity.

But unfortunately, this year at the World Economic Forum in Davos, it seemed the world is going backwards and shrinking away from globalization and towards a regional economic bloc, a model where nations put their own national interests above all else. We can no longer continue to live a self-serving lifestyle that only considers the present. Most wars are fought for the personal powers or interests of politicians; there are only a few instances that were fought for freedom and life.

The next leap forward for humankind is bound to be a sustainable revolution. This is no longer a paradigm change driven by technology, but more like a rebuilding of the mind, creating our mental framework with a sustainable mindset.



Nelson An-ping Chang
Chairman
TCC

Commitment to Action for the Common Good

2022 has turned out to be an unsettling year.

The year sees the world in turmoil and unrest as extreme weather conditions intensify, including rare rainfall on the Greenland ice sheet, heat waves causing havoc across Europe, flooding in South Africa and torrential rains in Asia, all exacerbated by the continuing spread of the pandemic, not to mention war and conflicts. The United Nations Intergovernmental Panel on Climate Change (IPCC) points directly to the phenomenon of human-induced climate change, which has caused a profound negative impact and irreversible environmental crisis around the world, endangering the survival of a large number of terrestrial and marine species. As many as 3.6 billion species, nearly half of the world's population, live in a fragile environment vulnerable to climate change. What's more, the effects of climate change do not stop at ecological species, but also threaten the food, water, cities, health, and well-being of modern human society.[1]

The environment is the last frontier of human beings, which is all the more reason why human beings should live in harmony with the environment and take care of each other. As a corporate citizen and part of the earth, Taiwan Cement Corporation (TCC) profoundly recognizes the global impact of climate change and plans. It implements sustainable climate mitigation actions in conjunction with its core businesses. The Board of Directors is the highest decision-making body for climate risks and opportunities, and regularly oversees the direction and progress of the company's sustainability and low-carbon strategies. Through the three core businesses of "Low Carbon Emissions Cement, Resource Circulation, and Green Energy", TCC is promoting seven carbon reduction strategies with Science Based Targets (SBT) to continuously mitigate climate risks and refine carbon negative technologies. We are committed to resolving the conflict points between human beings, industries, and the environment. In 2022, TCC is promoting the EARTH HELPER sustainability initiatives, which will link up sustainability partners across disciplines to promote a low-carbon, energy-saving and slow-living lifestyle, and share the earth in co-prosperity and mutual benefit.

TCC's Climate Milestones

TCC supports and actively participates in international initiatives on issues related to climate change, circular economy, and research and development of new low-carbon technologies, leading the green transformation of the cement industry with comprehensive carbon reduction strategies and innovative technologies. After committing to the science-based targets (SBT) in 2019, TCC passed the scientific review in June 2020 and became the first cement company in East Asia to complete SBT target setting. In 2022, TCC officially became a member of the climate organization CLIMATE GROUP EP100, the first large manufacturing company in Taiwan to join EP100 for energy efficiency improvement, and only the fourth cement company in the world to pass the EP100 audit. Looking ahead, we will continue to actively carry out actions with "Low Carbon Cement, Resource Recycling, and Renewable Energy" as the main axis of our development for the next decade.

2022
- Issued climate-related financial disclosure report
- TCC became the first EP100 member among Taiwan's large manufacturing enterprises.

2021
- Launched new energy businesses and entered the global energy storage and charging pile market
- Responded to the EP100 initiative
- Joined Business for Nature
- Joined Taiwan Alliance for Net Zero Emission (founding member)
- TCC's Hoping and Su-Ao Plants' Type I cement obtained the EPA Carbon Reduction Label
- CDP Supply Chain Industry - "A" Grade Supplier Engagement Leader
- MSCI ESG Rating BBB (upgraded for three consecutive years from 2019 - 2021)
- Sustainalytics ESG Top-Rated (2020 - 2022 for three consecutive years)
- Selected as a member of the DJSI Sustainability Yearbook

2020
- Established TCC's Risk Management Committee
- Committed to GCCA's ambition of delivering carbon neutral concrete by 2050
- Established TCC's carbon emissions management platform
- Completed science-based reduction target setting

2019
- Constructed the first integrated wind and solar power plant in Taiwan
- Applied for the first fishery and solar symbiosis project in Taiwan
- Commenced support to the TCFD initiative
- Committed to the Science Based Target (SBT) Reduction
- Began cement carbon footprint inventory project

2018
- Established TCC Green Energy Corporation
- Obtained BS 8001 Circular Economy certification
- Established TCC's Corporate Sustainable Development Committee
- Joined the Global Cement and Concrete Association (GCCA)

2017
- Initiated the transformation of carbon reduction blueprint

2015
- Joined the carbon dioxide capture and storage (CCS) research and development consortium established by the Ministry of Economic Affairs

2011
- Established Asia's largest calcium-looping carbon capture pilot plant at Hoping Cement Plant.

2000
- Established the first circular economy park in Asia with a cement plant, a thermal power plant and an port integrated into one industrial area.

Actively Participate in Policy Negotiations to Lead the Low-Carbon Transformation of the Industry

Apart from actively promoting low-carbon transformation, TCC also actively engages in policy discussions with the government, participates in public hearings on sustainability-related policies, and works with domestic and foreign associations to develop strategies. TCC is committed to sharing the cement industry's experiences and challenges in low-carbon transformation with industry, government, and academia through discussions and exchanges of opinions to promote the transformation of the industry as a whole.

TCC is a member of the Global Cement and Concrete Association (GCCA), and in September 2020, TCC joined 40 benchmark cement companies around the world to commit to the "2050 Cement and Concrete Industry Roadmap for Net Zero Concrete" and is responsible for providing an integrated assessment of the feasibility of a decarbonization roadmap for Taiwan's cement industry in Asia and the direction of low carbon transformation for the next 30 years, as well as participating in and advising on the Science-Based Targets Initiative (SBTi) "SDA Net Zero Roadmap for the Cement Industry" (Cement Science Based Target Setting Guidance). In 2021, TCC participated in more than 30 seminars and conferences, and collaborated with international peers and scholars to develop carbon neutral roadmaps and exchanged carbon reduction experiences and specific practices. On October 12 of the same year, TCC Chairperson An-Ping Chang was invited to participate in the GCCA High Level CEO Panel and discussed the industry's carbon reduction strategy with cement companies in the Americas, Europe, Asia and Africa. The panel jointly announced a 25% carbon reduction by 2030, in an effort to achieve the net zero carbon emissions target by 2050.

As a founding member of the Taiwan Alliance for Net Zero Emission (TANZE), TCC, together with the Taiwan Institute for Sustainable Energy (TAISE) and cross-disciplinary corporate members, launched the "Net Zero 2030/2050 Initiative", which commits the operation headquarters, offices and production sites to achieve 100% net zero carbon emissions by 2030 and 2050 respectively. TCC has already obtained the Green Level net zero label in 2022. TCC also attended the policy dialogue meeting of Taiwan's Climate Change Response Act (Draft) held by TANZE, providing industry perspectives and practices for reference in the development of regulations, and actively echoing the "Taiwan's Pathway to Net-Zero Emissions in 2050" initiative proposed by the Taiwan government this year.

TCC participated in the annual meeting of the Taiwan Concrete Institute (TCI) and presented 7 research papers and participated in the meeting on the revision of national cement standards held by the Bureau of Standards, Metrology, and Inspection of the MOEA (BSMI). The BSMI later increased the total content of cement additives from the original 5% limit to 10%, so that low-carbon cement could be gradually implemented in compliance with Taiwan regulations.

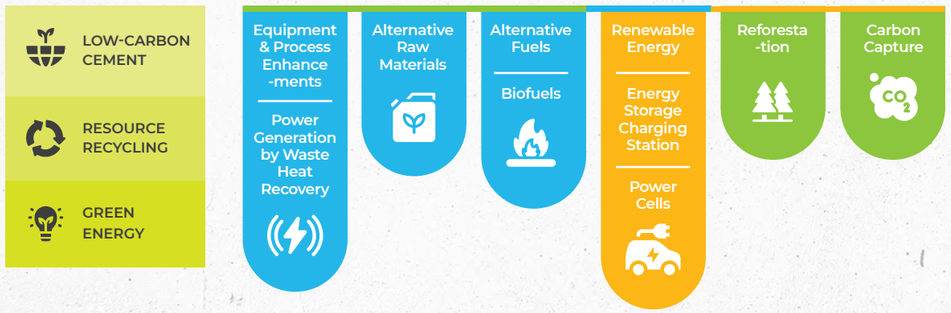
ONLINE PANEL DISCUSSION:

- High Level CEO Panel
- Concrete Future – Roadmap to Net Zero
- Amendment to the 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete in response to COP26
- SBTi – SBTi Promotion Progress
- Task Group – Professional project discussion, technical R&D, and sharing on carbon reduction
- GNR – Data and discussion on carbon emissions from the cement industry
- Green Procurement – Discussion on green procurement

TCC's 2050 Net Zero Transformation Roadmap

In 2021, TCC officially announced the Group's net-zero strategy, regularly reviewing the implementation status and proposing improvement actions through various sustainability-related meetings. From the three core business sectors of TCC, we will link the 2025 SBT and 2030 mid-term carbon reduction targets, and develop a clear carbon reduction path from the perspective of global and specific quantitative management, covering seven carbon reduction strategies and integrating multiple aspects towards the 2050 net zero targets.

Illustration of three core business sectors and seven carbon reduction strategies



Potential Challenges and Opportunities in the Transformation Process

The cement industry belongs to the Hard-to-abate Sector[2], invariably posed with many potential challenges in the process of carbon reduction. At this stage, the most pivotal carbon reduction challenges TCC is subject to are derived from the regulatory restrictions on the chloride limit in cement, the proportion of cement mixes used, and breakthroughs in carbon capture technology bottlenecks. The former involves cement clinker ratio, alternative raw material types, and chloride content are stringently restricted by regulations, and TCC actively communicates with the government through the Taiwan Cement Manufacturer's Association (TCMA). TCC provides information on international regulatory trends and key points in the process of developing carbon reduction technologies, as a reference proposal for regulatory standard adjustments. In 2021, TCC also replied to the Industrial Technology Research Institute (ITRI) on TCC's proposal to adjust the limit value of chloride in cement specifications from the current 240ppm to 350ppm. Through the TCMA, TCC responded to the BSMI on the revision of the national standards for cement-related test methods.

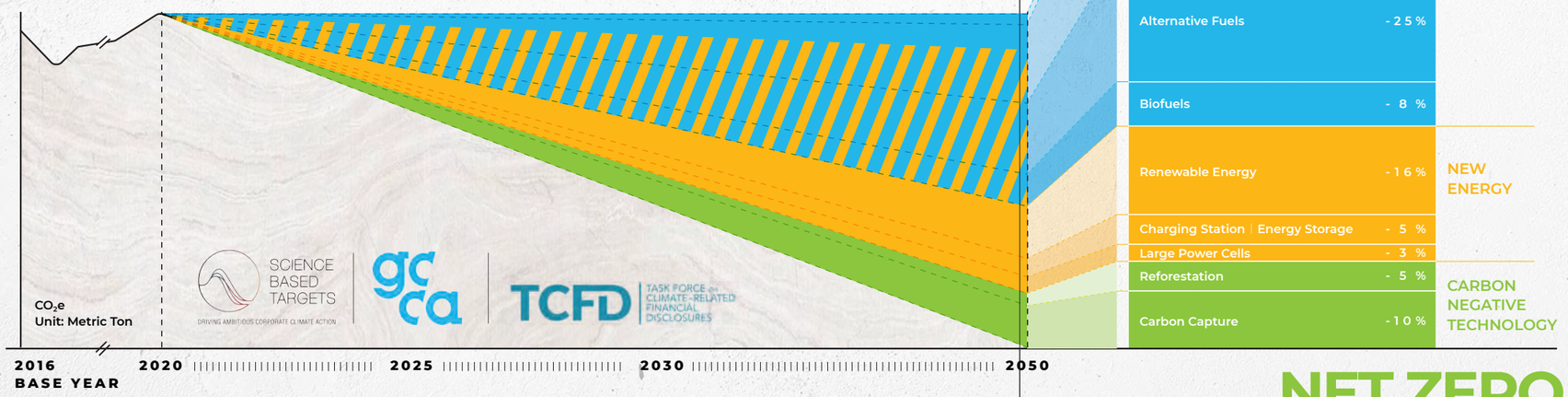
Although the national standard CNS 61 has increased the total content of cement additives from the original 5% limit to 5% limestone and 5% inorganic process additives[3]. However, the capacity of alternative raw materials that can be added today is still insufficient, such as the limited source capacity of slag to meet the demand of cement production.

Therefore, TCC will continue to develop other alternative fuels and materials in order to effectively utilize the benefits of regulatory adjustments and enhance the effectiveness of alternative fuels and materials in reducing carbon emissions. Carbon capture technology is a promising carbon reduction strategy for the cement industry as a whole. However, it is still in the early stage of development and still faces many technical bottlenecks. Based on the experimental results of carbon capture technology, TCC will adopt oxygen-enriched combustion technology to reduce the use of coal and increase the use of alternative fuels at the front end of the cement production process to reduce carbon emissions from combustion during the production process.

TCC continues to pursue opportunities for low carbon transformation. In addition to applying for national subsidies related to energy saving and carbon reduction, TCC also participates in carbon reduction conferences, policy communication and expert meetings with government agencies to share industry experiences. In 2021, TCC attended various conferences, including a discussion on net-zero emission pathways for Taiwan's manufacturing industry at the Advisory Platform for Policy Recommendations on Sustainable Transformation and Carbon Reduction of Academia Sinica (Center for Sustainability Science). TCC also participated in the EPA's Expert Meeting on Solid Renewable Fuels and Alternative Fossil Fuel Reduction Methodologies, as well as the Meeting on Carbon Pricing Package and CCUS Carbon Reduction Potential of Taiwan, organized by the Industrial Development Bureau, Ministry of Economic Affairs. TCC actively participates in the discussion of carbon fee reduction conditions for the cement industry in the amendment to the Greenhouse Gas Management Act, and supports the promotion of the carbon trading system, as well as provides experiences in the implementation of carbon capture technology and proposals for application planning in the cement industry. In the future, TCC will continue to actively invest resources and take practical actions to lead the industry to break through the challenges of carbon reduction in the cement industry.

TCC's Roadmap to 2050 Net Zero

SOURCE: TCC 3Q21 INVESTORS' CONFERENCE



1.1_ Board of Directors' Governance Structure and Oversight Mechanism

The Board of Directors is TCC's highest decision-making body for climate risk, and oversight on the Company's climate change governance and management structure is directly supervised by the Board of Directors. The Board of Directors has established the "Corporate Sustainable Development Committee", which is responsible for overseeing the strategy and implementation of corporate social responsibility and sustainable management issues, including low-carbon issues related to climate governance. In addition, the Risk Management Committee of the Board of Directors is responsible for identifying and managing climate change risks and spearheading the planning of related responses.

TCC also takes concrete actions to implement the concept of sustainable development and climate change adaptation. The Board of Directors reports annually on risk management and corporate sustainable development through the Risk Management Committee and the Corporate Sustainable Development Committee, respectively, to monitor and track the implementation of climate risk management and the achievement of performance targets.

TCC Climate Change Governance and Management Framework

Board of Directors
Highest Decision-Making Unit for TCC's Climate Change Topics

Corporate Sustainable Development Committee
Approve and supervise sustainable development tasks

Corporate Sustainable Development Taskforce
Execute sustainable projects and provide suggestions, indicators and targets

Risk Management Committee
Assess climate-related risks and opportunities; supervise established risk management mechanisms

Risk Management Taskforce
Assess and analyze climate-related risks and opportunities; execute climate-related strategies and action plans

The Board of Directors oversees the Group's sustainability and climate change projects

In 2021, the Board of Directors oversaw projects related to TCC's climate change strategies, including external advocacies, carbon labeling of cement products, carbon management in the value chain, TCC's sustainability report disclosure plan, and financial disclosure of climate-related risks and opportunities.

Sustainability Initiatives
Participation in the Global Cement and Concrete Association (GCCA), Taiwan Alliance for Net Zero Emission, and Climate Group EP100.

Value chain carbon management
Promote carbon inventory practices for suppliers across the Taiwan Strait

Product carbon footprint management
Hoping and Su-Ao Type 1 cement plants obtained cement carbon reduction labels

Sustainability report framework planning
Three cores "Low Carbon Cement, Resource Recycling, and Renewable Energy" as the main axis of the structure

Progress of implementation of financial disclosure of climate related risks and opportunities
—
financial impact and implementation of response strategies after identification of risks and opportunities

Enhancement of the Board of Directors' awareness and knowledge of climate change

Board of Directors attended

122 HOURS

of ESG-related courses in 2021

including

30 HOURS

of courses related to **climate governance and sustainable development**

	Corporate Sustainable Development Committee	Risk Management Committee
Members	Composed of 3 members, the Chairman of the Committee is the Chairman of the Board of Directors. The other two members are President Jong-Peir Li and Independent Director Victor Wang	Composed of 3 members, the convener is Independent Director Shiou-Ling Lin. The other two members are Independent Director Victor Wang and Independent Director Lynette Ling-Tai Chou.
Frequency of meetings in 2021 attendance of members	**2 times, 100% attendance**	**2 times, 100% attendance**
Authority and Responsibility	Oversee a series of sustainable development strategies and implementation plans drawn up under the Company's climate commitment, and approve the relevant targets and goals proposed by the executive team of the Sustainability Management Committee, track their implementation and review their effectiveness, and report to the Board of Directors at least once a year or more.	Identify and manage the Company's climate risk management and improvement mechanisms, and review the risk management reports submitted by the functional units that actually manage the risk issues, and report on the implementation of climate risk management to the Board of Directors at least once a year. If deemed necessary, submit proposals for improvement to the Board of Directors for approval.
Content of the 2021 Review Meeting	▪Promotion of sustainability projects from 2020 to 2021, including SBT, sustainability Initiatives participation, and low-carbon product management. ▪Main axes and timeline of the sustainability report	▪Annual update of the Company's seven major risk aspect identification matrices ▪Current status of TCFD implementation

1.2_ Management's Authority and Responsibility

Under the Corporate Sustainable Development Committee of TCC's Board of Directors, the Corporate Sustainable Development Working Group consists of eight executive task forces, including "Corporate Integrity and Risk Management", "Eco-Manufacturing", "Sustainable Products", "Employee Care", "Social Care", "ESG Finance", "Information Security" and "Supply Chain", which are composed of first-level executives and senior staff from each relevant department. The task forces identify ESG-related businesses according to the functions of each department, and are responsible for optimizing strategies and actual implementation. Every year, the task forces shall confirm the relevant promotion and future planning in writing and through meetings. The Executive Secretary of the Committee compiles and submits them to the Corporate Sustainable Development Committee.

In order to improve risk assessment and strengthen management functions, TCC's Board of Directors resolved in May 2020 to establish a "Risk Management Committee" with the President as the highest management level responsible for climate related issues. Under the Risk Management Committee, a Risk Management Working Group is set up, with first-level executives from relevant departments as representatives, to identify risks in the seven major aspects of operations, finance, legal compliance, human resources, national security, information security, and ESG according to the functions of each department, and to formulate strategies and implement them into practice.

	Corporate Sustainable Development Working Group	Risk Management Working Group
Members	Engineering Affairs, Human Resources, Sales, Finance, Procurement Department, General Affairs, R&D Department, Legal Office, Internal Audit and Compliance Office, Compliance Office Board Secretariat, and Sustainability and Responsibility Office, etc. 11 departments and units, and the first-level directors of 6 affiliated companies, including TCCI, TCC Green Energy, NHΩA TCC, E-One Moli, Hoping Port, and Hoping Power Plant.	First-level executives from the Sustainability and Responsibility Office, Finance Department, Engineering Affair Department, Legal Office, Sales Department, R&D Department, Information Security Management Committee, Human Resources Department, Materials Management Department, and Compliance Office Board Secretariat
Communication frequency in 2021	**7 times**	**2 times**
Results in 2021	▪Implemented carbon reduction strategies to reduce the carbon intensity of cement plants in Taiwan by 5.1% and in Mainland China by 3% (base year 2016). ▪Resource recovery of waste as alternative fuels, with a treatment volume of 1.141 million tons in Taiwan and 8.069 million tons in Mainland China. ▪More than 190 MW of renewable energy was installed, and 28,161 kW of renewable energy was self-generated (cumulative figure until the end of 2023). ▪Energy storage capacity reached 2.9 GWh, covering Taiwan, Mainland China and Europe; high-end lithium battery capacity reached 3.3 GWh/year (all estimated to 2024). ▪Invested in power generation by waste heat recovery system, generating 138,257,000 kWh of power from waste heat, equivalent to a 31% reduction in purchased electricity for the year. ▪Obtained ISO 46001 water efficiency management system certification and set water reduction targets: 50% reduction in water intensity in Taiwan by 2030 and 30% reduction in Mainland China by 2030 (base year 2016). ▪Carbon capture technology scale-up verification measures under development ▪Promoted carbon inventory of suppliers, with 61.5% of greenhouse gas inventory of key suppliers in the 1st phase of implementation.	▪Annual update of risk identification matrix for seven major aspects: operations, finance, national security, legal compliance, ESG, personnel and information security. ▪Conducted qualitative and quantitative analysis of financial impacts of risks and opportunities

In response to the management's approach to overseeing climate issues, TCC has taken various climate actions. The Company held meetings at least once every two weeks or once a month to implement climate management responsibilities and make major climate related decisions. On the other hand, in order to have a practical grasp of progress on climate issues, the Chairperson held regular meetings with the President and Vice Presidents of functional units to monitor the current status of climate issues.

Meeting name	Title of participating departments or personnel	Main discussion items	Meeting frequency	Major resolutions in 2021
Interdepartmental Monthly Meeting Report	Senior executives of Engineering Affairs, Finance, Sales, Procurement department, Human Resources, Cement Plant, and RMC Plant	Market operations, monthly profit and loss, material procurement, alternative fuel and material use, carbon emission status	Once/ month	The carbon emission intensity (tCO2/Metric Ton of Cementitious Materials) of cement plants in 2022 is targeted to be reduced by 3% compared to 2021 and included in the quarterly bonus carbon emission assessment target of each plant
Biweekly Meeting on Environmental Protection	Engineering Affairs, R&D, Finance, Mainland Cement Plant, Su-Ao Plant, and Hoping Plant	● Survey on the types, sources and quantities of alternative fuels and materials, setting of disposal price mechanism, use of alternative fuels and materials, and construction of waste disposal projects ● Ultra-High Performance Concrete (UHPC) Test Progress Report	Once/ 2 Weeks	● Alternative fuel and materials acceptance criteria and prices ● Application for Carbon Reduction Label for <Hoping Plant> and Carbon Label and Carbon Reduction Label for <Su-Ao Plant> ● Price and quality determination for disposal of waste from other industries ● UHPC dry mixing equipment and plant planning
SBT Meeting	Cement plant senior level and middle managers, Engineering Affairs managers, R&D managers	● Cement plant carbon emission intensity tracking and analysis ● Cement plant carbon reduction project implementation progress tracking ● Tracking the use of alternative fuels in cement plants. ● Planning of alternative fuel intake, storage and feeding process	Once/ 2 Weeks	Carbon Reduction Related Projects **Hoping Plant** Investment in cooling machine renovation equipment Investment in denitrification ultra-low emission technology improvement project Investment in additional wood chip feeding equipment Investment in solar power generation facilities in cement plant 4,118 kWp **Su-Ao Plant** Investment in kiln nozzle pipe enhancements Investment in alternative fuel treatment, storage and transportation system construction Investment in cooling machine equipment enhancements Investment in technical improvement of power generation by waste heat recovery systems Investment in cement mill main dust collector and exhaust fan to variable-frequency drive models Investment in oxygen enriched combustion systems Investment in additional wood chip feeding equipment Investment in 1,842KWp of solar power generation in cement plant

ESG Performance-Linked Remuneration Policies

To implement and enforce ESG, TCC continues to track its sustainability strategy's mid- and long-term goals and the performance of various non-financial indicators, which are subsequently incorporated into the performance evaluation system tied to the remuneration of senior executives. TCC also includes the performance results of the aspects of corporate governance, green finance, social care, and sustainable environment in the personal performance evaluation of the President, and the Remuneration Committee reviews the contribution to the Company's operation and the reasonableness of the remuneration before resolution by the Board of Directors. In addition, TCC also links each plant's carbon reduction target achievement rate to the performance evaluation and salary incentive of each respective plant.

For details, please refer to **5.2 Carbon Reduction Indicators for Each Plant Linked to the Performance-Based Remuneration System.**

2.1_ Climate Risk Identification and Assessment Process

TCC established the Risk Management Policy and Principles in August 2020. The highest decision-making unit for risk management is TCC's Board of Directors, which is responsible for reviewing TCC's risk management policies and monitoring the operation of risk management. With regards to risk issues, TCC conducts risk identification and analysis in the seven major aspects of operations, finance, legal compliance, HR, national security, information security, and ESG according to business areas, and climate change risk has been incorporated into TCC's overall risk management process. In accordance with the TCFD framework, climate risk identification is conducted, and based on the risk identification results, each department conducts strategic planning to integrate and manage risks that may affect operations and profitability, and the Risk Management Committee submits a risk control report to the Board of Directors annually.

TCC is currently evaluating climate risk identification for TCC's cement business in Taiwan and Mainland China. Primary considerations include that these two regions accounted for nearly 84% of the Group's revenue in 2021, and the Group's carbon emissions are mainly concentrated in the cement business.

CLIMATE RISK IDENTIFICATION PROCESS

RISK IDENTIFICATION → **RISK ASSESSMENT** → **ADAPTATION** → **SUPERVISION AND TRACKING**

Through external issues such as international scientific and technical reports, operating location regulation trends, domestic and international industry-related disclosures, and internal communications within TCC, the Company collects feedback on climate risk factors and identifies the types of risks, including physical risks such as extreme climate and water management crisis, and transformation risks such as policy, legal, reputational, and market risks.

TCC convenes the relevant departments to jointly evaluate and consult with external consultants and experts, and then evaluates the possibility of occurrence and the degree of operational impact, thus arriving at an agreed risk matrix, confirming the risk level and ranking its significance.

For details of the risk identification results, please refer to 2.2 Short-, Mid- and Long-Term Climate-Related Risks and Opportunities.

The financial impact materiality threshold is based on the average pre-tax net income over the past 3 years, and adopts four levels to indicate TCC's risk tolerance capabilities:

Level	4	3	2	1
Impact Level	Severe	Serious	Normal	Minimal
Pre-tax net income range	>15%	10≤15%	5≤10%	<5%

TCC implements various strategic actions in response to major climate risks and opportunities, from climate policy, operations management, and product service to external communication, etc.

Please refer to 3 Comprehensive Climate Strategy for details.

Review respective strategies through regular meetings, and monitor the carbon reduction amount of each plant through the carbon reduction management platform. The Risk Management Committee submits annual risk control reports to the Board of Directors, and discloses the results of GHG management and environmental management in TCC's sustainability reports.

2.2 Short-, Mid- and Long-Term Climate-Related Risks and Opportunities

In light of global warming and the possible operational impact of extreme weather patterns, TCC is taking concrete actions to assess and participate in climate change mitigation and adaptation. With the senior management team highly concerned about the possible climate risk of the company, TCC has established inter-departmental working groups to systematically identify the climate risks and opportunities of TCC, integrate the existing risk management procedures, and submit regular reports to the Board of Directors and the climate change adaptation strategies.

In accordance with TCFD guidelines and industry-specific recommendations, TCC has optimized its climate risk and opportunity assessment by analyzing international research on climate science and low-carbon technologies, collecting climate regulations for its operating locations, and considering industry characteristics to identify risk factors relevant to TCC, so as to optimize climate risk and opportunity assessments. Through interdepartmental communication and external expert consultations, we studied possible scenarios and evaluated the impact and timing of the impact on TCC, and finally focused on the 7 major climate risks and the opportunities arising from them. We plan specific strategies and integrate them into six strategic aspects - low-carbon circulation, natural disaster adaptation, supply chain mutual benefit, low-carbon products, R&D innovation, and new business ventures - to kickstart the deployment of climate transformation strategies[4].

Emerging Climate Risks Identification Process

01_Risk Factors Collection

- ★ 17 key risks of high relevance to the cement industry
- ★ 10 derivative opportunities of high relevance to the cement industry

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- ★ International scientific and technical reports and publications
- ★ Regulatory trends in areas where TCC has a presence

Industry related disclosures

02_Assessment of Impact on TCC

- ★ 7 interdepartmental meetings
- ★ 5 evaluation questionnaires

- ★ Interdepartmental research
- ★ Business Impact Assessment
- ★ Risk Factor Analysis

03_Risk Factor Analysis

- ★ 7 Key Identified Risks
- ★ 6 Derivative Opportunities

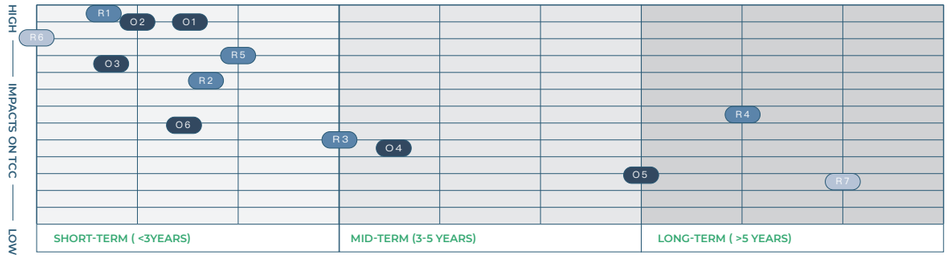
- ★ Impact on TCC
- ★ Time of occurrence

04_Strategic Response

- ★ 6 major strategic aspects

- ★ Establishment of mid- and long-term science-based targets
- ★ Life cycle environmental footprint management
- ★ New business development

Climate Risk and Opportunity Matrix



OPPORTUNITIES

- O1 Smart low-carbon production and waste co-processing
- O2 Involvement in the carbon trading/renewable energy/energy storage markets
- O3 Differentiation for competitiveness elevation
- O4 Expansion into the new energy business
- O5 Application of carbon capture technologies
- O6 Securing inventors' willingness for long-term investment

TRANSITION RISK

- R1 Costs in the low-carbon technologies, equipment and management
- R2 Carbon cap and trade, carbon fee, and carbon tax systems
- R3 Regulations and procurement of renewable energy
- R4 Decommission of Hoping Power Plant
- R5 Impacts to Corporate Image

PHYSICAL RISK

- R6 Increased costs in transportation and equipment maintenance arising from heavy rainfall/severe typhoon/flood
- R7 Increased transportation costs arising from drought

Climate change risks and opportunities and strategies to address them

Risks to TCC	Derivative opportunities	Financial Impacts	Strategic response measures
Low carbon technology, equipment and management cost investments	Smart low carbon production and cement kiln co-processing of wastes	Capital expenditures	Establishing SBT and moving toward carbon neutrality in the long term
Total carbon emissions and carbon trading, carbon fee and carbon tax system	Involvement in carbon trading/renewable energy markets	Operating costs	Introduction of 7 key strategies, including alternative fuels and materials, equipment & process enhancements, power generation by waste heat recovery, carbon capture, renewable energy, and reforestation.
	Differentiation to enhance competitiveness		Construction of recycling centers and waste co-processing projects to increase the use of alternative raw materials and alternative fuels
			Carbon emission intensity performance included in the annual bonus assessment
Renewable energy regulation and procurement	Expansion of new energy business	Capital expenditures	divest into clean energy and energy storage business, actively developing new energy sources such as solar, biomass and geothermal energy
Decommissioning of Hoping Power Plant	Carbon capture technology development and application	Operating costs	Continued development of carbon capture technology for long-term scale-up and economization
		Revenue	TCC's power plant has planned efficiency upgrades to equipment, and intends to complete the renewal of two low-pressure generators in 2022 and 2024, respectively.
			Planned the transformation of fuel into a biomass-fired low-carbon power plant, with a target of over 50% wood pellets and an increase in the proportion of syngas combustion.
Corporate image impact	Stabilize investors' long-term willingness to invest	Investment and fundraising	Establish dedicated ESG departments
			Regular communication with institutional investors/media on specific results
Increased transportation and equipment maintenance costs due to heavy rainfall/typhoon flooding	Strengthened operational resilience	Operating costs	Real-time monitoring of rainfall, water level and water condition changes to establish emergency response coordination mechanism for production and sales
Increased transportation costs due to drought		Operating costs	Utilize real-time information from the Water Resources Administration to monitor water conditions and formulate water shortage countermeasures
			Real-time data dashboard: adopt the most appropriate inventory and transportation flexibility
			Utilize WRI's scientific model to assess the physical risk of each production site

CHAPTER 03

Comprehensive Climate Strategy

3.1_ Low carbon Production Cycling

Low carbon circulation strategy

Increase use of alternative raw materials	Continue to develop alternative raw materials to replace raw materials in the clinker process and clinker substitutes in the cement process, and maximize the external benefits of cement kiln waste co-processing
Increase use of alternative fuels	Continue to expand alternative fuel sources, reduce coal use, and maximize the external benefits of cement kiln waste co-processing.
Apply power generation by waste heat recovery technology	Improve heat recovery and power generation efficiency
Develop carbon dioxide capture technology	Continue to break through the threshold of carbon capture technology and develop negative carbon technology.
Equipment & Process Enhancements	Optimize manufacturing processes and energy-saving equipment, introduce ISO international certification and join the EP100 Energy Productivity organization to continuously improve energy use efficiency.
Reforestation	Expanded afforestation, utilizing natural carbon sequestration capacity to reduce environmental impact
Install renewable energy facilities in the factory	Instead of purchasing green power certificates as a means to reduce carbon emissions, we are developing green energy through a dual-track approach of self-generation and self-development.

Unit: NT$

Management capital or cost investment	Alternative fuel and material	Energy saving and carbon reduction equipment	Equipment & Process enhancements	Renewable energy equipment	Electric vehicles	Total
2020	98.06 million	580 million	390 million	3.96 million	0.21 million	1.1 billion
2021	460 million	4.14 billion	1.89 billion	23.33 million	1.97 million	6.5 billion
2022 including projected investments	410 million	2.29 billion	1.51 billion	590 million	7.35 million	4.8 billion

TCC assessed the maturity of carbon reduction technology and analyzed the proportion of greenhouse gas emissions in the production process. The carbon reduction strategy for the 2050 Cement and Concrete Industry Roadmap is centered on the substitution of primary fuel use to effectively reduce the major source of emissions in Scope 1. In order to enhance the efficiency of alternative fuel use, TCC is planning to add an oxygen-enriched (liquid oxygen) combustion system at the Su-Ao Plant, which is estimated to save 8,967 tons of coal per year upon completion at the end of 2022, equivalent to a reduction of 26,870 tCO_2e.

The World Business Council for Sustainable Development (WBCSD) stated that cement co-processing technology is the most scientific, safe and effective way to treat waste[5], because the cement kiln has the characteristics of three highs: "high temperature, high retention time and high turbulence", which can completely decompose the organic matter in the waste. This technology is safe, economical and can effectively convert waste into energy, which is conducive to sustainable urban development and helps industries deal with waste and urban waste that are difficult to decompose on their own, achieving waste and carbon reduction benefits, just like an “City Waste Purifier”. In 2021, TCC assisted Taiwanese industries in disposing of 1.141 million tons of waste, which translates into 218.2 kilograms of reuse per ton of cement and 72,841.1 tCO_2e of carbon emissions reduction. Compared to the 2016 reuse volume of 177.1 kg per ton of cement, a 35.1% increase in reuse rate and a 5.1% reduction in carbon emission intensity compared to the 2016 base year. In the future, TCC will expand the use of biomass fuels to achieve carbon reduction in its own operations and to of a circular economy by recycling resource. 100% of TCC's cement plants are equipped with power generation by waste heat recovery systems to address Scope 2 emissions. However, greenhouse gas emissions from electricity use account for about 4% of the total emissions from the cement production process. Nevertheless, TCC is still actively promoting energy saving measures to improve energy efficiency. In 2021, TCC generated 138 million kWh of waste heat in Taiwan, which is equivalent to a 31% reduction in purchased electricity. In addition, from 2022 to 2023, we will continue to invest in a number of energy efficiency improvement projects, including power generation system renovation, which is expected to increase net electricity generation of waste heat from 13 kWh to 29 kWh per ton of clinker. The efficiency of power generation will more than double, and the clinker coolers at Su-Ao and Hoping plants will be upgraded, which is expected to reduce 31.39 million kWh of purchased electricity per year, equivalent to a reduction of 9,760 tons of coal consumption and 37,200 tCO_2e emissions. In addition, ISO 50001 energy management system certifications have been obtained for 100% of cement plants. TCC has committed to the EP100 goal of increasing energy productivity by 50% by 2040 compared to the 2016 base year, with key indicators of energy transformation to manage energy saving performance.

TCC actively promotes green energy and takes inventory of renewable energy resources within the Group, covering cement plants, mines, RMC plants, and operation headquarters. The Company gradually installs solar power generation facilities and develops green energy solutions through a dual-track approach of self-generation and self-development. 50,114 kWh of renewable energy was generated in the Group’s operational headquarters building in 2021, equivalent to 50 renewable energy certificates. From 2019 to 2022, a total of 168 renewable energy certificates (T-REC) were accumulated for the headquarters building. As of 2021, the operational capacity of installed solar energy facilities for self-use in the Group's plants reached 900 kW, and the self-generated and self-use electricity usage reached 274,431 kWh in 2021, with a cumulative amount of 412,364 kWh generated from 2019 to 2021.

TCC also continues to replace its self-owned concrete mixer trucks to meet the emission standards of the Phase V environmental protection regulations, and plans to procure electric vehicles for company use, thereby accelerating its low-carbon transport transformation by combining its new energy business to meet EV100 targets.

Establishing an Internal Carbon Pricing Mechanism to Accelerate Carbon Reduction and Transformation

In order to strengthen the promotion and management of carbon reduction targets for each plant, TCC implelmented an internal carbon pricing mechanism as a basis for capital expenditures, business transisiton strategies and material operational decisions. Furthermore, TCC implemented an internal carbon pricing mechanism for the Group's cement plants on a pilot basis from July 2022 onwards, with reference to the Guangdong Carbon Emissions Trading Scheme and the EU Emissions Trading System (ETS). By means of the Group's carbon emission control measures, the Group HQ issues annual carbon emission credits to each cement plant based on each plant's quarterly bonus assessment target and imports them into the internal carbon trading information platform. This provides a short-term reference to the daily carbon trading price in Guangdong Province, while in the long run provides internal carbon price reference for pricing offers and matching trading, as well as contract performance at the end of the year. Group HQ will regularly review the transaction price, volume and remaining quota to optimize the operation of the relevant mechanisms. Through the internal carbon pricing and carbon trading management mechanism, the Group motivates each plant to achieve carbon reduction targets and promote the Group's sound carbon management. Furthermore, in the future, TCC shall study the feasibility of an internal climate fund to enhance the potential resources for energy saving, carbon reduction and green energy projects.

3.2_Climate Disaster Adaptation

Adaptation Strategy

Strengthen Water Resource Management	Optimize process water conservation, recycle, and reuse water resources
Enhance the Climate Resilience of Plants	Grasp real-time information on climate change and optimize preventive measures and emergency response mechanisms.

Unit: NT$

Management capital or cost investment	Water Reclamation System	Additional typhoon insurance	Total
2020	35.26 million	10.89 million	46.15 million
2021	260 million	10.63 million	270 million
2022 including projected investments	84.91 million	10.63 million	95.54 million

Extreme weather events are growing in frequency around the world and resulting in severe impacts. TCC operates many production sites and relies on a strong upstream and downstream supply chain for the transportation of raw materials and products, as well as the deployment of a multinational supply chain. Therefore, the Company needs to implement adaptation strategies to strengthen its operational resilience and its ability to respond to climate disasters. TCC monitors changes in water resources at each production site through government websites to strengthen its ability to prevent and respond to floods and droughts, and includes optimal inventory and transportation flexibility adjustment mechanisms. The raw materials and fuels are also sourced from different countries to avoid abnormal weather conditions in a single region that may prevent the supply of materials. TCC also regularly reviews the extreme climate risks and takes resilient measures to improve them by referring to the most severe RCP8.5 scenario in the Sixth Assessment Report [6] published by the Intergovernmental Panel on Climate Change (IPCC). In addition to the installation of rainwater and process water recycling and purification facilities at all manufacturing plants, the Taichung ready-mix concrete plant had new groundwater wells drilled in 2021 to address the risk of drought water shortage.

In order to strengthen water resource management, in 2021, TCC's cement plants in Taiwan introduced the ISO 46001 water efficiency management system, becoming the first cement company in the world to be certified. At the same time, the Company increased water reclamation and water efficiency through various water conservation measures, and established a water footprint analysis platform to track the water consumption status of each cement plant and strengthen water resource management. In 2021, a new shaft water reclamation system was installed at the Hoping Mine. The Su-Ao Plant was equipped with a discharge water reclamation project, which, together with new and renovated water management projects, saved a combined total of 247,000 tons of water.

WATER EFFICIENCY MANAGEMENT SYSTEM ISO 46001

TCC DAKA Renewable Resource Recycling Center Integrates Architectural Designs for Resilience to Climate Change

The design of the TCC DAKA Renewable Resource Recycling Center was commissioned by the internationally renowned American architectural design firm Kohn Pedersen Fox Associates (KPF), together with the Sanyi Architects of Taiwan, to provide master planning and design with the concept of an ecological valley. The Center will not only assist in treating domestic waste in the Hualien area, but also realize the concept of an open ecological circular plant and local revitalization and co-prosperity. The project is expected to cost more than NT$4 billion and is planned to be operational in the first quarter of 2024.

The design is based on the geographical features of the Hualien Hoping Plant. It takes into account the fact that eastern Taiwan is directly affected by typhoons, so that the building's resilience to withstand the impact of strong winds is strengthened. The design of the building is based on a 50-year return period wind tunnel experiment with reference to the maximum wind speed in Hualien, and can withstand winds of over 17 on the Beaufort scale to prevent the risk of potential strong typhoon damage. The overall planning and design won the Gold Award at the 2021 A&D Awards.

3.3_ Supply Chain Carbon Reduction and Co-Prosperity

Supply Chain Carbon Reduction Strategy

Strengthen suppliers' carbon management	Require suppliers to conduct carbon inventories and recognize excellent supplier partners, while requiring them to implement carbon reduction measures in the future
Electrification of company and concrete mixer vehicles	TCC has set EV100 as the target which includes installing electric vehicle charging piles at major operating bases to replace traditional gas-powered company vehicles, and continuing to evaluate the feasibility of introducing electric concrete mixers.

Unit: NT$

Management capital or cost investment	Procurement of eco-friendly bulk carriers	Procurement of eco-friendly cement vessels	Construction of alternative maritime power (AMP) system	Total
2020	490 million	-	21.07 million	510 million
2021	470 million	-	38.79 million	510 million
2022 including projected investments	1.72 billion	1.46 billion	58.58 million	NT$3.24 billion

TCC's upstream and downstream supply chain transportation mainly relies on shipping and trucking, and it also carries out logistics transportation with self-owned vessels through the Group's subsidiary, Ta-Ho Maritime Corp. In order to develop towards green logistics services, Ta-Ho Maritime Corp. continues to improve fuel efficiency and transportation capacity by replacing its vessels.

In 2019, it purchased two all-round, fully-automated, zero-pollution eco-friendly cement vessels. In 2022, three new eco-friendly cement vessels were purchased for chartering by customers. From 2020, the company will be required to switch to low-sulfur fuel oil, which is better than the emission standard regulated by the International Maritime Organization (IMO). Furthermore, the ports of Taichung, Kaohsiung and Hoping were equipped with an alternative maritime power (AMP) system to reduce fuel oil for docking and loading. In addition, the Group's subsidiary, Taiwan Transport & Storage Corp, purchased two new electric trucks in 2022, making it the first company in the Asia-Pacific region to introduce Europe's most advanced electric trucks. TCC plans to purchase at least three more electric trucks in 2023, and electric concrete mixer trucks remain the direction for TCC to implement the electrification of transportation, and will continue to evaluate the feasibility of procuring electric concrete mixer trucks in the future since it is still in the trial stage before mass production.

In order to expand the influence of a green supply chain and integrate the concept of the product life cycle, TCC started to require suppliers to conduct carbon inventory in 2021, and assist suppliers in formulating carbon reduction plans based on the evaluated results. It is also envisaged to require suppliers to implement carbon reduction in the future. If the requirements are not met and counseling is not successful, the business relationship shall be terminated. A total of 332 suppliers participated in the 2021 Supplier Conference, which not only announced the target policy of requiring first-tier key suppliers to conduct carbon inventories, third-party consultants were invited to provide education and training on carbon management and supplier practices related to carbon inventories. The Company also recognized five suppliers for their excellent sustainability performance. The Chairperson of the Group personally expressed to suppliers the expectation of jointly implementing a green supply chain, which is also the standard of TCC's future green procurement, and invited the supply chain partners to join hands and reduce carbon emissions.

3.4_Low Carbon Products and Services

Low carbon products and services strategy

Obtain recognition for low environmental impact products	Continuously promote cement products to obtain gold environmental labels
Promote carbon footprint system for cement and concrete	Continuously expand the number of products with carbon footprint certification and pursue carbon reduction label certifications, which are to be reviewed and implemented every two years.

Commitment to carbon neutral concrete products	Implement the 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete

Unit: NT$

Management capital or cost investment	Consultancy and verification of the carbon footprint of Portland Cement Type I (bulk)	BS 8001 Circular Economy Renewal Certification Checking Operation	RMC ISO 14064 & ISO 14067 project consulting and certification	Total
2020	0.62 million	-	-	0.62 million
2021	0.78 million	-	-	0.78 million
2022 including projected investments	0.40 million	0.15 million	7.32 million	7.87 million

TCC is committed to developing environmentally friendly products. In addition to setting up a concrete laboratory to develop new types of concrete that can replace limestone as the main ingredient, and explores the legal issues of low-carbon emissions concrete at GCCA expert meetings. All of TCC's Portland I, II, IV, and I (low alkali) cements manufactured in Taiwan have already obtained environmental labels. Since 2019, TCC has commenced product carbon footprint initiatives. In 2020, TCC took the initiative to apply to the Environmental Protection Administration (EPA) for the establishment of Product Category Rules (PCR), and obtained the first EPA "Carbon Footprint Label" in the cement industry with the highest market share and the Gold-rated Green Mark certification for Portland Type I Cement. In 2021, it was verified that the carbon footprint reduction of the Su-Ao Plant and the Hoping Plant was 11% and 5.5%, respectively, both meeting the 3% standard set by the Environmental Protection Administration (EPA).

TCC was subsequently awarded the first EPA "Carbon Footprint Reduction Label" in Taiwan's cement industry. By the end of 2022, TCC expects to obtain the EPA carbon label for 12 concrete ratios and ISO 14067 carbon footprint certification for all concrete products from 1,000 to 10,000 pounds.

TCC helps customers to create a comfortable building environment while providing low-carbon emissions products to reduce the impact on the environment, and encourages concrete customers to apply for green building certification to expand sustainable construction and sustainable urban infrastructure, and to gradually fulfill the commitment of delivering carbon neutral concrete products.

EPA Carbon Label Certification
Portland Cement Type I
12 types of concrete products [Note 1]
with three specifications produced by the four plants.
280 kgf/cm2 (4,000 psi)
350 kgf/cm2 (5,000 psi)
420 kgf/cm2 (6,000 psi)

EPA Carbon Reduction Label Certification
Portland Cement Type I

ISO 14067 Carbon Footprint Certification
Full lineup of concrete products between 1,000 - 10,000 psi

[Note 1] The four plants include the Taipei Cement Products Plant, Taichung Cement Products Plant, Kaohsiung Cement Products Plant, and the ready-mixed concrete plant attached to the Hualien Cement Plant.

Establishing the Standard for the Cement Industry in Taiwan
The 1st Carbon Footprint Label & Carbon Reduction Label

Carbon footprint is defined as the greenhouse gases of an activity or product directly and indirectly generated from its whole life cycle, including raw material procurement, manufacturing, distribution and sales, use, and disposal or recycling in the end. To effectively capture the GHG emissions from its products, TCC launched the product carbon footprint project in 2019. In 2020, TCC proactively applied to the Environmental Protection Administration Taiwan (EPA Taiwan) for formulating the Product Category Rules (PCRs) for cement products and obtained the Carbon Footprint Label from EPA Taiwan. In 2021, the carbon footprint of bagged cement by the Suao and Hoping Plant was verified as a reduction of 11% and the carbon footprint from the Hoping Plant by 5.5% respectively, both way above the 3% reduction standard for the Carbon Reduction Label issued by the EPA Taiwan. TCC thus became the first cement company with products labeled with the “green footprint” in Taiwan.

3.5_Technology Development and Innovation

R&D Strategy

Develop low-carbon technology and green building materials	Develop new carbon reduction technologies from process advantages, and invest in developing low-carbon and lifecycle-extending building materials and apply operational mitigation measures.

Unit: NT$

Management capital or cost investment	Ultra High Performance Concrete (UHPC) and Laminate Production Technology Project	ITRI-Calcium Loop Carbon Capture Technology	Development of Efficient Biological Carbon Sequestration and Utilization Technology	ITRI-Indirect Carbonation Technology for Basic Oxygen Furnace Slag (BOFS)	Low-Carbon 3D Printing Technology and Materials Research and Development Project	Total
2020	-	7.82 million	7.54 million	-	-	**15.36 million**
2021	3.4 million	8.42 million	2.25 million	0.7 million	-	**14.77 million**
2022 including projected investments	2.55 million	-	-	0.4 million	1.5 million	**4.45 million**

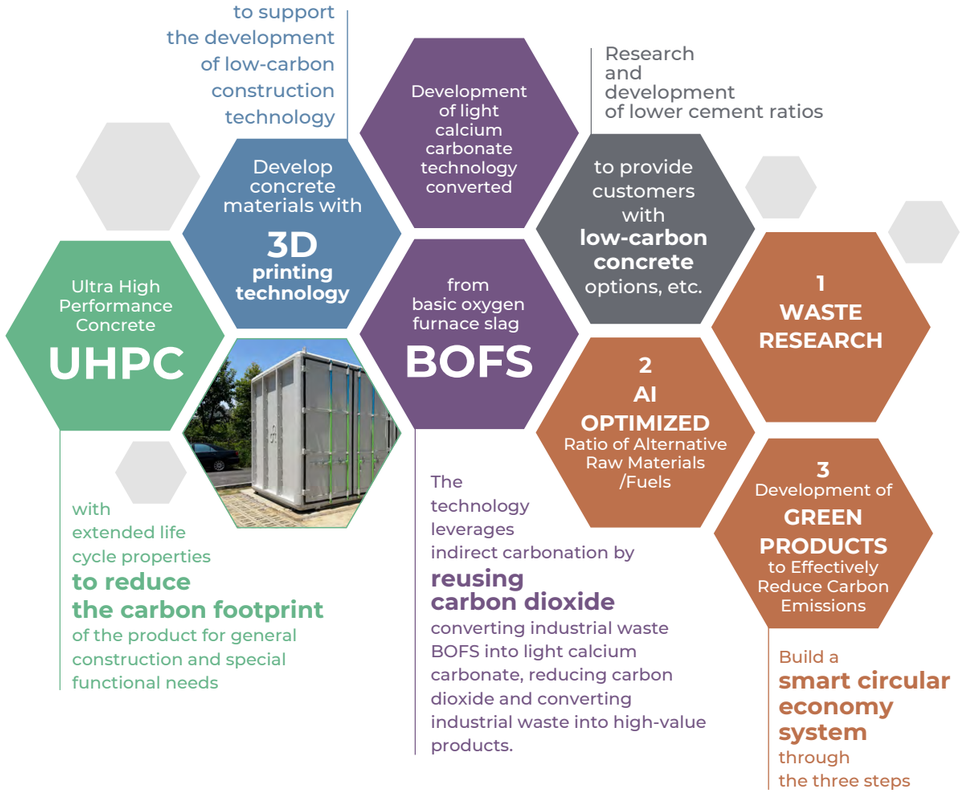
With the increasing demand for resilience in the buildings, TCC has combined its unique technology, determination in low carbon development, leadership position in innovation, and commitment to the mutual benefit of the Earth to invest in a full range of low-carbon technology and product development.

Low-carbon emissions development is identified as the core objective from the production process carbon reduction, and recycling to the product life cycle.

Since 2011, TCC has been actively investing in the research and development of carbon capture technology, and has partnered with ITRI to develop the 1st generation of 1.9MWt and the new generation of 500KWt pilot plant CO_2 capture system over the years.

It will be first applied to the oxy-calcination scale-up process planning (designed to capture 100,000 tCO_2 per year) at the #1K production line of the Hoping Plant, thus accelerating the progress of commercial operations. This technology was awarded the R&D 100 Award for Industry Innovation by The Oscars of Invention - The Chicago Tribune.

Other R&D achievements include:



Through innovative research and development, TCC is committed to exploring low-carbon solutions for the cement industry, and harnessing carbon reduction technologies and green building materials development that are superior to those of the industry, so as to serve as a benchmark for the manufacturing industry to achieve net-zero transformation.

New Materials: Ultra-High Performance Concrete (UHPC) - Whole New Applications of Low Carbon Building Materials

Ultra-High Performance Concrete (UHPC) is the most innovative cementitious engineering material developed over the past 30 years. It was developed by TCC's research laboratory in cooperation with the Taiwan Construction Research Institute. UHPC is made of a mix of cement, silica fume, quartz powder, quartz sand, high-range water reducer and fiber, thus it has the plasticity of concrete materials. Compared with conventional concrete, it has the characteristics of mechanical ultra-high compressive strength, high toughness and high durability, achieving a great leap in engineering materials performance. The life cycle of conventional buildings is 50 - 70 years, but UHPC building materials can be extended to 100 - 120 years, reducing the frequency of building reconstruction and mitigating construction waste generated, thus achieving the goal of reducing carbon emissions. TCC plans to complete the UHPC mass production plant in 2023 and take advantage of the material's fireproof and explosion-proof properties to develop patented energy storage cabinets, with mass production commencing in 2024.

UHPC uses TCC's own cement as its main raw material and other functional material combinations. The 28-day designed strengths of 120 MPa and 150 MPa have been successfully developed. Higher strength ratios are planned to be developed, with future applications in energy storage cabinets and use at the TCC DAKA Renewable Resource Recycling Center under construction. The total amount of UHPC used in the Center will be more than 5,000m^3 for exterior wall laminates and cement products such as staircase slabs, high pressure bricks, turf blocks, railings, etc. TCC is set to become the first company in Taiwan with the capability of UHPC research and development, mass production, quality control, and practical application, and will transition from being a supplier of UHPC raw materials to being a successor of research and development, and further become a practitioner of UHPC applications.

3.6_New Business Development and Deployment

New Business Development Strategy

Development of Renewable Energy Generation and Its Deployment	Continue to develop new renewable energy projects and diversified green energy sources
Develop Smart Energy Storage Business	Enhance energy storage technology and applications, and strengthen electric power auxiliary service capabilities
Promote the Research and Development of Battery Energy Transmission	Further refine battery research and development, integrate the advantages of energy creation and storage, and develop the electric transportation market

Unit: NT$

Management capital or cost investment	Solar energy and fishery and solar symbiosis project sites	Wind farms	Geothermal energy development	Ocean Thermal Energy Conversion (OTEC)
2020	34.71 million	35.87 million	-	-
2021	1.36 billion	-	-	54.65 million
2022 including projected investments	2.78 billion	82.69 million	450 million	-

Management capital or cost investment	Energy storage	Green buildings	Super battery production equipment	Advance Feasibility Assessment Plan for Gasifier Solutions at Hoping Power Plant	Total
2020	32.48 million	-	170 million	-	270 million
2021	120 million	1.29 billion	110 million	-	2.9 billion
2022 including projected investments	4.76 billion	5.44 billion	5.57 billion	0.60 million	19.1 billion

TCC has long adopted alternative raw materials and fuels in its cement business, and has enhanced its carbon capture technology to achieve carbon reduction targets. However, with the level of current technology, there is still a gap for the cement industry to achieve carbon neutrality on its own. In the international trend of net-zero transformation, renewable energy plays an indispensable role. In order to develop more carbon reduction potential, TCC has initiated the deployment of new energy and strives for clean energy. TCC is planning a new business blueprint and has invested in three major new energy fields, from renewable energy development to creating clean energy supply, and then with the deployment of smart energy storage systems to address the problem of intermittent green energy supply, as well as integration with battery energy transmission solutions, which shall lead us to the era of electric transportation. From energy saving and energy creation to energy storage and transmission, TCC has become the only energy conglomerate with the R&D and self-production capabilities of green energy, battery, energy storage, and electric vehicle fast charging. We hope to provide and meet the green power needs of Taiwan enterprises and move towards the RE100 goal together.

Renewable Energy | Energy Creation

In accordance with the spirit of SBT, TCC does not purchase green power certificates as a means of carbon reduction at this stage. Rather, the Group is expanding into the dual-track approach of self-generation and self-development. In response to the Taiwan government's goal of generating 20% of electricity from renewable energy by 2025, TCC is exploring clean energy sources, including integrated solar energy and onshore wind power farms, fishery and solar symbiosis projects, geothermal power generation, and ocean thermal energy conversion (OTEC). In 2018, TCC established a subsidiary, TCC Green Energy, to help develop renewable energy and meet the demands for green power in the market. In 2018, TCC Green Energy commenced the development of grid-connected power generation. Currently, TCC Green Energy focuses on the development of photovoltaic power generation and the government's fisheries and solar symbiosis project, which combines fishery farming and solar power generation facilities to make the most efficient utilization of land resources. In addition, TCC expects to start a 1 MW - 4 MW OTEC power generation project in Hualien in 2023 and 2025, and to complete the conversion of geothermal power generation in TCC's Vakangan Geothermal Green Energy Park in Taitung in 2024 to explore the potential of green power.

Renewable Energy Capacity | Scope covers Taiwan and Mainland China

Unit kW		2018	2019	2020	2021	2022	2023	2024	TOTAL
		Operational				Under Construction / Under Development			As of 2023
Self-developed	**Photovoltaic**	43	-	106	750	2,920	24,341	324	**28,161**
and self-used	**Photovoltaic**	1,999	10,078	2,102	-	43,400	72,572	Under planning	**160,751**
	Wind power	-	7,200	14,400	-	-	9,000		
Bulk tariff	**Geothermal energy**	-	-	-	-	-	-	1,000	
TOTAL INSTALLED CAPACITY		**2,042**	**17,278**	**16,608**	**750**	**46,320**	**110,950**	**–**	**193,948**

Estimated by the end of 2023

Renewable energy installed capacity

>190 MW

Self-generation and self-used capacity

28,161 KW

2019-2021

Historical cumulative renewable energy generation

>121 million kWh

Reduction of over 61,000 tCO_2

Estimated by the end of 2023

Renewable energy generation

>391 million kWh

Reduction of over 203,000 tCO_2 reduced

Smart Energy Storage

In response to the intermittent nature of green energy generation, energy storage technology has become an emerging trend that is pivotal to stabilizing the power grid and developing renewable energy and electric vehicles.

Under the policies of the Taiwan government and Taipower, with strict control of the quality and quantity of market participants, TCC is actively engaged in the energy storage market and established TCC Energy Storage Technology Corporation in 2020, with business scopes ranging from energy storage systems, microgrids, energy regulation solutions to electric vehicle charging stations. In 2021, TCC launched the first 5 MW large scale AFC (Automated Frequency Control) smart energy storage system in Changbin, in conjunction with its subsidiary, Molicel (E-One Moli Energy Corp.).

The system successfully stabilized the power grid within 0.25 seconds during power outage events in 2021 and 2022. TCC acquired the advanced energy storage technologies through the acquisition of Italian energy storage company Engie EPS in 2021, which was subsequently renamed NHΩA.

At the end of the same year, the Group invested in power supplier Phihong Technology to develop the EV charging pile market in Taiwan, Europe and the United States.

The Group plans to build the largest energy storage base in Taiwan at the Su-Ao and Hoping Cement Plants, with design specifications of 35MW / 87.5MWh and 100MW/250MWh respectively.

The sites are expected to be put into operation in 2023 to support the Electric Trading Platform.

In addition, a high-end lithium battery plant is being constructed in Kaohsiung, with a production capacity of 1.8 GWh in 2023, providing the long-range battery capacity required for 24,000 electric vehicles for one year.

In the long run, TCC shall continue to focus on the international energy storage and power auxiliary services market, integrating its past expertise in AFC service control and NHΩA products and maintenance experience to optimize energy management strategies and explore new energy market opportunities.

In response to the fire safety issues associated with energy storage, TCC shall combine its experience in cement and refractory materials to develop UHPC cabinets with high fire resistance and high compressive strength.

In the future, we hope to increase the flexibility of energy storage deployment and provide users with more secure and reliable energy storage solutions.

Cumulative energy storage capacity

Scope covers Taiwan and Mainland China

2021

5 MWh | COMPLETED

2022

48 MWh | UNDER CONSTRUCTION

2023

781 MWh | UNDER CONSTRUCTION

2024

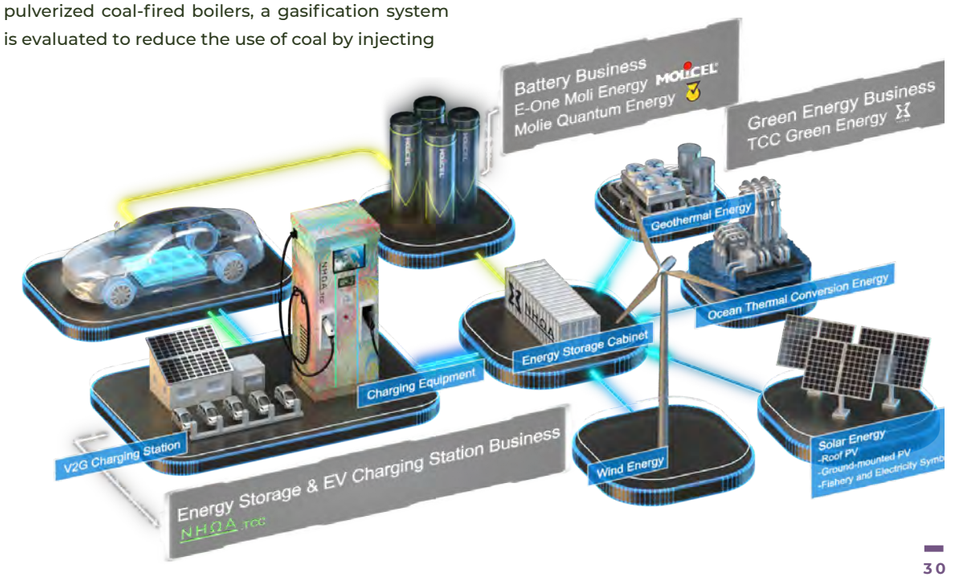
1,264 MWh | UNDER CONSTRUCTION

Hight Power Cells Energy Transmission

Low-carbon transportation is one of the primary strategies to realize the global net-zero emissions vision. TCC's Molicel focuses on the research, development and production of cylindrical lithium batteries, with an estimated battery capacity of 3.3 GWh per year by 2024. Battery applications covering emerging markets such as the aerospace industry, high-end EV supercars, aerial carriers, racing motorcycles, and micro carriers, are in line with the development of electrification in the transport industry. In 2022, TCC's NHΩA.TCC launched the first new-generation pure green power charging station at TCC DAKA in Hualien, combining solar power generation equipment and energy storage equipment to provide green power charging piles, effectively adjusting the difference in power consumption between day and night, and achieving a new model of comprehensive integration of green energy, energy storage and charging services. At present, TCC has successfully developed technology the reuses retired secondary batteries of electric vehicles in the energy storage system, which can prolong the battery life cycle.TCC will continue to invest in battery technology research and development in the future to create more diverse circular economy applications.

Hoping Power Plant Evaluates the Feasibility of Gasification of Solid Biomass Fuel Mass-Burning

The Hoping Power Plant will start the preliminary feasibility assessment program for its gasifier system in 2022. Based on the characteristics of pulverized coal-fired boilers, a gasification system is evaluated to reduce the use of coal by injecting the syngas generated from the gasification of solid biomass fuel into the pulverized coal-fired boilers for mass-burning, so as to reduce coal use.



CHAPTER 04

Climate Scenario Analysis and Resilience Evaluation

4.1 Transformation Risk Scenario Assessment
4.2 Physical Risk Scenario Assessment

TCC conducted a situational analysis and assessment of two climate risk factors, namely carbon price and emission control, and extreme climate events, referring to the Materials and Buildings Group in the *Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures*[7].The former analyzes the future direction of greenhouse gas regulation in TCC's major operating locations. It adopts the Net Zero Emissions by 2050 Case (NZE2050), Sustainable Development Scenario (SDS), and Stated Policies Scenario (SPS), especially their influence on carbon price trends to assess the financial impact on TCC.

The latter is based on the geographical locations of TCC's global operations, considering two physical risks, such as the increase in alternative transportation costs due to the actual impact of drought and the increase in equipment maintenance costs due to typhoons, and further selecting the most severe impact of the global warming scenario (RCP8.5), so as to assess the financial impact on TCC. After consolidating the aforementioned scenario analysis results, TCC incorporates the specific considerations of the medium- and long-term resilience strategic deployments, and actively adjusts mitigation and adaptation plans in response.

Risk Type	Scenario Selection	Scenario Assumptions		
		Assessment Year	Impact Scenario	Key Parameters
TRANSFORMATION Greenhouse Gas Regulation and Carbon Pricing Policy	IEA NZE2050 - Net Zero by 2050 Scenario Note 1	2025 2030	**TAIWAN** Carbon tax mechanism — **MAINLAND CHINA** Carbon trading mechanism control of carbon emissions through decreasing emissions baseline	Estimated carbon price for high carbon price scenario (1.5°C) (increasing year by year) [8, 9, 10]
	IEA SDS - Sustainability Scenario Note 1			Estimated carbon price in medium-high carbon price scenario (Well-below 2°C, WB2DS) (increasing year by year) [8, 9, 10]
	IEA SPS - Existing Policy Scenarios Note1			Nationally Determined Contribution (NDC) Note1 estimated Carbon Price (increasing year by year) [8, 9, 10]

| Assessment Content

Assess the operational impact of carbon pricing trends and carbon control regulations at TCC's operating locations over a 5-10 year period for carbon emission related expenditures at a controlled temperature rise of 1.5°C, <2°C and approximately 2.7°C, respectively

Risk Type	Scenario Selection	Scenario Assumptions		
		Assessment Year	Impact Scenario	Key Parameters
PHYSICAL Drought and Typhoon Risk	IPCC RCP8.5 Note2	2050 mid-century Note3	**MAINLAND CHINA** Increased alternative transportation costs due to drought — **TAIWAN** Equipment repair and maintenance costs due to typhoons	Duration of drought due to extreme weather Number of typhoons hitting Taiwan per year

| Assessment Content

If global warming control is not effectively carried out, the operational impacts of increased drought and increased number of severe typhoons due to extreme weather in the mid-century could lead to increased alternative transportation costs and equipment maintenance costs under the worst-case global warming scenario.

Note 1 : With reference to the NZE2050, SDS and SPS scenarios published in the International Energy Agency's 2020 Energy Reports (ETP; WEO)[8, 11]. They represent the control of temperature rise at 1.5°C, approx. 1.8°C, and the Nationally Determined Contribution (NDC) by the end of this century, respectively, so as to provide a carbon emissions reduction pathway and carbon price trend to control a 2.7°C rise in global warming at the end of the century.
Note 2 : With reference to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), specifically for the RCP8.5 scenario detailed in the report[6], which represents an increase in radiative forcing of 8.5 W/m2 at the end of the century compared to 1750 due to inaction to control and reduce carbon emissions, resulting in global warming of about 4.4°C.
Note 3 : Because the physical natural disaster risk focuses on long-term changes, we have made scenario assessments on a mid-century basis.

4.1_Transformation Risk Scenario Assessment

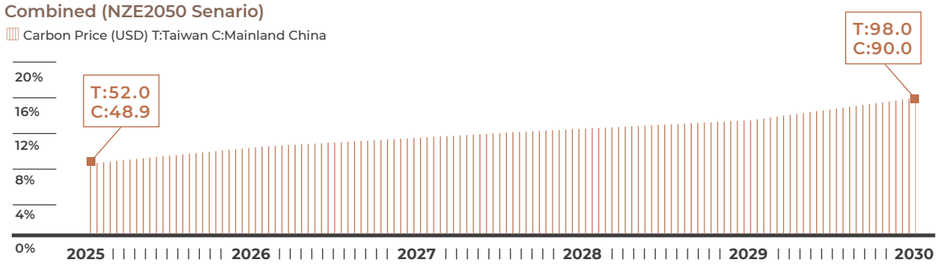
Greenhouse Gas Regulation and Carbon Price Impact Analysis

TCC's main cement production bases are located in Taiwan and Mainland China. The former has a carbon system planned with carbon tax collection as the policy research direction, which is expected to be implemented in 2024 at the earliest; the latter has instituted carbon emissions control in the cement industry through regional pilot carbon trading schemes for total volume control.
With the formal establishment of the national carbon trading market in Mainland China in 2021, the cement industry is expected to be included in the national carbon trading system in the near future. By evaluating the future changes in cement production and the carbon emissions of the SBT reduction target, TCC estimates the financial impact of the NZE2050, SDS and SPS climate scenarios in 2030, assuming that Taiwan's carbon tax system is implemented and the cement industry is included in the national carbon trading system in Mainland China. In considering the estimated carbon price under NZE2050, SDS and SPS scenarios, and analyzing the possible financial impact caused by carbon emission regulations, it is estimated that in 2030, the increased cost will account for 17.8%, 8.1% and 3.1% of annual revenue from cement business under NZE2050, SDS and SPS scenarios, respectively.
In the face of this low-carbon transformational risk, TCC plans to continue to strengthen its hybrid resilience strategy of alternative fuels, carbon capture and renewable energy to enhance the potential of operational carbon emissions reduction, and also incorporate carbon emissions intensity into the key performance indicators (KPI) at the plants, so as to enhance the reliability of achieving internal carbon reduction targets.

Analysis of the potential financial impact of greenhouse gas regulations

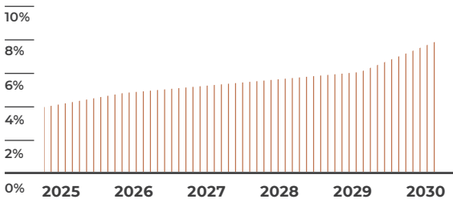
Unit Climate-related Financial Impact % on Cement Revenue

Climate-related Financial Impact on the Cement Revenue with Taiwan and Mainland China Combined (NZE2050 Senario)



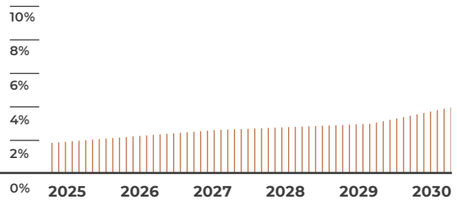
Financial Impact Evaluation of Carbon Emissions Regulations (SDS Scenario)

Unit Climate-related Financial Impact on the Cement Revenue with Taiwan and Mainland China Combined (%)



Financial Impact Evaluation of Carbon Emissions Regulations (SPS Scenario)

Unit Climate-related Financial Impact on the Cement Revenue with Taiwan and Mainland China Combined (%)



4.2_Physical Risk Scenario Assessment

Drought and Typhoon Operational Impact Analysis

Through internal deliberations, inventory and evaluation, TCC identifies extreme weather events (including typhoons, heavy rainfall and droughts) that may impact the Company's operations in terms of "plant equipment damage" or "shipping and transportation impact". The former of which may result in financial impact in terms of equipment repair costs, loss of revenue from production disruptions and increased insurance costs, while the latter may result in financial expenses such as replacement transportation costs and delivery delays. TCC has evaluated whether expenses have been incurred in the past due to climate factors and the availability of related expenses, focusing on the financial impact pathways of increased alternative transportation costs due to drought and increased equipment maintenance costs due to typhoons.

In terms of drought risks, Southern Mainland China is an important cement production base for TCC. During the traditional dry season in late winter and early spring, cement has to be transported on land instead of water due to low water levels, resulting in higher transportation costs. As the impact of climate change intensifies, the scale and frequency of droughts are likely to increase in the future, thus intensifying related impacts on operations. Based on the research data from the Chinese Academy of Sciences[12], TCC analyzed that under the most severe global warming scenario of RCP8.5, the dry period at its operations sites of Yingde and Longshan Plants shall extend by 54% in the middle of this century, from an average of 2.67 months at present to 4.11 months, and estimated the possible financial impact in the future by using historical replacement transportation costs to be between NT$40 million and NT$45 million per year. For typhoon risk, TCC considered the average number of typhoons and repair expenses for the Su-Ao, Hoping and Hualien Plants in Taiwan, and evaluated the mid-century change in the number of severe typhoons under the RCP8.5 scenario by referring to the Taiwan Climate Change Projection and Information Platform, (TCCIP).[13, 14, 15]The change in the number of typhoons in the middle of the century is expected to increase the annual maintenance expenses to about NT$12 million.

TCC Assesses the Potential for Drought Risk at Production Sites Based on Climate Science

In the face of potential physical risks, the only way to prepare preventive measures and effectively allocate resources is to continuously grasp the risk situation of all production sites, so TCC regularly conducts risk assessments of climate risk potential through external data from climate science models. TCC utilizes the Aqueduct - Water Risk Atlas[16] published by the World Resources Institute (WRI) to conduct a baseline risk assessment of drought risk for all plants in Taiwan and Mainland China. Based on the availability of current data and consideration of the more likely impact of drought on TCC's supply chain transportation, a mid-century risk assessment is also conducted for drought risks to study possible future trends and respond accordingly.

The results of the physical risk potential assessment indicate a relatively low impact for the base period on TCC's production sites. In terms of drought risk, only the Liaoning Plant is at high risk during the base period, which is expected to rise to severe risk by mid-century. The other four plants in Mainland China are also expected to rise in risk level in the middle of the century, with Guangan and Huaying Plants rising to medium-high risk level.

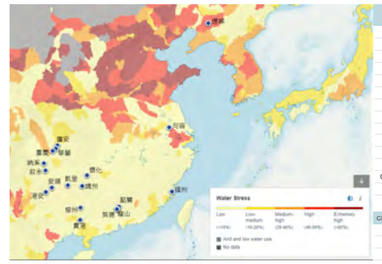
The impact of the drought on the future of Taiwan plants is relatively severe, although all plants in Taiwan are at low risk in the base period. By mid-century, the risk level of 15 plants shall increase, among which the Taichung, Dadu, Taiping RMC Plants and the Taipei Distribution Station are expected to reach a severe risk, while the other 11 plants had reached a medium-high risk level. TCC will gradually develop risk response plans for plants above the high risk level and those that may have elevated risk levels in the future.

WRI Aqueduct - Water Risk Atlas Assessment Methodology

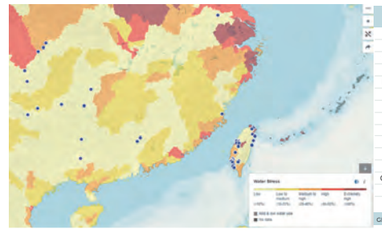
Risk Type	Assessment Factors
Drought	**Water Shortage Stress**
	Overview of assessment factors
	Ratio of total water withdrawals to available recycled (reclaimed) surface water and groundwater supplies

Base Period	Mid-Century	Mid-Century Adoption Scenario
1960–2014	**2040**	**RCP8.5**

Drought Risk Assessment of TCC Production Sites Base Period



MIXING STATION	WRI AQUEDUCT DROUGHT RISK LEVEL
LIAONING	HIGH
JURONG	LOW
SHAOGUAN	LOW
YINGDE	LOW
LONGSHAN	LOW
GUIGANG	LOW
HUAIHUA	LOW
JINGZHOU	LOW
GANGAN	LOW-MEDIUM
ANSHUN	LOW
KAILI	LOW
XUYONG	LOW
CHONGQING	LOW
GUANGAN	LOW-MEDIUM
HUAYING	LOW-MEDIUM
GRINDING STATION	
FUZHOU	LOW
LIUZHOU	LOW
NAXI	LOW



MIXING STATION	WRI AQUEDUCT DROUGHT RISK LEVEL
LIAONING	EXTREMELY HIGH
JURONG	LOW
SHAOGUAN	LOW
YINGDE	LOW
LONGSHAN	LOW
GUIGANG	LOW
HUAIHUA	LOW
JINGZHOU	LOW
GANGAN	LOW-MEDIUM
ANSHUN	LOW
KAILI	LOW
XUYONG	LOW
CHONGQING	LOW
GUANGAN	MEDIUM- HIGH
HUAYING	MEDIUM- HIGH
GRINDING STATION	
FUZHOU	LOW-MEDIUM
LIUZHOU	LOW
NAXI	LOW

CEMENT PLANT	WRI AQUEDUCT DROUGHT RISK LEVEL
HOPING	LOW
SUAO	LOW
HUALIEN	LOW

DISTRIBUTION STATION	WRI AQUEDUCT DROUGHT RISK LEVEL
TAIPEI	EXTREMELY HIGH
TAICHUNG PORT	MEDIUM- HIGH
ANPING PORT	MEDIUM- HIGH
KAOHSIUNG PORT	MEDIUM- HIGH

RMC PLANT	WRI AQUEDUCT DROUGHT RISK LEVEL
TAIPEI	LOW
TUCHENG	LOW
GUISHAN	LOW
TAOYUAN	LOW
TAOYUAN 2	LOW
ZHONGLI	LOW
ZHONGLI 2	LOW
BADE	LOW
HSINCHU	LOW
YILAN	LOW
TAICHUNG	EXTREMELY HIGH
DADU	EXTREMELY HIGH
TAIPING	EXTREMELY HIGH
CAOTUN	LOW
SHENGANG	LOW
KAOHSIUNG	MEDIUM- HIGH
NANZIH	MEDIUM- HIGH
SIAOGANG	MEDIUM- HIGH
LUZHU	MEDIUM- HIGH
CHIAYI	MEDIUM- HIGH
TAINAN	MEDIUM- HIGH
ANPING	MEDIUM- HIGH
SHANHUA	LOW
XINSHI	MEDIUM- HIGH
HUALIEN	LOW

CHAPTER 05

Climate Related Performance Indicators and Targets

5.1 Greenhouse Gas Emission Indicators and Targets
5.2 Other Climate-related Key Indicators

5.1_ Greenhouse Gas Emission Indicators and Targets

TCC is a green environmental engineering company dedicated to addressing the complex relationship between human civilization and nature. It is committed to proactively addressing environmental issues and promoting sustainability initiatives, from setting the Science-Based Targets (SBT), declaring the 2050 net zero target with the Global Cement and Concrete Association (GCCA), to responding to the Taiwan Net Zero 2030/2050 Initiative of the Taiwan Alliance for Net Zero Emission (TANZE). TCC has also established a climate change governance framework, planned the Group's net-zero transformation roadmap and the 2050 Cement and Concrete Industry Roadmap, and promoted climate risk scenario analysis, the quantitative results of which are used as concrete considerations for mid- and long-term strategic deployment to implement carbon reduction target tracking and climate risk management. By increasing the proportion of alternative fuels, improving the efficiency of power generation by waste heat recovery, and improving manufacturing processes, the cement business reduced carbon emissions per ton of cementitious materials by 5.1% in Taiwan and 3% in Mainland China in 2021 compared to the base year of 2016. The Group's six sustainability management strategies and targets have been achieved in 2021, and are well on track to our goals.

Six Strategic Targets

	2023	2024	2025	2030	2040	2050	Performance Results	Status of Achievement
Low Carbon Circulation								
GHG Reduction Taiwan (Base year 2016 | tCO_2e/Metric Ton of Cementitious Materials)	–	–	-11% (SBT)	-31%	–	Carbon Neutral	0.806(-5.1%)	V
GHG Reduction Mainland China (Base year 2016 | tCO_2e/Metric Ton of Cementitious Materials)			-11%	-20%		Concrete Products	0.709(-3%)	
EP100 Energy Productivity Target (Base year 2016 | Product revenue (NT$'000)/energy use (GJ))	–	–	–	–	+50%	–	36.9%	V
Resource Recycling Taiwan (Ten thousand tons)	–	–	125	157	–	250	114	V
Resource Recycling Mainland China (Ten thousand tons)			1,000	1,250		1,500	807	
Natural Disaster Adaptation								
Water Intensity Reduction Taiwan (2016 base year | m^3/Metric Ton of Cementitious Materials)	–	–	-45%	-50%	–	–	0.30(-38%)	V
Water Intensity Reduction Mainland China (2016 base year | m^3/Metric Ton of Cementitious Materials)			-25%	-30%			0.32(-9%)	
Mutually Benefiicial Supply Chain								
Supply Chain Management Taiwan (Percentage %)	100% Tier 1 Key Supplier Carbon Inventory	–	–	50% carbon reduction for Tier 1 key suppliers	–	50% carbon reduction for all suppliers	61.5% of Tier 1 key suppliers completed carbon inventories, with third-party on-site audits to be completed for 10 suppliers by 2022	V
Low Carbon Products								
Percentage of green building materials applications [Note2] Taiwan (Percentage %)	–	–	5%	6%	–	–	11.2%	V
R&D Innovation								
Carbon capture and reuse (light calcium carbonate) technology Taiwan (Ten thousand tons/year)	–	–	–	10	–	160	Carbon capture technology scale-up verification measures under development	–
New and Emerging Business Development								
Energy Creation - Cumulative Renewable Energy Installations (MW)	–	–	570	700	–	1,000	190(as of 2023)	V
Energy Storage - Cumulative Capacity of Energy Storage Systems (MWh)	781	1,264	1,264	1,264	–	1,264	5	V
Transmission Capacity - High-end Lithium Battery Capacity (GWh/year)	–	3.3	–	–	–	–	1.5	V

Note 1 Unless otherwise indicated, the scope indicated covers TCC Taiwan and TCC Mainland China.

Note 2 The percentage of green building materials applications is defined as the percentage of TCC's sales of concrete products sold to customers for green building materials applications to the total concrete revenue.

Greenhouse Gas Emissions

Cement Plants Greenhouse gas emissions

Unit: tCO_2e

Item		2018	2019	2020	2021
Scope I	Taiwan Plants	4,228,688	4,266,390	4,411,086	4,797,296
	Mainland China Plants	–	31,362,071	31,255,099	25,867,678
Scope 2	Taiwan Plants	247,702	223,096	202,312	212,047
	Mainland China Plants	–	1,313,966	1,257,882	1,094,397
Total	Taiwan Plants	**4,476,390**	**4,489,486**	**4,613,398**	**5,009,703**
	Mainland China Plants	**–**	**32,676,037**	**32,512,981**	**26,962,075**
Carbon Emissions Intensity tCO_2e/Metric Ton of Cementitious Materials	Taiwan Plants	0.820	0.814	0.813	0.806
	Mainland China Plants	–	0.728	0.723	0.709
Scope 3	Taiwan Plants	15,041	21,083	22,427	28,761

RMC Plants Greenhouse gas emissions

Unit: tCO_2e

Item		2018	2019	2020	2021
Scope I	Taiwan Plants	1,992	2,088	2,059	1,517
Scope 2	Taiwan Plants	6,144	5,010	7,101	6,866
Total	Taiwan Plants	**8,136**	**7,098**	**9,160**	**8,383**
Carbon Emissions Intensity tCO2e/m3 concrete	Taiwan Plants	0.0018	0.0015	0.0018	0.0016

Note 1 Shaoguan plant is not included in the data of Mainland China plants because the plant finished construction in mid-November 2021, which does not correspond to the scope of disclosure in the report.
Note 2 The most significant Scope 3 emissions of cement plants inventoried since 2018 are "upstream transportation and distribution".
Note 3 Scope 2 emissions for Taiwan plants are calculated with reference to the 2019 electricity emissions coefficient of 0.509 kg CO_2e/kWh announced by the Bureau of Energy, Ministry of Economic Affairs; the electricity emissions coefficient of 0.6101 kg CO_2e/kWh applies to Mainland China plants.
Note 4 The Taiwan plants conduct third-party audits annually, and the Mainland China plants cooperate with respective local governments in arranging third-party audits on a uniform basis.
Note 5 Greenhouse gas emissions from TCC's Taiwan plants increased in 2021 due to an 8.9% increase in clinker production compared to 2020, while greenhouse gas emissions from Mainland China plants decreased in 2021 compared to 2020 due to the implementation of off-peak production halts in accordance with national policies.

Operation Headquarters Greenhouse gas emissions

Unit: tCO_2e

Item	2018	2019	2020	2021
Scope I	–	142	140	132
Scope 2	2,172	1,240	1,199	1,119
Total	**2,172**	**1,382**	**1,339**	**1,251**
Scope 3	–	942	907	814

Note 1 Scope 3 inventory for TCC Headquarters includes upstream indirect emissions from purchased electricity and downstream leases.

5.2_Other Climate-related Key Indicators

Energy use (unit GJ)

Indicators			2018	2019	2020	2021
Cement Plants	Taiwan Plants	Direct energy use (including coal and diesel)	15,735,860	16,190,492	16,316,761	17,667,458
		Indirect energy use (purchased electricity)	1,681,200	1,558,800	1,481,726	1,580,660
		Total	**17,417,060**	**17,749,292**	**17,798,487**	**19,248,118**
	Mainland China Plants	Direct energy use (including coal and diesel)	–	140,398,069	138,074,570	113,184,305
		Indirect energy use (purchased electricity)	–	9,756,450	9,303,773	8,179,002
		Total	**–**	**150,154,519**	**147,378,343**	**121,363,307**
RMC Plants	Taiwan Plants	Direct energy use (including diesel and gasoline)	27,020	28,507	28,170	20,786
		Indirect energy use (purchased electricity)	39,924	33,696	50,219	48,636
		Total	**66,944**	**62,203**	**78,389**	**69,422**
Operation Headquarters		Direct energy use (including diesel, gasoline and natural gas) Note 2	–	–	251	354
		Indirect energy use (purchased electricity)	13,687	13,064	12,420	11,700
		Total	**13,687**	**13,064**	**12,671**	**12,054**

Renewable energy use | Self-generated (unit kWh) Note3

Indicators		2018	2019	2020	2021
Operation Headquarters		–	46,275	48,371	50,114
Cement Plants	Taiwan Plants	–	–	30,987	70,531
RMC Plants	Taiwan Plants	–	–	–	19,745
Electricity Generation Business	Hoping Power Company (Taiwan)	–	–	12,300	134,041
	Total	**–**	**46,275**	**91,658**	**274,431**

Power Generation by Waste Heat Recovery (MWh)

		2018	2019	2020	2021
Cement Plants	Taiwan Plants	74,094	100,335	119,024	138,257
	Mainland China Plants	1,317,532	1,292,718	1,283,372	1,034,320
	Total	**1,391,626**	**1,393,053**	**1,402,396**	**1,172,577**

Carbon Reduction From Power Generation by Waste Heat Recovery (Unit tCO_2e)

		2018	2019	2020	2021
Cement Plants	Taiwan Plants	37,714	51,070	60,583	70,373
	Mainland China Plants	670,624	657,994	782,984	631,038
	Total	**708,338**	**709,064**	**843,567**	**701,411**

Energy Use Efficiency

		2018	2019	2020	2021
Cement Plants (Unit GJ/Metric Ton of Cementitious Materials)	Taiwan Plants	3.191	3.219	3.137	3.097
	Mainland China Plants	–	3.345	3.279	3.191
RMC plants (Unit GJ/m3 concrete)	Taiwan Plants	0.0149	0.0128	0.0150	0.0134
Operation Headquarters (Unit GJ)	-	13,687	13,064	12,671	12,054

Total Energy Savings From Energy Saving Initiatives (Unit kWh) Note4

		2018	2019	2020	2021
	Taiwan Plants	2,084	3,084	1,157	2,313

Proportion of Alternative Raw Materials Used (Unit %)

		2018	2019	2020	2021
Cement Plants	Taiwan Plants	19	19	23	22
	Mainland China Plants	10	17	20	20

Proportion of Alternative Fuel Used (Unit%)

		2018	2019	2020	2021
Cement Plants	Taiwan Plants	8	8	10	11
	Mainland China Plants	3	4	5	4.8

Water Resources Used (Unit million liters)

			2018	2019	2020	2021
Cement Plants	Taiwan Plants	Domestic water use (including groundwater and industrial water)	2,337.53	2,100.23	2,065.35	1,861.55
		Recycled water from the manufacturing process	452.68	23.22	93.48	102.43
		Total	**2,790.21**	**2,123.45**	**2,158.83**	**1,963.98**
	Mainland China Plants	Domestic water (river water)	–	15,590.86	16,184.48	12,318.97
		Recycled water from the manufacturing process	–	14,926.16	15,510.87	11,773.31
		Total	**–**	**30,517.02**	**31,695.35**	**24,092.28**
RMC Plants	Taiwan Plants	Domestic water (including tap water and groundwater)	247.78	402.56	580.90	589.56
		Recycled water from the manufacturing process	152.13	247.28	307.39	430.20
		Total	**399.91**	**649.84**	**888.29**	**1,019.76**
Operation Headquarters		Domestic water (tap water)	16.45	17.28	14.96	12.69
		Total	**16.45**	**17.28**	**14.96**	**12.69**

Total Water Savings From Water Saving Initiatives (Unit m³)

Indicators		2018	2019	2020	2021
	Taiwan Plants	–	–	–	246,841
	Mainland China Plants	–	–	–	1,822,336

Water Use Intensity (Unit m³/ton of cementitious material)

Cement Plants	Taiwan Plants	0.43	0.38	0.36	0.30
	Mainland China Plants	0.34	0.33	0.33	0.32
Percentage of Green Building Materials Applications (Unit percentage %)		–	–	7	11.2

Note 1 TCC Taiwan is the scope of coverage if Mainland China plants are not otherwise indicated.
Note 2 The operation headquarters commenced the collection of natural gas usage data in 2019.
Note 3 Self-generated and self-use renewable energy had not been activated at Mainland China plants for 2018 - 2021.
Note 4 Electricity-saving statistics from energy saving initiatives cover the main promotion schemes with higher electricity savings.

Carbon Reduction Targets for Each Plant Linked to the Performance-Based Remuneration System.

In order to effectively implement ESG, TCC continues to track the mid- and long-term targets of adopted sustainability strategies and the performance of various non-financial indicators, and link them to the annual performance appraisal and remuneration incentive system. The Group has set carbon reduction targets for each cement plant starting in 2019. Through an online carbon emissions reduction platform, the Company reviews and tracks the achievement of carbon emissions reduction, and continues to adjust and optimize the carbon reduction emissions program to realize its carbon neutral vision.

To integrate with corporate governance, overall business operations and sustainable development, quarterly bonuses are calculated according to the achievement rate of EPS, environmental protection and key measurement indicators of each plant in each quarter, and annual performance bonuses are calculated according to the annual achievement rate in the annual performance assessment. Through quarterly bonuses and annual performance bonuses tied to the results of carbon emissions reduction promotion, TCC enhances the responsibility and motivation of all employees to implement carbon emissions reduction actions and deepen the promotion of low-carbon transformation. In addition, TCC has planned alternative fuel performance assessment indicators and targets for each plant. Through monthly tracking of alternative fuels usage and carbon emissions intensity for each plant, and combined with the alternative fuels assessment system, we encourage our employees to work together to implement the Group's carbon emissions reduction targets.

Coexisting in Harmony with the Earth and Life

This Report is the inaugural TCFD report issued by TCC, and it is the first time that TCC's strategic actions and management practices in response to climate change are fully disclosed through a systematic framework. TCC has referred to the TCFD guidelines and industry-specific recommendations to assess the financial impact of climate change, quantify the results as a concrete consideration for mid- and long-term strategic planning, and develop a sustainability blueprint for its three core businesses: low-carbon cement, resource recycling and green energy. Furthermore, we have set targets according to the SBTs, and strive toward our 2050 target of delivery carbon neutral concrete.

Climate change is a pivotal issue faced by all humankind, and achieving a balance between CO2 emissions and the environment has always been a challenge for the cement industry. In the cement business, TCC has been actively adopting alternative raw materials and fuels, upgrading carbon capture technologies, and improving energy efficiency through equipment & process enhancements.

In addition, TCC has actively deployed new energy sources, explored natural and clean renewable energy sources as much as possible, and invested in the development of energy storage to pursue energy transformation. These dynamic and diverse carbon reduction strategies all aptly demonstrate TCC's commitment to reducing greenhouse gas emissions.

The extreme climate disasters facing the world today are the backlash of nature out of balance against human behaviors. As the side effects of human-made prosperity gradually emerge, the cement industry, which is closely related to human civilization and nature, is obliged to strive its utmost to repair the imbalance between itself and nature. As a pioneer in the search for environmental solutions, TCC shall continue to pursue a sustainable mindset, uphold the principles of sound business operations and environmental friendliness, share the attitude of living in harmony with nature with its business partners, and lead the industry to the next stage of development, for the mutual benefit of the Earth and all living things.

Appendix

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[9] World Energy Outlook 2021 (IEA, 2021)

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[11] Energy Technology Perspectives 2020 (IEA, 2020)

[12] Spatial and temporal patterns of drought hazard for China under different RCP scenarios in the 21st century (IJDRR, 2021)

[13] Climate Change Data Service - Future Projection (Taiwan Climate Change Projection and Information Platform, TCCIP)

[14] Projection of Extreme Typhoon Events (National Science and Technology Center for Disaster Reduction, NCDR)

[15] Climatic Analysis of Typhoons (Central Weather Bureau, Ministry of Transportation and Communications)

[16] Aqueduct - Water Risk Atlas (WRI)

TCC Sustainability and Climate Related Policies, Reports and Publications

TCC Sustainability Report 2021

TCC Annual Report 2021

TCC CSR Report 2021

/ TCC Corporate Sustainable Development Committee Organizational Procedures

/ TCC Risk Management Committee - Organizational Procedures

/ TCC Risk Management Policy and Principles

TCFD Disclosure Comparison Table

General Industry Indicators

Aspects

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Governance		
a) Describes the risks and opportunities associated with the Board's oversight of climate-related matters	1.1 Board Governance Structure and Oversight Mechanisms	9-11
b) Describes the role of management in assessing and managing climate-related risks and opportunities	1.2 Management's Authority and Responsibility	11-13
Strategies		
a) Describes the short-, mid-, and long-term climate related risks and opportunities identified by the organization	2.2 Short-, Mid- and Long-Term Climate-Related Risks and Opportunities	15-17
	TCC's Climate Milestones	5
b) Describes the climate related risks and opportunities that have a significant or material impact on the organization's business, strategy and financial planning, and clearly discloses the actual financial impact on the organization and information on the organization's low carbon economic transformation plan	TCC's 2050 Net Zero Transformation Roadmap	7-8
	2.2 Short-, Mid- and Long-Term Climate-Related Risks and Opportunities	15-17
	3 Comprehensive Climate Strategy	18-30
	4.1 Transformation Risk Scenario Assessment	32-33
c) Describes the organization's strategic resilience, taking into account different scenarios of climate change, including scenarios of 2°C or lower	4.2 Physical Risk Scenario Assessment	33-34
Risk Management	2.1 Climate Risk Identification and Assessment Process	14-15
a) Describes the organization's process for identifying and assessing climate-related risks	2.1 Climate Risk Identification and Assessment Process	14-15
b) Describes the organization's process for managing climate-related risks	2.1 Climate Risk Identification and Assessment Process	14-15
c) Describes how the organization's processes for identifying, assessing, and managing climate related risks are integrated into the overall risk management program	2.2 Short-, Mid- and Long-Term Climate-Related Risks and Opportunities	15-17

TCFD Disclosure Comparison Table

General Industry Indicators

Aspects

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a) Discloses the metrics used by the organization to assess climate related risks and opportunities in accordance with the strategy and risk management process	5.1 Greenhouse Gas Emissions Indicators and Targets 5.2 Other Climate-related Key Indicators	35-37 37-39
b) Discloses Scope I, II, III emissions quantities and related risks (if applicable)	5.1 Greenhouse Gas Emissions Indicators and Targets	35-37
c) Describes the organization's goal for managing climate-related risks and opportunities and the performance of that goal, adding disclosure of milestones (if the organization has a mid- to long-term goal)	5.1 Greenhouse Gas Emissions Indicators and Targets	35-37

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Aspects

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Conformity Statement

Climate related Financial Disclosure
Conformity Statement

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Holds Statement No: CFD 780721

As a result of carrying out conformity check process based on TCFD requirement, BSI declares that:

- Taiwan Cement Corporation follows Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) for the materials and buildings sector to disclose climate-related financial information which is clear, comparable and consistent about the risks and opportunities and its financial impact. The disclosures cover four core elements and have been prepared by seven principles for effective disclosures.
- The maturity model for the Climate-related Financial Disclosures is **Level-5+: Excellence** grade.

For and on behalf of BSI:

Managing Director BSI Taiwan, Peter Pu

Latest issue: 2022-11-24 Expiry date: 2023-11-23

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Location	Conformity Check Overall Result
Taiwan Cement Corporation No. 113, Sec. 2, Zhongshan North Road Zhongshan Dist., Taipei City 104414, Taiwan 台灣水泥股份有限公司 臺灣台北市中山區 中山北路 2 段 113 號 104414	The maturity model for the Climate-related Financial Disclosures is **Level-5+: Excellence** grade.

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