the ENERGY lab

PROJECT FACTS

ICCS - Area 2

Recovery Act: Carbon Mineralization by Aqueous Precipitation for Beneficial Use of Carbon Dioxide from Flue Gas

Background

The United States Department of Energy (DOE) National Energy Laboratory (NETL) is helping to develop technologies to capture, separate, and store carbon dioxide (CO_2) in order to reduce greenhouse-gas emissions without adversely influencing energy use or hindering economic growth. To further this mission, DOE has partnered with the Calera Corporation to design, build, and operate a CO_2 Conversion to Material Products (CCMP) Pilot Plant that will employ Carbon Mineralization by Aqueous Precipitation (CMAP) technology. CMAP converts the captured carbon dioxide (CO_2) from power plant flue gas into carbonate minerals that can be used to produce building materials for use in the construction industry.

The Calera technology is based on directly capturing CO_2 from the flue gas and then reacting the solution with calcium containing streams and forming a precipitate (a solid substance that drops out of the solution). The technology converts the CO_2 to reactive carbonate minerals that can be made into marketable building materials. Integrating this technology into a power plant facility can greatly reduce the net operating costs of sequestering CO_2 produced at the plant by generating a saleable product. Carbon sequestration technologies capture and store CO_2 that would otherwise reside in the atmosphere for long periods of time. Through leveraging proprietary techniques, Calera has developed a new electrochemical platform called ABLE that integrates with CO_2 absorption and produces alkalinity for production of carbonate materials, but also coproduces a range of potentially valuable chemical products such as ethylene dichloride which is used in PVC plastic manufacturing. Calera's proprietary electrochemical technology enables the production of these industrial chemicals at lower energy than conventional production methods resulting in a reduction in overall carbon emissions while at the same time directly capturing and converting CO_2 to carbonate material products.

This project will demonstrate at a pilot plant the full carbonate mineralization technology through to commercially viable construction products ready for deployment. The demonstration pilot plant will capture CO_2 from the Dynegy Power Plant in Moss Landing, California. The beneficial use products derived from the mineralized CO_2 will be tested and optimized to maximize their marketability and value.

Project Description

The work will be done in two phases. During Phase 1, Calera prepared a management plan for the project; develop the conceptual design of the Building Materials Demonstration Plant; perform environmental analysis and start the permitting process; and prepare the preliminary plant design, an engineering plan, and a detailed design of the plant.

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PROJECT DURATION

Start Date	End Date
01/15/2010	09/30/2015

COST

ARRA funded
Total Project Value
$41,919,378
DOE/Non-DOE Share
$20,959,689 / $20,959,689

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

During Phase 2, the plans developed in Phase 1 will be used to direct the final design, construction, and operations of the plant. The project team will test and operate the CO_2 Conversion to Material Products (CCMP) Pilot Plant for 12 months and optimize the integrated process to achieve key metrics for the carbonate mineralization process including the percentage of CO_2 removed from flue gas, net operational costs per quantity of CO_2 converted to useful product, capital cost per quantity of CO_2 converted, product performance indicators, and lifecycle metrics. Phase 2 will conclude with an analysis that will produce the data needed to facilitate scale-up and commercial deployment of the carbonate mineralization technology.

Goals/Objectives

The project will demonstrate an innovative process to mineralize CO_2 from flue gas into carbonate form and maximize the value and versatility of the mineralized products. Specific objectives include optimizing the integrated CMAP process and demonstrating its commercial viability; developing a useful product stream from the CO_2 captured from power plant exhaust; and testing a variety of unit operations to find optimal combinations that maximize the value of carbonate mineralization beneficial use products.

Accomplishments

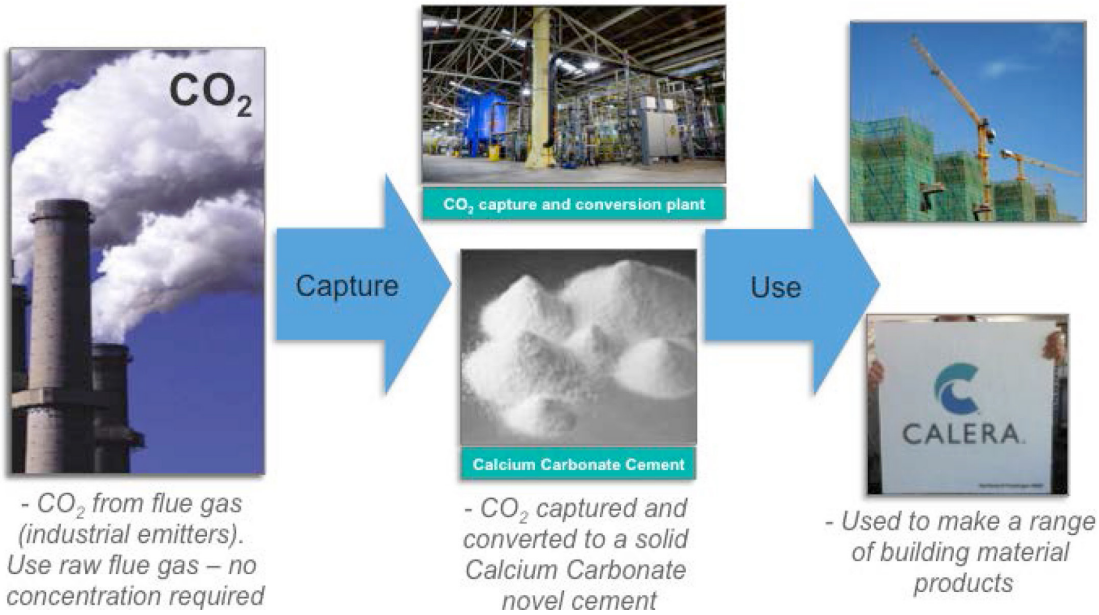
During Phase I of the project, Calera developed the technical plan, process design basis, and conceptual design block flow diagram; completed the preliminary process flow diagram with equipment list, major equipment connectivity, stream table, and material and heat balances; and prepared a complete list of required permitting and associated agencies for construction and operation. Calera prepared an environmental management plan, risk analysis, project schedule, cost estimate, detailed design specification sheets for all major equipment, utility and infrastructure analyses, and a control system package. The team created process & instrumentation diagrams (P&IDs) for all major pieces of process and auxiliary equipment as well as a competitive analysis and production readiness plan.

In the Sub-phase 2a, Calera completed the detailed design of all subsystems required for the pilot demonstration. Materials of construction were selected and proven in both lab scale and prototype testing to be acceptable for the reagent conditions of interest. Cement Fiberboard was selected as the application for the reactive carbonate material generated from captured CO_2 based upon prototype testing. The design of a continuous cement fiberboard production line has been completed that will continuously produce full commercial size boards for test marketing. The electrochemical cell architecture and components have been selected based upon both lab scale and prototype testing. The appropriate quality control and diagnostic techniques have been developed and tested along with the required instrumentation and controls. Furthermore, Calera has developed new processing techniques as part of the Sub-phase 2a program that allow the use of alternative calcium sources such as waste calcium oxides that can also be used as the source of alkalinity and calcium.

Finally the demonstration site infrastructure, NEPA categorical exclusion, and permitting is all ready for the construction and installation of the new units and upgrades.

Benefits

The DOE's Industrial Carbon Capture and Sequestration (ICCS) projects develop technologies that capture, separate, and store CO_2 in order to reduce greenhouse gas emissions without adversely influencing energy use or hindering economic growth. Companies that implement CMAP technology for carbon sequestration will realize a reduction in net costs through the sale of carbonate minerals to the construction industry. This technology will provide a monetary incentive for reducing CO_2 emissions in the environment as well as a renewable resource to produce construction materials. This project supports the DOE's goal to decrease the negative environmental impact of energy production.



Calera's process reduces carbon dioxide and pollutant emissions by using waste streams to make useable products.