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Secil Group – Cement Towards Decarbonization and Sustainability

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Abstract **-** Cement industry is one of the largest emitters of carbon dioxide (CO_2), globally accounting for 8% of all emissions. With concrete being the second most used material on the planet after water, innovative solutions are required to reduce this industry's carbon footprint. This decarbonization challenge and transition towards a net-zero economy will be challenging and Secil Group, a Portuguese cement manufacturer, has taken the lead towards sustainability. To achieve carbon neutrality in 2050 in accordance with the guidelines established for the industry sector, Secil has committed to reduce emissions associated with the entire value chain by 2030 in 36% (equivalent to 456 Kg CO_2/t cement) and around 22% (553 KgCO_2/t cement) considering the cement value chain, by developing a set of projects focused on product, operation, and transport. Secil aim to contribute to the circular economy by increasing the incorporation of secondary raw materials (the consumption of renewable raw materials has more than tripled in 2022) and increase 25% in the use of alternative fuels. In operation terms Secil is implementing new technologies and procedures to reformulate the manufacturing process, having already recorded a 12% reduction in total energy consumption compared to the previous year. In transportation the preferential use is maritime and rail transport to move goods. The Clean Cement Line (CCL) is Secil's main project, focusses on a 20% reduction in CO_2 emissions within cement production. This target is accomplished through a multifaceted approach, with 30% of the reduction attributed to electricity recovery and an additional 20% through enhanced energy efficiency. The CCL, along with concurrent innovative technologies and practices, underscores Secil's commitment to carbon emissions reduction, thereby advancing the prospect of a sustainable future.

Keywords**:** Carbon Footprint; Cement Industry; Clean Cement Line; CO_2; Decarbonization; Environmental Sustainability; Renewable Energy; Secil Group.

1. Introduction

The global cement industry, responsible for annual 4 billion tonnes of cement and contributing 8% of global CO_2 emissions, faces a challenge in reducing emissions by 16% by 2030 to meet the Paris Agreement. Yet production may exceed 5 billion tonnes annually over the next three decades [1]. However, a 1% increase in direct CO_2 emissions intensity in 2022 hampers progress towards Net Zero Emissions (NZE) by 2050 falling short of the 4% annual reduction required [2]. Predominantly, these emissions originate from two sources: 60% from direct CO_2 emissions due to limestone heating and 40% from fuel combustion in cement kilns [3].

Emission targets for electricity decarbonization are set at 54% reduction by 2030 and 100% by 2050 [3]. Electricity consumption adds to the carbon footprint, with thermal energy intensity plateaued at 3.6 GJ/t clinker and electricity intensity at 100 kWh/t cement in 2022 [2]. The NZE Scenario targets less than 3.4 GJ/t clinker and 90 kWh/t cement by 2030, excluding additional energy for emission reduction technologies like Carbon Capture and Storage (CCS) and Carbon Capture Utilization (CCU) [2]. Carbon Capture Utilization and Storage (CCUS) may increase global electricity intensity by around 5 kWh/t cement [2]. Global recarbonation is estimated at 318 Mt CO_2 by 2030 and 242 Mt CO_2 by 2050 [3].

Globally, the clinker binder factor stands at 0.63 projected to decrease to 0.58 by 2030 and 0.52 by 2050. Alternative cements are forecasted to reach 1% in 2030 and 5% in 2050, reducing emissions by 0.5% [3]. Optimizing binder utilization can reduce demand by 5% in 2030 and 14% in 2050 [3].

Fossil fuels dominate thermal energy sources at 90% (2022), but alternative fuels may rise to 22% by 2030 and 43% by 2050. Innovations such as hydrogen use, and kiln electrification may play a small role starting from 2040 [3]. The transition to low-carbon fuels aims to reduce fossil fuels to 79% and non-renewable waste to 3% by 2030. Bioenergy and renewable waste aim to contribute 16% by 2030, with hydrogen at 2% of total thermal energy share [2].

Secil aligns its 2030 and 2050 commitments with GCCA's pathway to neutrality by efficiency in concrete production, savings in cement, binders, clinker production and de-carbonization of electricity (Fig. 1). *Solidia* in Piscataway, N.J., employs low-temperature solidification (reactive hydrothermal liquid-phase densification), licensed from Rutgers University, to reduce emissions by 30%. Dartmouth's *CarbonCure* stores carbon dioxide from industrial processes in concrete through mineralization. *CarbiCrete* in Montreal replaces traditional cement in concrete with steel slag. In Norway, *Norcem* aims to create the first zero-emissions cement-making plant, already substituting 70% of fuel with waste-based alternatives and planning carbon capture and storage to eliminate emissions by 2030 [4].

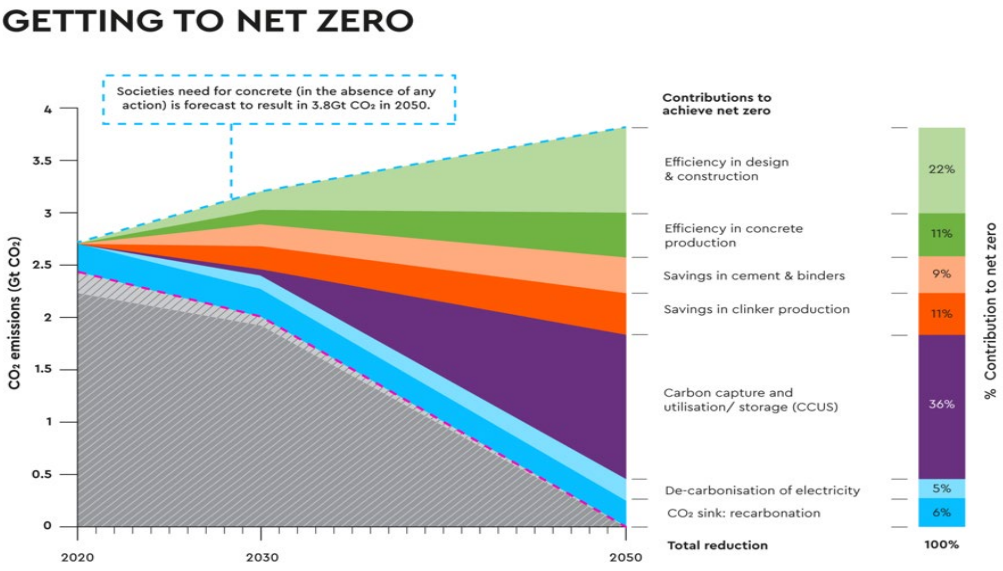

Fig. 1: Getting to Net Zero. Seven contributions to achieve net zero. [3]

2. Results/Discussion

Secil Group, Portugal's second-largest cement industry, has embarked on a comprehensive sustainability journey aimed at reducing its carbon footprint throughout the value chain. This strategic effort, known as *Ambition2025, Sustainable Growth*, include increasing renewable energy and alternative fuel adoption, enhancing energy efficiency, and pursuing innovative products and processes to cut emissions. Secil is executing an important investment in R&D in modernizing the Secil-Outão unit under the Clean Cement Line (CCL) project since 2021.

2.1 Cement decarbonization

Secil is committed in achieving carbon neutrality by 2050 (Fig. 2), with a primary focus on reducing CO_2 emissions across the entire value chain by 36% (equivalent to 456 Kg CO_2/t cement) by 2030, compared to the 2020 baseline and aligned with *Ambition2025, Sustainable Growth*. In compliance with the requirements of the NP EN ISO/IEC 17025 standards, the clinker factor of 0.78 was maintained for quality assurance determinations.

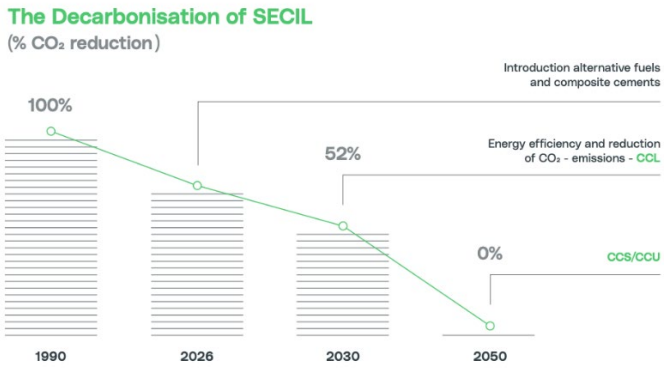

Fig. 2: Roadmap for Secil Decarbonization by 2050. [5]

Notably, in 2022, Secil successfully reduced its total CO_2 emissions (Fig. 3a) to 3 395 902 t CO_2e, (3 250 351 t CO_2e Scope 1 and 145 551 t CO_2e Scope 2), which reflects a 10% reduction compared to 2021 [5].

In terms of energy consumption, Secil made substantial progress in 2022, with a total energy consumption of 16 583 373 GJ (Fig. 3b), representing a noteworthy 12% reduction compared to the previous year and a 7% decrease compared to 2020. An especially promising development was the remarkable threefold increase in renewable energy consumption compared to 2021 [5].

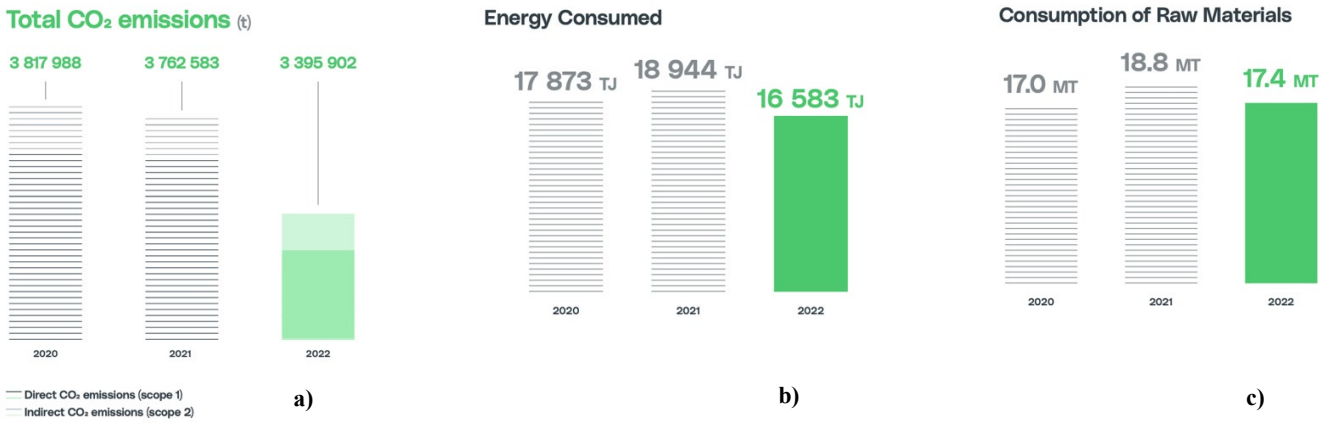

Fig. 3: Secil's performance in the years 2020 to 2022, in terms of **a)** total CO_2 emissions; **b)** energy consumed, and **c)** consumption of raw materials**.** [5]

Additionally, Secil effectively managed its raw material usage in 2022, with a total consumption of 17 404 646 metric tons (Fig. 3c), a considerable 9% reduction compared to the previous year. Furthermore, a significant transformation was observed in the use of Raw Materials (RM), with a notable shift towards renewable RM. This transition was driven by the incorporation of biomass in alternative fuels like Refuse-Derived Fuel and tires, also aligned with *Ambition2025, Sustainable Growth* initiative that aims to achieve 25% in alternative fuels. In 2022, waste production reached 28,658 tons of which 0.16% was used as RM and 65.2% allocated for valorisation and 34.8% designated for disposal. [5]

2.2 Clean Cement Line (CCL)

CCL is Secil's primary initiative, focusing on reducing CO_2 emissions in cement production by 20%, achieved through the generation of 30% of electricity by recovery and another 20% in energy efficiency. The CCL project includes several sub-projects such as the *Low Carbon Clinker* (LCC), *Zero Fossil Fuel*, *Combustion Boost*, and *Sun2dry* (Fig. 4).

As part of the CCL project, Secil plans to eliminate the use of primary fossil fuels entirely and transition to the new alternative fuel, *Energreen*, derived from biomass bio-refining, to optimize its utilization in cement. [5]

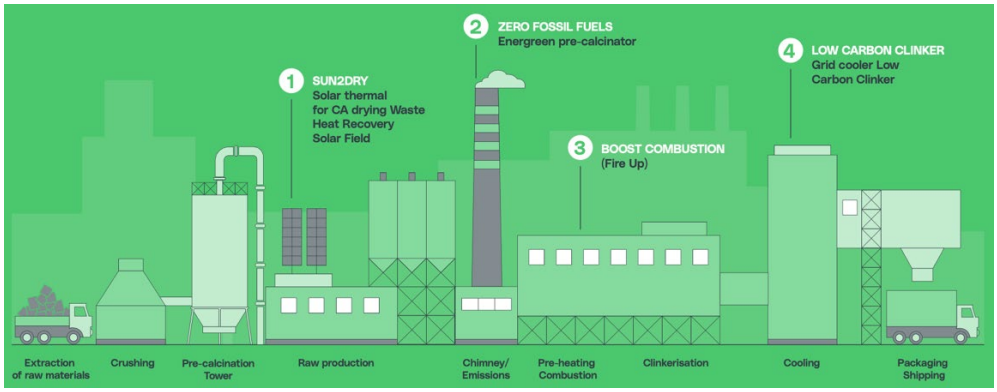

Fig. 4: CCL - Integration of several projects for energy efficiency and reduction of CO_2 emissions (combustion and process). [5]

The LCC is an innovative technology that produces clinker with a 15% lower carbon footprint by reducing the clinkerization temperature introducing new raw materials and additives combined. The Zero Fossil Fuel project consumes renewable energy sources such as wind, solar energy, and biomass as fuel in cement production. The Combustion Boost focuses on improving the efficiency of the combustion process in cement kilns to reduce fuel consumption and the associated carbon emissions. The Sun2dry project uses solar energy to dry raw materials before they enter the cement production process, reducing CO_2 emissions and energy requirements for the drying process [5].

2.3 Other Sustainability Initiatives

In addition to the CCL project, Secil has implemented several other sustainability initiatives. The *BeInAHand* aims to improve the company's waste management practices reducing waste and promoting a circular economy by developing new products using recycled materials. Project *Baterias2030* and *OnThermalHp* initiative focus on developing new energy storage solutions for renewable energy sources (wind and solar) and on improving efficiency using waste heat recovery technologies, respectively, to decrease energy consumption and related carbon emissions, while improving the overall efficiency in cement production. Finally, the *Be-Charged* project promotes the use of electric vehicles in company's operations and the *Clean4G* combines green hydrogen and CO_2 capture and utilization to produce a low-carbon fuel for the cement production, also reducing fossil fuel use while providing a sustainable energy source [5].

These projects collectively contribute to emissions reduction and sustainability, positioning Secil at the forefront of the cement industry's sustainability drive.

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