Algae: Single-Celled Savior Of The Climate Crisis

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Green Tech
From Chicago, I write about green technology, energy, environment.

Can marine algae sustainably replace behaviors that are damaging the climate? © 2018 Bloomberg Finance LP

A team of Cornell University scientists set out to produce carbon-neutral fuels from algae and found what they believe is a "doable" and profitable system to not only render the transportation sector carbon negative, but reduce pressure on

forests, on fresh water and on ocean fisheries.

And, they say, it will make money.

"We were not getting into this to grow algae and make money," said Charles Greene, a Cornell University oceanographer who leads a pair of consortiums investigating marine algae. "There's a lot of small companies out there that grow algae and produce sort of niche products and make a lot of money doing it. But we got into this because we were really interested in solving the climate problem."

The scientists have published a number of papers on what they've found, but the forthcoming one promises to be a doozy.

"This is the paper that that we're working on now: Basically we figured that a scaled-up marine microalgae industry could profitably—and that's a really important term, profitably—meet the projected global demand for animal-feed protein, for vegetable oil, and for liquid-transport fuels."

In a recent visit to Stanford University, Greene outlined a system developed with colleagues including Cornell visiting scholar Mark Huntley. If scaled globally, the system promises a suite of stunning co-benefits, including:

• Reducing global freshwater consumption by 18 percent,

• Freeing 2.8 million square kilometers of cropland for reforestation,

• Reducing the demand for wild-caught fish by 34 percent (the portion currently dedicated to fish meal),

• And, potentially, helping to feed 9.5 billion people.

"Think of it this way: there will no longer be pressure to deforest the Amazon for soy or to deforest Indonesia for palm oil. We can actually lead to an emissions reduction of about 13 gigatonnes of carbon dioxide per year by 2040, and that's

roughly a third of our current CO2 emissions. That's why we got into this, and we're really excited because this is doable."

Greene described the system at Stanford, beginning with the effort to clean up transportation:

Electrify What You Can

The team foresees electrifying as much transportation as possible, especially light vehicles, and of course cleaning up the power sector.

"First of all we're just going to assume electrification of the light-vehicle fleet by 2040," Greene said. "Now people can argue whether that's going to happen or not, but it is doable. But we're still going to need liquid fuels for other parts of the transportation sector."

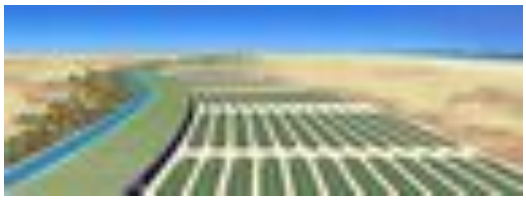
Those parts are more difficult to clean up: aircraft, ships, trains, trucks, heavy machinery. "Right now we don't see a way to avoid liquid fuels for those, but things happen, so you can't you can't say for sure what the future holds. But anyway we're going to go with the fact that we are likely to need liquid fuels into the future."

Fuel The Rest With Algae

"How can we continue to use liquid hydrocarbon fuels and become effectively net negative? So this is where algae come in."

Marine algae grow in sea water, so they don't compete for fresh water. And they grow best on non-arable land, so they don't compete for crop land. The algae grow best in arid subtropical regions of the world, Greene said. "These are deserts."

Feed The Algae Captured CO2



The Cornell researchers' vision of marine algae grown in the world's deserts.
CORNELL UNIVERSITY

Algae need surplus CO2 to optimize their productivity (which the Energy Department estimates can be up to 100 times higher than the land plants usually used for fuel).

Power plants have long been considered a source for this captured CO2, but such a system would not be carbon neutral if the carbon comes from the burning of fossil fuels. So the CO2 should come from direct-air capture. That sounds expensive. Former Energy Secretary Ernest Moniz estimates the cost at about $1,000 per ton, much higher than the $40-$50 social impact of a ton of carbon. But Greene is working with Global Thermostat, a carbon-capture company that claims to have reduced the price to $100 per ton, and that pitches itself as "the only company that can economically capture CO2 anywhere — directly from the air as well as from industrial smokestacks."

If that dream becomes a reality, fossil carbon disappears from the equation. The carbon emerges from tail pipe, jet engine or ship's funnel is just carbon returning to the atmosphere from whence it came. That's carbon neutrality. The next step renders the system carbon negative:

Sell The Co-Products

Once captured, CO2 can be used in a litany of products including building materials, cements, chemicals, plastics, grid batteries,. Greene foresees using 80 percent of the CO2 that way, and delivering only 20 percent to the algae. Once consumed by algae, the carbon can be used in bio-petroleum wherever fossil fuels are now used.

"If you produce other longer-lived bio-petroleum products like plastics and perhaps use those in the human-built environment, then you have the potential to store that carbon in these long-lived

materials, essentially sequestering it," Greene said. "So then it actually becomes carbon negative."

The algae can also produce salable products like ethanol, feed for fish and livestock and food for people. A system that meets the world's demand for liquid fuels, Green calculated, would be large enough—thanks to algae's vigorous productivity—to produce ten times as much protein as the annual global yield of soy.

"This is how we're going to come up with the protein that's going to feed nine and a half billion people by mid-century."

Greene, Huntley and their colleagues set out to solve a fuel problem but discovered an unexpected opportunity:

"If you were just growing the algae for fuel, you know, kind of best-case scenario, if everything's working well, it's about $10 a gallon in the end," Greene said. "And that was when we said 'Okay fine we're not going to be able to compete with fossil fuels.' DOE had this objective of growing algae and trying to get it to $5 a gallon, and I just don't see that happening. But if you have these other co-products, you know, we've done the calculations, you can basically almost give the fuel away because you're making so much money."

Watch Greene's presentation to the Stanford Precourt Institute for Energy:

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