



# NET-ZERO INDUSTRIES

MISSION



|                                     |   |
|-------------------------------------|---|
| <b>Project Title</b>                | <b>Harnessing Solar Radiation to Drive CO<sub>2</sub>-Free Clinker Manufacturing – SOLAR CLINKER</b>  |
| <b>Industry Partner</b>             | Synhelion, CEMEX  |
| <b>Industry Sector</b>              | Cement & Lime   |
| <b>Technology Pathway (Primary)</b> | Fuel switch / Alternate Fuels & Feedstocks  |
| <b>NIM Pillar</b>                   | Technology Demonstration  |
| <b>Source</b>                       | NIM Awards 2024   |
| <b>Description</b>                  | <p>SOLAR CLINKER is a project that addresses one of the most pressing challenges in the cement industry: reducing CO<sub>2</sub> emissions in clinker production. In 2020, Cemex launched its Future in Action program, aiming for net-zero emissions by 2050. As part of this program, Cemex has partnered with over fifty organizations to develop industrial-scale, carbon-neutral solutions. SOLAR CLINKER, a flagship initiative within this portfolio, focuses on decarbonizing the cement (clinker) manufacturing process by replacing fossil fuels with concentrated solar thermal (CST) energy.</p> <p>Clinker production, the most energy intensive part of cement manufacturing, typically requires heating rotary kilns to 1,500°C using fossil fuels, which contribute to over 40% of the industry's direct CO<sub>2</sub> emissions. SOLAR CLINKER leverages Synhelion's cutting edge technology to generate these high temperatures using solar energy, thus eliminating fossil fuel use. Additionally, the project captures 100% of CO<sub>2</sub> emissions from the process, which can be used, among others, as feedstock to produce synthetic fuels like kerosene, diesel, and gasoline.</p> <p>In 2023, the U.S. Department of Energy awarded the project Solar MEAD \$3.2 million to optimize heat transfer in the clinker raw material mix specific to the CST process. The project is in collaboration with Sandia National Laboratories, which provides research facilities and expertise in CST technology to optimize its application in cement production, thus, further advancing the technology's potential while enhancing its efficiency. The project has also received recognition in the Eco-Innovator category of the Corporate Citizenship Innovation Awards.</p> <p>By integrating CST technology into cement production, SOLAR CLINKER is poised to transform the industry, making fully solar-powered, net-zero cement plants a reality.</p> |
| <b>Innovations Employed</b>         | <p>SOLAR CLINKER introduces a revolutionary approach to cement (clinker) production by combining Synhelion's advanced high-temperature solar heat technology with Cemex's expertise in clinker manufacturing. Synhelion's technology generates extreme heat required for clinker production, reaching temperatures beyond 1,500°C, entirely through concentrated solar thermal (CST) energy. In collaboration with Cemex, the project has innovatively integrated this solar receiver with the clinker production process, replacing traditional reliance on fossil fuels and reducing over 40% of the industry's direct CO<sub>2</sub> emissions. Additionally, the project captures 100% of the process's carbon emissions, converting them into synthetic fuels. This partnership not only decarbonizes cement production but also sets a new standard for sustainability and efficiency in the industry, surpassing current state-of-the-art methods.</p>   |



# NET-ZERO INDUSTRIES

MISSION



|  |  |
|--|--|
| <b>Project Title</b>   | <b>Harnessing Solar Radiation to Drive CO<sub>2</sub>-Free Clinker Manufacturing – SOLAR CLINKER</b>   |
| <b>Dimension of Novelty</b>  | It was new to the International Market   |
| <b>Innovation Collaboration</b>  | External Partners<br>Concentrated solar thermal energy receiver: primarily developed in-house by Synhelion.<br>Receiver integration into clinkering manufacturing process: Developed by Cemex in collaboration with Synhelion.   |
| <b>Intellectual Properties</b>   | All the intellectual property related to the clinker chemistry and clinker manufacturing process as a result of the application of high temperature CST is and will belong to Cemex.   |
| <b>IP Links</b>  |  |
| <b>Timetable &amp; Progress</b>  | Developed in 2018<br>Prototype system tested in intended environment and operating at close to expected performance (TRL 6).   |
| <b>Financing (Public/Private)</b>  | In 2023, Solar MEAD received a \$3.2 million award from the U.S. Department of Energy to study conditions that maximize heat transfer to raw cement mix.   |
| <b>Finance Links</b>   |  |
| <b>Project Phase TRL</b>   | TRL 6  |
| <b>Problems to be Solved and Risks to be Managed</b>                                   | Ensuring that heating the clinker raw material with a fuel composed of CO <sub>2</sub> + water vapor did not alter/affect the clinker's chemistry.<br>Designing a continuous production pilot to properly manage the process required in clinker production.   |
| <b>Preliminary or Final Results Achieved</b>   | The SOLAR CLINKER project has achieved the world's first production of clinker using solar radiation, demonstrating the feasibility of using solar energy for the most energy intensive part of cement production. This breakthrough paves the way for scaling the technology to industrial levels, potentially eliminating fossil fuel use in cement manufacturing.<br>Preliminary results indicate a significant reduction in CO <sub>2</sub> emissions, contributing to the industry's goal of net-zero emissions by 2050. The project has also gained recognition and funding from the U.S. Department of Energy, further validating its potential.  |
| <b>CO<sub>2</sub> Emissions Reduction Potential - Implementation and Future Market</b> | SOLAR CLINKER has strong implementation potential both domestically and internationally, particularly in regions with high solar irradiance. The project's ability to eliminate fossil fuel use in cement production addresses a critical need in the industry, positioning it as a viable solution for achieving carbon neutrality by 2050. Its market potential is amplified by growing regulatory pressures and consumer demand for sustainable construction materials. The project could lead to significant CO <sub>2</sub> emissions reductions globally, given the widespread use of cement in infrastructure. Additionally, besides eliminating fossil fuels, the project also is a carbon capture project because the gases produced have a very high concentration of CO <sub>2</sub> that can |



# NET-ZERO INDUSTRIES

MISSION



## Project Title

**Harnessing Solar Radiation to Drive CO<sub>2</sub>-Free Clinker Manufacturing – SOLAR CLINKER**

be easily separated by condensing the water vapor. With continued development, SOLAR CLINKER could transform the cement industry into a cornerstone of sustainable building practices worldwide.

## Market Positioning

## Project Location

Mexico

## Project & Technology Links

First Cement Fully Produced with Solar Heat, PDF, Cement generated with solar heat. IMDEA (Móstoles, Spain) Solar Tower, PDF, IMDEA Solar Tower where Cemex and Synhelion have produced the first solar clinker.