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For Carbon Emissions, a Goal of Less Than Zero

By MATTHEW L. WALD
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IF the world is going to sharply reduce the amount of carbon dioxide pumped into the atmosphere by midcentury, then many businesses will have to go carbon neutral, bringing their net emissions of the greenhouse gas to zero.



Jose A. Martinez/Solena Biofuel Group
GREEN GIANTS Algae, which have a high energy value per pound and consume carbon dioxide, are being cultivated at a biofuel demonstration facility run by the Solena Group in Alicante, Spain.

But some could go even further by removing more CO2 than they produce. Instead of carbon neutral, how about carbon negative?

In academic and industrial labs worldwide, researchers are working on technologies to reach that goal.

Success could create the ultimate green business — for example, one that produces fuel whose emissions are more than offset by carbon dioxide stored during production. The businesses would be successful if, as anticipated, Congress puts a tax on emissions or starts a trading plan that makes carbon credits valuable.

For some experts, it's not a question of whether businesses will go carbon negative but when.

Carbon-negative technologies of some sort will be essential, said Daniel M. Kammen, director of the Renewable and Appropriate Energy Laboratory at the University of California, Berkeley. The world is facing the certainty of massive emissions for decades to come from plants already

running, he said, adding that atmospheric concentrations must be stabilized. "We've got such a carbon overshoot looming in the future that this is going to have to happen," he said.

The United Nations Intergovernmental Panel on Climate Change said that an 80 percent cut in carbon dioxide emissions was necessary to avoid the worst consequences of [climate change](#). But capturing the gas from coal plant smokestacks or switching to fuels that produce less of it when burned goes only so far.

"The great problem is actually removing carbon dioxide from the atmosphere," said Geir Vollaeter, an environment expert and former general manager of carbon dioxide at Shell

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International, a subsidiary of the oil giant.

While much engineering work would have to be done to make a business carbon negative, the outlines are clear.

Take the concept of building a coal plant that captures and stores carbon dioxide. Such a plant could have zero emissions, because the coal would be turned into gas and processed to produce hydrogen and carbon dioxide. The hydrogen, a pollution-free fuel, would be burned, and the CO2 pumped underground for permanent storage.

But Robert Williams, a research scientist at [Princeton University](#), said that not only coal could be gasified; you could also make the same fuel by starting with plant matter or other biomass.

And then, he said, “if you put any CO2 underground that is derived from biomass, that’s negative CO2 emissions.” That is because plants or trees — the raw material for the fuel — pull carbon dioxide from the atmosphere as they grow, and the gasification and storage takes that carbon out of circulation.

Mr. Williams said the more likely route would be to gasify a mixture of coal and biomass to keep the process carbon neutral. But the balance depends on the cost of separation and storage versus what kind of tax or other fee Congress might put on emissions.

More audacious is a plan by two professors at [Columbia University](#) to suck carbon dioxide out of the air, using waste heat from a solar plant, which has no smokestack.

Peter M. Eisenberger, a professor of earth and environmental sciences whose résumé includes positions at [Exxon](#) and other major companies, and Graciela Chichilnisky, an economist and mathematician, have proposed a “global thermostat strategy,” which would adapt a chemical process for capturing carbon dioxide from smokestacks.

Ordinarily, the process requires a large amount of energy. But the professors noted that McMahan L. Gray, a scientist at an Energy Department laboratory, has modified the process so that the relatively small amount of waste heat from a solar-generating plant could do the job. They estimate that they could remove about five pounds of carbon dioxide per kilowatt-hour of electricity produced. (A coal plant emits about two pounds when it makes that much electricity.)

“If you want to solve the global warming problem, you can’t do that by staying even,” Dr. Eisenberger said.

It will probably take a bounty on a ton of carbon, though, before anyone will do tests to see how well the chemistry will work on a practical scale.

A carbon-based process that may be a step closer to commercialization was created by George A. Olah, a Nobel laureate in chemistry, and G. K. Surya Prakash, a fellow faculty member at the [University of Southern California](#). To recycle carbon dioxide, they developed a kind of reverse fuel cell, which makes methanol by mixing the gas with water and applying a jolt of electricity.

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