CASE STUDY

BUSINESS MODELS FOR GREEN HYDROGEN IN LATIN AMERICA

2. DECARBONIZING CHILE'S CEMENT INDUSTRY

This publication is part of the activities of the project "Advancing a Regional Approach to the Green Hydrogen Economy in Latin America and the Caribbean" (H2 ¡Vamos! / H2 Go!), an initiative led by the United Nations Environment Programme (UNEP) and funded by the Green Climate Fund. The project aims to strengthen regional capacities to promote a just, inclusive, and sustainable green hydrogen economy.

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1. EXECUTIVE SUMMARY

Cementos Melón, one of the leading cement companies in Chile, is spearheading an innovative project to reduce CO_2 emissions in the sector by integrating green hydrogen as fuel in its raw mills. This pilot project uses electrolyzers powered by renewable energy to produce hydrogen, which is then blended with natural gas. With an expected emission reduction of up to 60 tons of CO_2 per year and a scalable approach, the project aims to position the company as a sustainability leader within the cement industry, both regionally and internationally [1].

2. BACKGROUND AND CONTEXT

The cement industry accounts for 8% of global CO_2 emissions due to the intensive use of fossil fuels in the calcination of clinker and the chemical emissions inherent to the process (decarbonation of limestone). In Chile, construction represents a significant portion of the GDP and has experienced growing demand for sustainable materials, driven by the energy transition and global climate goals. Within this context, the “Cement and Concrete Roadmap to 2050” and the National Green Hydrogen Plan provide an ideal regulatory and strategic framework for companies like Cementos Melón to lead innovative decarbonization initiatives [2].

3. PROJECT DESCRIPTION

The Cementos Melón pilot project aims to integrate green hydrogen as fuel at its production plant located in the Los Lagos region. The hydrogen will be produced locally through electrolysis, using solar and wind energy, ensuring a fully sustainable production cycle. In the initial phase, a blend of

green hydrogen and natural gas is planned, with the goal of reaching a 10% hydrogen share by 2050 (as per the agreement signed by Melón in the NetZero 2050 Roadmap of the Inter-American Cement Federation) [3].

4. USE OF TECHNOLOGY

The integration of green hydrogen in the raw mills involves the following processes:

1. Green Hydrogen Production:

Alkaline electrolyzers produce hydrogen using electricity from renewable sources. The water used is pre-treated through deionization systems to optimize process efficiency.

2. Fuel Blending:

In the initial phase, the raw mills will operate with a blend of green hydrogen and traditional fossil fuels. The hydrogen share will gradually increase as technical and logistical systems are optimized.

3. Technical Adaptations:

- **Modified Burners:** Designed to handle the high combustion velocity and lower energy density of hydrogen.
- **Combustion Control Systems:** Real-time monitoring of combustion efficiency and emitted gas quality.
- **Refractory Linings:** Upgrades to the interior of the mills to withstand the temperatures and conditions associated with hydrogen combustion.

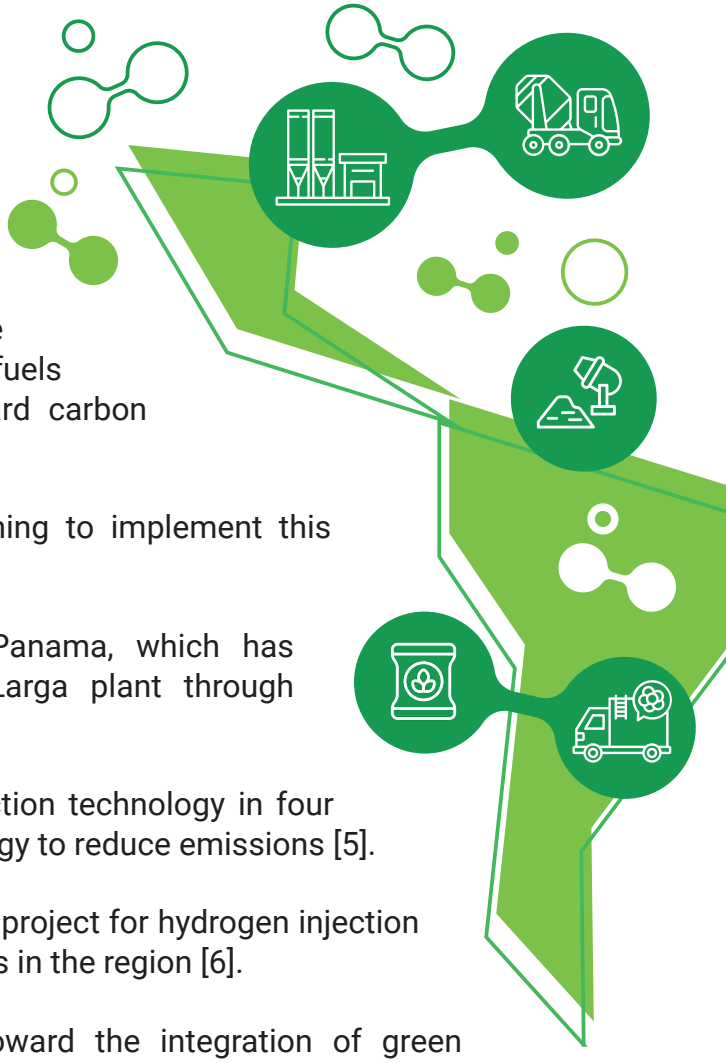
4. Expected Results:

- A reduction in annual CO_2 emissions.
- Improvements in thermal efficiency and reductions in secondary pollutants such as nitrogen oxides (NO_x).

5. VALUE PROPOSITION

The cement produced using green hydrogen enables Cementos Melón to offer a product with a reduced carbon footprint, meeting the demands of international markets that prioritize sustainable materials. This approach not only reduces dependence on fossil fuels but also enhances the company's competitiveness in a market where environmental regulations are becoming increasingly stringent. Moreover, the project contributes to positioning Chile as a leader in the transition toward a low-carbon economy [1].

6. SIMILAR PROJECTS IN LATIN AMERICA AND REGIONAL ADAPTATION



The cement industry is among the most carbon-intensive, accounting for approximately 8% of global CO_2 emissions. In this context, the use of green hydrogen as a substitute for fossil fuels represents a key strategy for progressing toward carbon neutrality.

In Latin America, several companies are beginning to implement this technology.

One of the most notable cases is CEMEX Panama, which has incorporated green hydrogen at its Calzada Larga plant through continuous combustion systems [4].

In Mexico, CEMEX will implement hydrogen injection technology in four cement plants as part of its Future in Action strategy to reduce emissions [5].

Meanwhile, Holcim Mexico has announced a pilot project for hydrogen injection in cement kilns as part of its decarbonization plans in the region [6].

These cases demonstrate tangible progress toward the integration of green hydrogen in the Latin American cement industry, although challenges remain related to production costs, infrastructure, and technological implementation.

7. MARKET SEGMENT

The target market for Cementos Melón's project focuses on meeting the growing demand for sustainable materials in the construction industry and other industrial sectors.

At the national level, construction companies developing public infrastructure projects—such as hospitals, roads, and housing—represent a key segment. These stakeholders seek materials that comply with sustainability standards established by Chilean regulations and international climate commitments.

At the international level, the project is aimed at markets such as Europe and North America, where there is high demand for products certified with low environmental impact. Increasing regulatory pressure in these markets compels construction firms and developers to use materials that reduce their carbon footprint. Additionally, Cementos Melón plans to collaborate with mining and energy industries engaged in large-scale projects, where low-carbon cement can play a significant role in reducing overall operational emissions [1].

Finally, local governments implementing sustainable projects and promoting responsible construction practices are also a relevant market. This includes public-private partnerships for the development of sustainable infrastructure in Chile and abroad.

8. KEY ACTIVITIES

The success of the Cementos Melón project is supported by a series of strategic activities designed to ensure the technical, economic, and environmental viability of the initiative. These activities are described below:

1. Green Hydrogen Production
2. Technological Adaptation: including refractory linings
3. Environmental Monitoring and Certifications
4. Training and Awareness-Raising

PROJECT DEVELOPMENT PHASES:

- **Phase 1 (2024–2025):** Feasibility studies and conceptual design.
- **Phase 2 (2026):** Installation of initial infrastructure and pilot testing.
- **Phase 3 (2026–2027):** Start of large-scale operations and technology validation.
- **Phase 4 (2028–2030):** Scaling up hydrogen use and process optimization.

These activities ensure not only the successful implementation of the project but also its capacity to serve as a model for other cement industries.

9. KEY PARTNERS

The project involves collaboration with several strategic partners who play fundamental roles in its implementation and long-term success. These include:

1. **Government of Chile:** Through tax incentives and favorable regulations, the government facilitates project execution. It also promotes Cementos Melón's participation as a benchmark in industrial decarbonization initiatives.
2. **International Organizations:** Institutions such as the Green Climate Fund and the World Bank provide financing and technical assistance, strengthening the project's economic viability and alignment with global climate goals.
3. **Academic Institutions:** Chilean universities are involved in research and development of technological adaptations, as well as in workforce training for those participating in the project.

10. RESULTS AND BENEFITS

1. Environmental:

Reduction of other pollutants, such as nitrogen oxides (NO_x), through advanced emission control systems.

2. Economic:

Increased competitiveness of low-carbon cement, enabling access to international markets with strict environmental regulations.

3. Social:

Promotion of sustainable industrial development and creation of skilled employment opportunities in emerging technologies.

These results confirm the technical, economic, and social viability of the project, establishing it as a replicable model for other cement plants and industrial sectors.

11. COST STRUCTURE

The cost structure of Cementos Melón's decarbonization project through the use of green hydrogen is divided into two main categories: initial investment and recurring operating costs.

1. Adaptation of Raw Mills:

- Burner and Combustion System Modifications: Adapting the kilns to use hydrogen as fuel requires modification of the burners and combustion systems.
- Control and Monitoring Systems: Implementation of advanced systems to monitor and control hydrogen combustion, ensuring efficiency and safety.

2. Logistics and Transportation Infrastructure:

- Internal Transportation Systems: Development of systems for the safe handling and transport of hydrogen within the plant.

3. Training and Environmental Certification:

- Technical Training Programs: Staff training on the management of new technologies and safety protocols.

It is important to note that green hydrogen production costs are subject to variation depending on electricity tariffs, electrolyzer efficiency, and economies of scale. It is projected that with decreasing renewable energy costs and technological advancements, the cost of green hydrogen production in Chile could be reduced by 30% by 2030 [7].

12. FINANCING STRUCTURE

Detailed information regarding the financing structure of this project has not been provided by the developer company. However, given the innovative and strategic nature of the initiative, it is estimated that it has been supported through a combination of internal resources, government support, and incentives available under the national green hydrogen strategy and sectoral roadmap.

Cementos Melón's experience demonstrates that, even in the absence of external climate financing, companies with a long-term vision can lead energy transition processes through progressive investments, leveraged by favorable regulatory frameworks and corporate sustainability goals.

13. REVENUE SOURCES

The project's revenues come from several key sources that contribute to its profitability and long-term sustainability. Including Tax Benefits: Incentives granted by the Chilean government, including reduced costs for renewable energy and tax exemptions for sustainable projects, represent an annual saving.

14. LESSONS LEARNED

The development of this project has revealed several important lessons for the decarbonization of the industrial sector:

1. Public–Private Collaboration:

The combination of government incentives, international financing, and private resources is essential to make projects of this scale viable.

2. Technological Adaptation

Implementing green hydrogen in cement production requires complex technical adaptations, but current technologies allow for maintaining product quality while significantly reducing emissions.

3. Training and Awareness:

Training technical personnel and conducting awareness campaigns for local communities are essential to ensure social acceptance and the operational success of the project.

4. Economic Viability:

Although initial costs are high, the projected decline in green hydrogen prices and the additional revenue from carbon certificate sales make the project economically viable in the long term.

5. Scalability:

This model can be replicated in other cement plants and industrial sectors, serving as a reference for future decarbonization initiatives in Chile and across Latin America.

15. CONCLUSIONS

The Cementos Melón project represents a significant step forward in the transition toward a sustainable cement industry in Chile. By incorporating green hydrogen as a fuel, the company not only reduces its carbon footprint but also enhances its competitiveness in international markets. This model combines technological innovation, strategic financing, and collaboration among key stakeholders, setting a precedent for the decarbonization of other industrial sectors in the region.

With proper planning and a scalable approach, Cementos Melón is positioning itself as a leader in sustainability, contributing to global climate goals and reinforcing Chile's commitment to carbon neutrality by 2050 [1].

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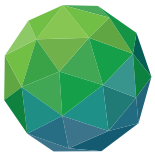

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