Strategy | Energy | Product design and testing | Deterministic / Stochastic

Decarbonized Cement Manufacturing via Advanced Production Technologies

BUSINESS PROBLEM

NextEra Energy, Inc. is one of North America's foremost electric power and energy infrastructure companies. The broad economy-wide transition from highly polluting, fossil fuel-based processes to renewable electricity-based processes creates business opportunities for NextEra Energy. Cement production contributes 7% of all CO2 emissions and cannot be decarbonized with existing commercial technologies. Accelerating the development of technologies that reduce the carbon intensity of cement production while increasing the usage of renewable electricity provides the opportunity for NextEra Energy to access a new market.

APPROACH

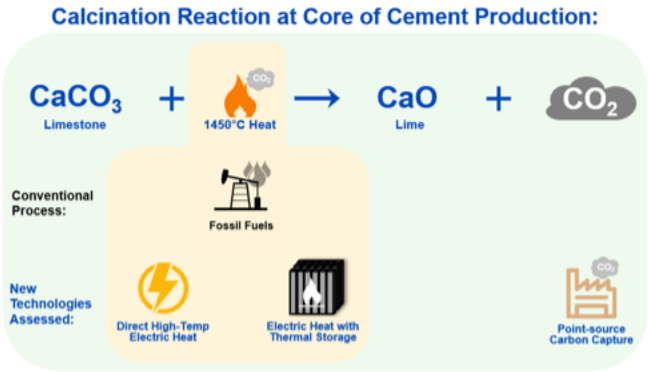
The economic returns for three candidate decarbonization technologies were calculated for five different potential cement production locations. Models incorporated technology and location-specific production costs in addition to taxes, logistics costs, and available economic incentives. For market viability, the returns of a new production technology must exceed those of conventional technology.

DATA SOURCES

Data for technology-specific costs were sourced from publicly released reports. Electricity prices were calculated from hourly locational marginal prices combined with the relevant capacity, transmission, and REC costs. Industrial natural gas prices were derived from the Energy Information Administration. Logistics costs were sourced from relevant industry publications and US government reports.

Data Types and Format

Data types were generally .csv files for tabular data and in direct numerical format for the majority of capital and operating costs, sourced from the relevant data owner or report.



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IMPACT

Cement production is considered a "hard-to-decarbonize" industry due to the high temperatures needed for production, necessitating the use of fossil fuels, as well as the inherent carbon dioxide-releasing chemistry of the production process. Its hard-to-decarbonize nature combined with its ubiquity and importance worldwide have spurred significant R&D efforts resulting in numerous proposed technology pathways for decarbonization. This analysis provides a framework for NextEra Energy to evaluate potential investments in the low carbon cement space aligned with the company's business objectives and to develop appropriate demonstration & implementation strategies. The study first assesses the technology landscape to determine three candidate technologies for further evaluation. The results of the analysis then inform which of the candidate technologies evaluated, if any, should be prioritized for investment and where further R&D effort should be focused in order to increase competitiveness with traditional production methods. The results also illustrate which markets are best positioned for cement production and consumption. Finally, the study proposes several policy recommendations that can accelerate the adoption of low carbon cement in the United States.

DRIVERS

Cement production does not currently require large amounts of electricity. As new technologies are developed that can reduce the carbon intensity of cement production, the penetration of electricity into the industry may increase, generating a market opportunity for electricity producers. In addition, the presence of economic incentives in the U.S. and E.U. can increase the attractiveness of otherwise uncompelling projects.

BARRIERS

Many of the technologies under assessment are immature and lack significant publicly available information resulting in greater uncertainty on costs. In addition, many of the inputs to the models can be highly volatile, making the selection of a baseline value more difficult. Many of these barriers can be overcome with sensitivity analysis and through further technology development efforts.

ENABLERS

The project was enabled by a highly supportive and experienced team at NextEra Energy. The team enabled conversations with relevant technology providers and facilitated cross-functional interactions within the company to develop the next steps and implementation plan based on the work in this study.

ACTIONS

Low carbon cement technology developers and experts were engaged to understand the competitive landscape and their view of industry dynamics and strategies. With the results of the study, the team's efforts could be focused on technologies and applications that are best positioned for success. Internal stakeholders were engaged to understand market opportunities and next steps.

INNOVATION

The study assesses a set of leading-edge technologies applicable to many industries. Their use in cement production would be innovative as they have not yet been validated or demonstrated at scale in that context. In addition, the notion of producing low carbon cement in the U.S. for export to the E.U. market to take advantage of U.S. tax incentives and the E.U. carbon pricing mechanism is a novel approach to entering the market.

IMPROVEMENT

The decarbonization pathway capable of producing the greatest economic returns was identified as point-source carbon capture. Producing low carbon cement with this technology for export to the E.U. generates economic returns larger than those achieved with conventional methods. For the domestic market, with an approximately 50% reduction in carbon capture CAPEX, economic returns can also become competitive with those of conventional methods.

BEST PRACTICES

A full understanding of the both the technology landscape as well as the strategic objectives of the interested company is required to ensure that the technologies pursued align with the business need. In addition, thorough interrogation of public cost data is required to justify appropriate back-to-back comparisons. Finally, the assessment of electricity prices on an hourly basis is critical for evaluating thermal storage technologies.