

Promoting a Low-Carbon Transition in the Cement Industry of Chinese Taipei: Strategies and Outcomes

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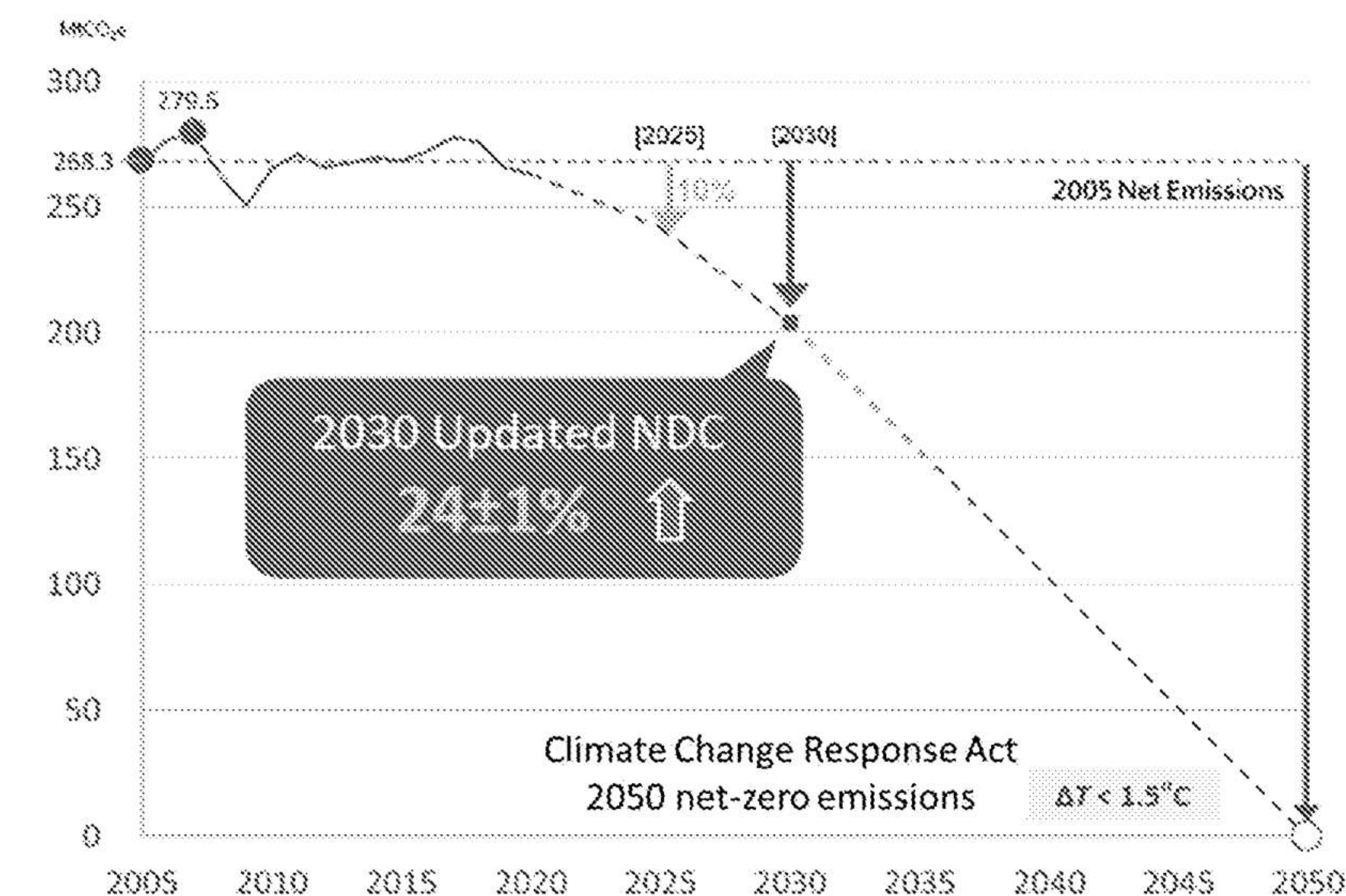
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Abstract

The cement industry is one of the main contributors to carbon emissions, and hence its decarbonization actions play a crucial role in achieving national net-zero target. In Chinese Taipei, the cement industry's carbon emissions primarily arise from the calcination of limestone into calcium oxide (54.9%) and the combustion of coal for fuel (35.6%). Under government guidance for green transition and industry collaboration, the cement sector in Chinese Taipei has implemented several low-carbon transition strategies. These include process improvement, energy transition, circular economy practices, and the application of carbon capture, utilization, and storage (CCUS) technologies. These efforts are designed to effectively reduce carbon emissions and enhance energy efficiency. Additionally, the government has offered various resources and incentives, such as carbon fee mechanisms and tax reductions, to support companies in striving for the vision of net zero by 2050.

1. Introduction

In 2022, the National Development Council of Chinese Taipei, under the Executive Yuan, announced the "Pathway to Net-Zero Emissions by 2050," along with a 12-Key Strategies action plan for achieving this transition. The goal is to achieve a $24 \pm 1\%$ reduction in carbon emissions from 2005 levels by 2030, setting the stage for net-zero emissions by 2050 (Figure 1). In 2023, the Climate Change Response Act was enacted, incorporating the 2050 net-zero emission target into law. This act strengthens climate change adaptation measures and establishes carbon fee mechanisms, thereby laying a solid legal foundation for Chinese Taipei's journey toward net-zero emissions.



Source: National Development Council (2022).

Figure 1: National Long-Term Emission Reduction Pathway Plan

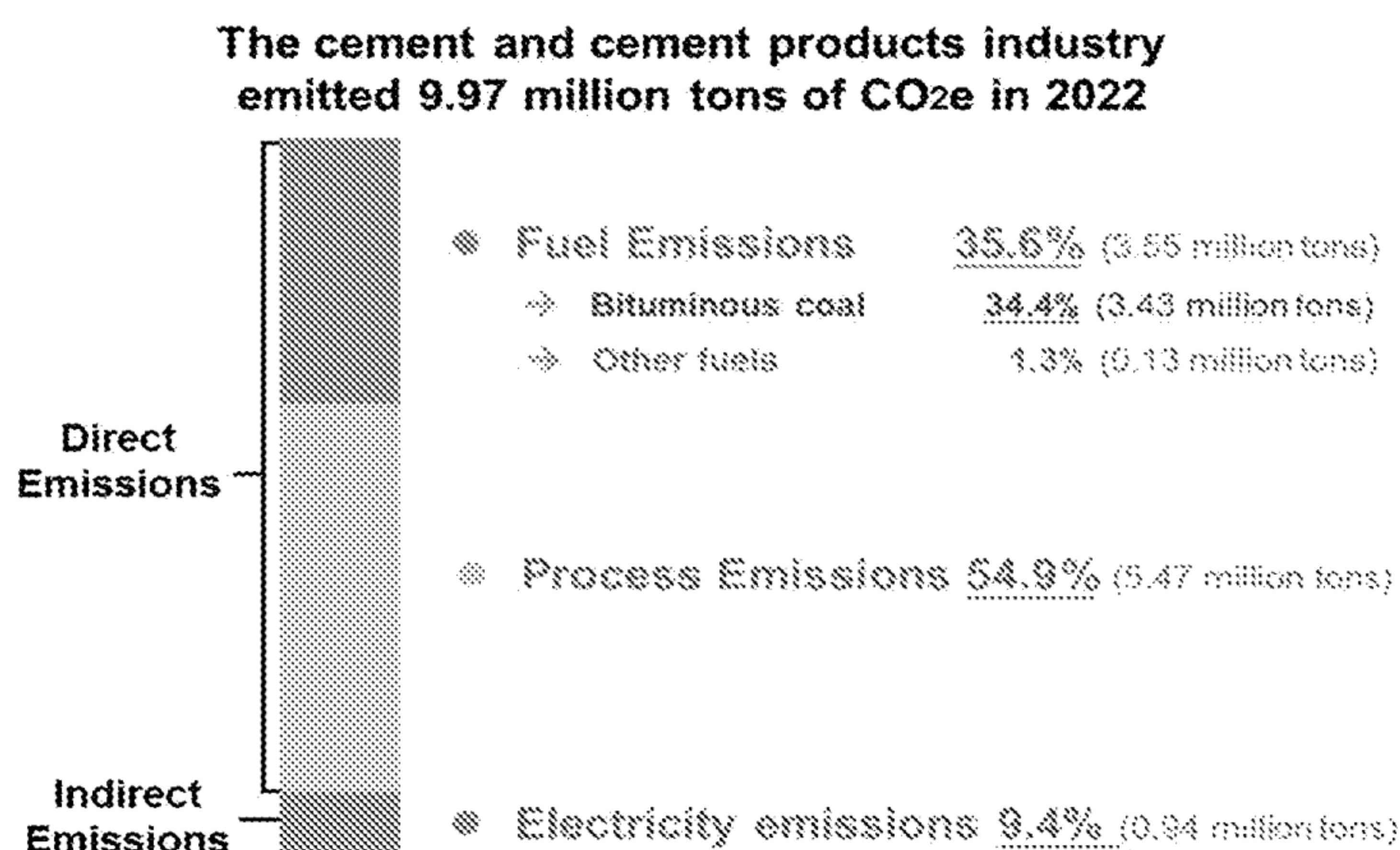
In response to the global trend toward net zero, corporate action on carbon reduction has become increasingly imperative. However, the long-term, high-temperature combustion process in cement production leads to significant energy consumption and substantial carbon dioxide emissions

from burning limestone, which accounts for approximately 8% of global greenhouse gas emissions. As one of the main contributors to carbon emissions, the cement industry is actively seeking effective decarbonization solutions. To address this challenge, Chinese Taipei's cement industry has implemented various carbon reduction strategies, including process improvements, energy transitions, circular economy practices, and carbon capture and utilization. These efforts aim to reduce carbon emissions and achieve net-zero goals.

2. Background

In Chinese Taipei, five companies continue to use rotary kilns for cement production. Over the past five years, these companies have produced approximately 11.3 million tons of cement annually to meet domestic construction needs. In 2022, the total greenhouse gas emissions from the cement and cement products industry in Chinese Taipei amounted to about 9.97 million tons of CO₂e, primarily attributed to process emissions and fuel emissions. The calcination of limestone, the main raw material in cement production, releases CO₂ as calcium carbonate decomposes, accounting for approximately 54.9% of the total emissions from cement production.

Additionally, due to geographic constraints, most cement plants are located in eastern Chinese Taipei, where access to natural gas pipelines is limited. As a result, the majority of these plants still rely on coal as their primary fuel source. Fuel-related carbon emissions account for approximately 35.6% of the total emissions from cement production (Figure 2).



Source: Bureau of Energy, Ministry of Economic Affairs(2024); Ministry of Environment (2024).

Figure 2: Greenhouse Gas Emissions in the Cement and Cement Products Industry

3. Policy Promotion

To achieve the goal of net-zero emissions, the Ministry of Economic Affairs (MOEA) and the Chinese National Federation of Industries (CNFI) jointly established the Industry Carbon Neutrality Alliance in 2022, encouraging industry associations and member companies to participate. The alliance promotes a model in which large enterprises lead small and medium-sized enterprises (SMEs), facilitating the sharing of carbon reduction experiences and fostering mutual learning.

The Ministry of Economic Affairs (MOEA) actively guides industries in their carbon reduction efforts by offering companies consultation, site visits, and diagnostics to identify carbon emission hotspots. Additionally, the MOEA provides carbon reduction planning and technical support services, while influential large enterprises within the industry assist small and medium-sized enterprises (SMEs) with their technological transitions. For benchmark carbon reduction companies, the MOEA offers financial

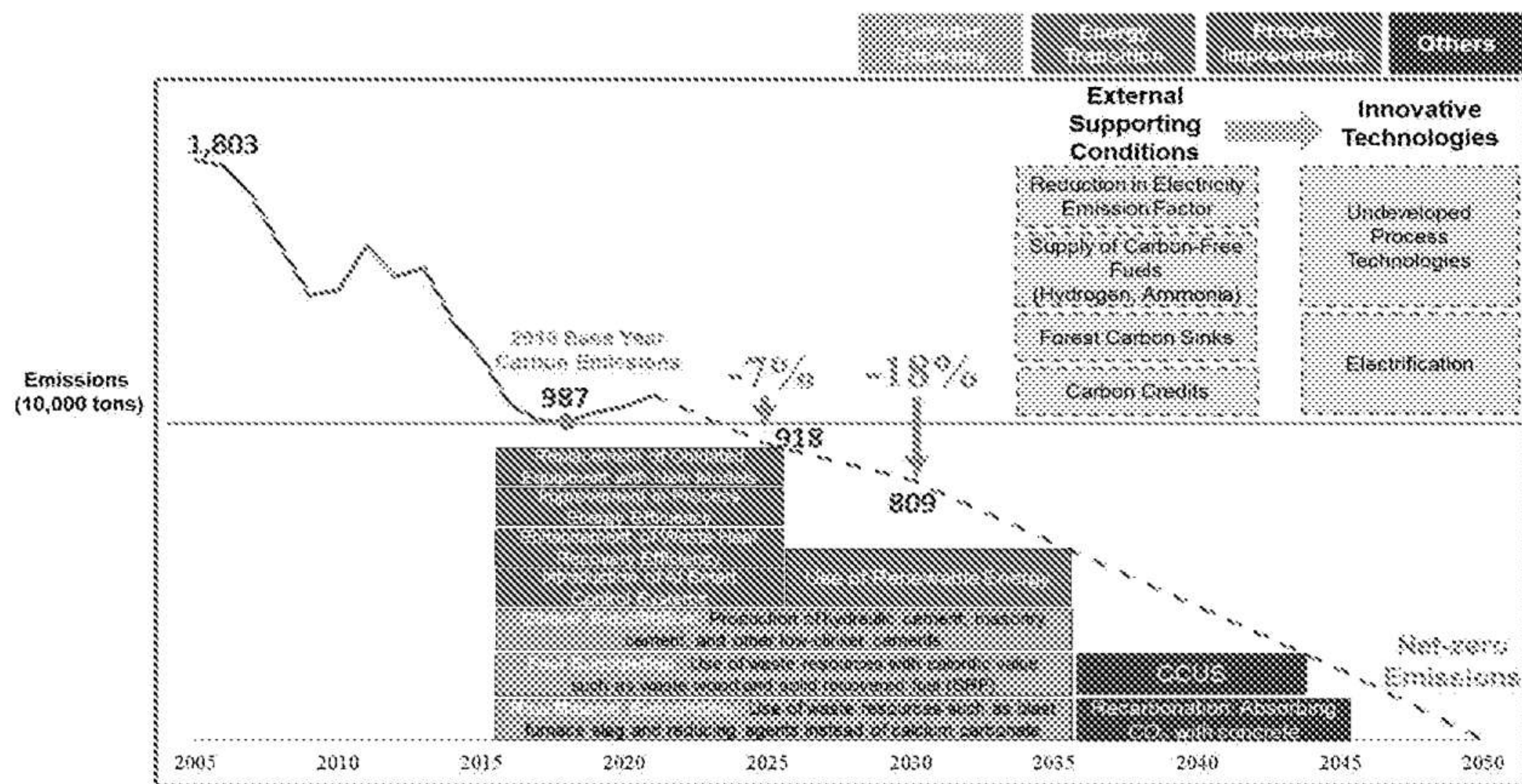
assistance, preferential financing, and credit guarantees to support their technological advancements and the development of innovative carbon reduction technologies.

To incentivize companies to meet national carbon reduction targets, Chinese Taipei will impose carbon fees on companies with annual carbon emissions exceeding 25,000 tons of CO₂ from the previous year, starting in 2025.

Companies that achieve designated reduction targets and submit self-reduction plans may qualify for preferential rates. Additionally, amendments to the Statute for Industrial Innovation make investments in net-zero emissions eligible for corporate income tax reductions. Through the implementation of carbon fees and tax reductions, the government aims to provide tangible incentives and resources to help companies reduce their carbon emissions.

4. Promoting Low-Carbon Transition: Strategies and Outcomes

By referencing the guidelines of the Global Cement and Concrete Association (GCCA) and the net-zero emission goals set by the National Development Council, domestic cement associations and companies have developed a carbon reduction pathway for the cement industry in Chinese Taipei (Figure 3). The carbon reduction strategies are primarily categorized into four areas: process improvement, energy transition, circular economy, and carbon capture, utilization, and storage (CCUS). The details are outlined as follows:



Source: Industrial Development Administration, Ministry of Economic Affairs (2023).

Figure 3: Carbon Reduction Pathway for the Cement Industry

(1) Process Improvement

By replacing equipment and improving process design, energy efficiency can be enhanced. Furthermore, AI smart systems have been introduced to establish carbon reduction targets, track progress, and optimize the feedstock of raw materials and fuels, as well as temperature control, thereby reducing fuel consumption.

(2) Energy Transition

Energy transition refers to the increased use and investment in renewable energy sources, such as solar and wind power, within the industry. It also involves the introduction of smart grids and energy storage systems to enhance the utilization of renewable energy.

(3) Circular Economy

1. Substitute Raw Materials and Fuels

The cement industry repurposes waste and industrial by-products in a safe and environmentally friendly manner. Fly ash from coal-fired power plants and reducing slag from steel mills are utilized

as substitute raw materials. Additionally, waste wood chips, pulp and paper sludge, and solid recovered fuel (SRF) with calorific values are used as alternative fuels. Over the past five years, the industry has processed an average of 2 million tons of waste annually, successfully promoting a circular economy and reducing its carbon footprint.

2.Low-Carbon Cement

The primary source of greenhouse gas emissions in cement production comes from the clinker calcination process, which accounts for 90–95% of total cement emissions. To reduce clinker content, low-clinker cement has been promoted in recent years, particularly Portland Limestone Cement, which can lower the carbon footprint by approximately 10% compared to Ordinary Portland Cement. In 2024, the government adjusted the commodity tax on low-carbon cement and revised the guidelines for public construction projects to encourage both the supply and demand for these products. As a result, market demand for low-carbon cement is expected to increase year by year.

(4)Carbon Capture, Utilization, and Storage (CCUS) Technologies

The cement industry is leveraging its process characteristics to actively develop carbon capture and storage (CCS) as well as decarbonization technologies. For example, Taiwan Cement Corporation is collaborating with Germany's thyssenkrupp Polysius to jointly develop oxyfuel combustion technology. This project is expected to be completed in 2026 and will capture an estimated 100,000 tons of CO₂ annually.

5. Conclusion

Driven by the global trend toward net-zero emissions, Chinese Taipei has successively announced its national 2050 net-zero emissions pathway, strategies, and key action plans. Furthermore, the government has codified the net-zero emission target into law and introduced carbon fee mechanisms. These actions have established a legal foundation and demonstrated that Chinese Taipei's commitment to achieving net-zero emissions aligns with international efforts.

Through policy promotion and industry collaboration, Chinese Taipei's cement industry has implemented diverse carbon reduction strategies, including process improvement, energy transition, circular economy, and carbon capture technologies. These initiatives aim to effectively decarbonize and enhance energy efficiency.

The government's support for corporate green transitions and the promotion of carbon fee mechanisms will encourage companies to actively adopt carbon reduction measures and collaborate to achieve the 2050 net-zero emission vision, while also facilitating the transformation and upgrading of the entire industry. In response to the challenges of global climate change, continuous innovation and collaboration will be essential for Chinese Taipei's cement industry to maintain a competitive edge in the future.

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