Restoring the Climate by Building with Synthetic Limestone

Restoring the climate requires removing and storing a trillion tons of legacy CO_2 by 2050.

Nature has stored 99 percent of all the CO_2 on earth in the form of limestone, made of calcium and CO_2 by shellfish and other marine organisms.[1] Nearly half carbon dioxide by weight, limestone is an ideal, permanent storage system for this greenhouse gas.

Recently, scientists have learned how to make synthetic limestone, on a far accelerated timescale, by copying how oysters and corals build their shells. This "biomimicry" enables entrepreneurs to produce high-quality synthetic limestone and limestone-based aggregate for concrete. The synthetic version directly replaces, and eliminates the environmental harm from, quarried rock. Today the world uses 55 billion tons of rock from quarries each year.

A synthetic limestone industry could scale massively enough to remove all trillion tons of excess CO_2 and sequester it as concrete in our built environment. Thus climate restoration would be financed by the sale of synthetic limestone for building and paving. Demand for concrete and buildings is expected to soar as we raise coastal cities above the rising seas.

Synthetic limestone: A climate restoration solution that pays for itself

Synthetic limestone meets the three criteria for climate-restoration solutions: it can scale massively, store carbon permanently; and be financed from existing sources.

Each cubic meter of limestone sequesters about a ton of CO_2. Substituting 55 billion tons of quarried rock with carbon-negative synthetic limestone would permanently store 25 gigatons of CO_2 a year. Consumption of rock is doubling every 12 years, so potential carbon removal could be as high as 60 Gt a year by about 2030.

The business case for investors is compelling, as rock is already a trillion-dollar industry and the customer base grows constantly. Synthetic limestone is cost-competitive with quarried rock, partly because it can be produced near construction sites, which saves the cost (and emissions) of long-haul transport.

Blue Planet Systems, based in California, manufactures synthetic limestone from CO_2 captured from fossil-fuel-plant exhaust or directly from the air, and calcium from demolished concrete. Synthetic limestone stores so much CO_2 that Blue Planet concrete is strongly carbon-negative despite its cement content.

In 2016, San Francisco International Airport built a terminal with carbon-negative concrete. The quality was so high that the airport has purchased Blue Planet System's output for the next two years for new terminals and runways.

Next steps—
Policy support and investment

This new industry could achieve the needed scale of between 25 and 60 Gt of carbon removal per year by 2030 if required.

Policy can promote faster adoption of carbon-negative materials for building and paving. For instance, the U.S. Government recently created a procurement rule requiring all government contractors to use low-carbon or carbon-negative concrete as it becomes available. The more investment it receives, the larger and faster the carbon-negative concrete industry will scale.

Reclaiming a Pre-Industrial Climate by 2050

Everyone wants to restore a "safe harbor" climate, one that humans have actually survived and thrived in long-term, with CO_2 levels below 300 ppm.

Reaching a safe harbor climate will require pulling a trillion tons of legacy carbon from the atmosphere by 2050. We can do this by copying nature. Nature pulls massive amounts of CO_2 from the atmosphere by two major pathways: Boosting photosynthesis in the ocean and forming limestone from the calcium carbonate shells of sea animals.