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News: Briefing

Sucking carbon out of the air

Are plans to take carbon dioxide out of the air just a pipe dream, or a cure for global warming?

Nicola Jones

In a **Commentary** in this week's *Nature*, science policy experts Daniel Sarewitz of Arizona State University in Tempe and Richard Nelson of Columbia University in New York argue that removing carbon dioxide directly from the air is an effective way to tackle climate change. *Nature News* asks how advanced the plans to do this are.

David Keith is one of a number of researchers developing devices to capture carbon dioxide from the air.

D. Keith

Why do we need to capture CO_2 from the air?

Power plants and other major industrial sources only account for half of world emissions. The other half comes from very distributed or mobile sources, such as homes and cars, which aren't convenient for capturing carbon at the source. That's where air capture comes in.

Are there any companies looking at this?

A few. Global Research Technologies, based in Tucson, Arizona, was founded in 2004 and is the biggest commercial name in the business. Graciela Chichilnisky and Peter Eisenberger of Columbia University also have a company, called Global Thermostat, founded in 2006. But many others are working in the field. David Keith of the University of Calgary in Canada is now raising funds and hopes to start a company called Carbon Engineering within a few months.

How do their devices work?

There are various schemes. One main one first extracts CO_2 from the air by dissolving it in sodium hydroxide (NaOH), giving a solution of sodium carbonate (Na_2CO_3). To get the carbon out of solution, a trick is borrowed from the pulp and paper industry: slaked lime ($Ca(OH)_2$) or titanium dioxide (TiO_2) is added to the mix. This creates particles — of limestone ($CaCO_3$), if you're using lime — that settle out and can be collected. These particles are then thrown into a kiln and heated to release the CO_2 and regenerate the material needed (slaked lime or titanium dioxide) to keep the system running. In effect, the entire system simply separates CO_2 from air and concentrates it into a pure stream, so it's suitable for use or disposal.

This is the technique that Keith is pursuing, using a fine spray of liquid NaOH to suck up as much CO_2 as possible. Keith calls it "Russian tractor" technology, because it is based on very conventional chemistry, scales up well and has a low technological risk. In the near term, says Keith, that makes it a solid bet.

Another idea is to use a solid ion-exchange resin, such as those found in the water-softening industry. This is the system being mainly pursued by Global Research Technologies. They have hit on a commercially sold resin that absorbs CO_2 when dry, and releases it when exposed to humid air. This provides a very simple, low-energy way to mine CO_2 from the air. But, Keith notes, if the resin proves vulnerable to contamination in scaled-up systems, that will be very hard to fix.

Global Thermostat is looking at using amines stuck to a porous substrate, which releases captured CO_2 when exposed to low heat. They hope to use the spare heat from an electricity generator — perhaps a solar power plant — to run their process.

What do you do with the gas after capturing it?

There are many options. Global Research Technologies has talked about pumping their CO_2 into greenhouses or algae beds, where it might encourage plant growth. Keith and others, such as Frank Zeman, director of the Center for Metropolitan Sustainability at the New York Institute of Technology, have talked about combining it with hydrogen to make fuels for cars. But this requires a source of hydrogen — which requires energy and money.

Perhaps the simplest option is to bury it underground. You could put an air-capture plant right at an old oil well or some other suitable geological feature, so no transport of the gas would be needed.

So why hasn't the technology been scaled up?

It's expensive. Zeman guesstimates it will cost something like \$100 to \$200 per tonne of CO_2, in an optimistic world.

Compare that to the price of carbon in the European trading scheme: companies can buy credits to emit more CO_2 for less than \$20 per tonne. So any company that tried to make a living out of extracting CO_2 from the air would have a very hard time — right now.

When can we expect to see giant pipes littering the landscape, sucking up CO_2?

Rob Socolow of the Princeton Environmental Institute in New Jersey says his team is at the start of a year-long study of the feasibility of air capture, which might provide an answer to that question. "I hope I will have something useful to say a year from now," he says.

Global Research Technologies is raising funds now with the aim that, in two years, they'll have a production-run of several hundred prototype machines, costing less than $250,000 each, that run at less than $125 per tonne of CO_2. Global Thermostat aims to have a prototype in September 2009 .

Keith says he plans to have a rigorous assessment of the costs for his scheme in three years time: "you shouldn't believe a university professor telling you what the technology costs without some serious vetting by contract engineering firms", he says.

"Nobody doubts it's technically feasible," notes Zeman. "It's a question of how much people are willing to pay. At some point, we'll be willing to pay $200 per tonne."

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