

How to Reduce Global Warming for Fun and Profit

Innovative uses of CO2 may fuel a new generation of green industry

Carol J. Clouse, National Geographic, 10-7-14

It's easy to get depressed about climate change. We've made so little progress in reducing carbon-dioxide emissions that our previous goal - to limit the rise in global temperature to 2 degrees Celsius - is almost laughable.

But what if companies could make money from carbon dioxide, the heat-trapping gas that's the main contributor to global warming?

We're not actually so far off from turning emissions into commodities, it turns out. In the United States alone, a number of companies aim to convert waste carbon dioxide into chemicals that can be used to make products we buy every day: bleach, baking soda, car seats, diapers, even fuel. What's more, these companies aren't just green do-gooders. They're all on the verge of commercialization and aim squarely at making money. There's certainly potential: The market for jet fuel alone was \$200 billion in 2010.

"The world is moving toward carbon capture, and if they can do it while making money, they'd much rather do it that way," says Stacy MacDiarmid, a spokeswoman for Skyonic, based in Austin, Texas.

Skyonic sets up shop near carbon emitters, like power plants, and captures their emissions. It then combines them with salt, water and electricity to yield high-purity sodium bicarbonate, aka baking soda, as well as hydrochloric acid and bleach. The company will open its first commercial carbon-capture plant later this month and believes it will generate \$50 million in annual revenue.

Bedford, Massachusetts-based Joule is another one to watch. Its genetically engineered bacteria catalyze a chemical process that converts CO₂, sunlight and water into fuel that cars can use. This all takes place in giant tanks where bacteria grow. They're pond scum, basically, but they work a marvel: They metabolize carbon dioxide and produce synthetic fuel as a byproduct.

In other words, Joule's technology eliminates the middleman - the dinosaurs, for example, that have spent hundreds of millions of years underground, fossilizing into hydrocarbon-based substances - and radically condenses the fuel production process by starting at the end - with the CO₂. "What we are producing is really the same product that is being produced by the fuel industry today. We're just doing it in real time," says Tom Jensen, the company's head of corporate development.

Joule's fuel could be used in combustion engines, which means, theoretically, you could drive green without an electric car. Kiss your Tesla justifications goodbye. And if everything goes right, Joule says, its fuel could be sold for roughly \$50 a barrel, or \$1.20 gallon.

Of course, that's a big if. We're a long way from those sort of prices, and it's worth remembering that rosy projections are the hallmark of nascent industry. One industry adviser cautions that technological development is always risky and, even in the best-case scenario, still takes a long time. Joule, for instance, doesn't even expect its commercial facility to be up and running for another few years.

And yet, even the cautious recognize the potential: Transforming emissions into useful stuff could have huge implications - for both business and the environment. It's definitely a giant step forward from carbon capture and sequestration, or "CCS," which was state of the art for decades. CCS entails separating the carbon dioxide from emissions, liquefying it under high pressure, then burying it in a geological formation where it stays for millions of years. CCS gets rid of carbon, but it's awfully expensive, and there's no commercial incentive to do it.

Which is why carbon utilization is so promising: It might actually make money while helping reduce carbon dioxide - and at very large scale, too, because fuel and chemicals are huge markets.

So are polymers, the base material for things like plastic containers, paints, mattress foam, even disposable diapers. That's what Novomer, based in Waltham, Massachusetts, has its eye on. As currently constructed, polymers are terribly ungreen: The industry today uses an estimated 7 to 8 percent of extracted oil and gas. (See: "Gulf Oil Spill 'Not Over'")

Novomer's technology cuts the need for these fossil fuel-based raw materials in half. With a proprietary catalyst, the company reacts carbon molecules from carbon dioxide or carbon monoxide waste with traditional chemical feed stocks. The waste gas replaces 50 percent of the petroleum-based (propylene or propylene oxide) feedstock, which is an excellent deal for Novomer: It figures it can buy waste CO₂ from industrial gas makers (like those that supply to soda manufacturers) for \$100 a ton. Propylene oxide costs about \$2,000 per ton, says Peter Shepard, Novomer's chief business officer. "So it's 20 times less expensive," Shepard says.

Founded in 2007, Novomer has two base polymer products, each sold in three formats: hot-melt adhesives (for autos, shoes, furniture, textiles); rigid insulating foam (used for insulating homes and buildings); and coatings (used for decoration and protection of metal, plastic and wood). The products were launched commercially in June, and the company has capacity at a plant in Houston to produce them. Novomer expects to be profitable in the next 24 months or so.

Shepard acknowledges Novomer's work is but a small piece of the puzzle. "Realistically, there's way more CO₂ than our product can ever capture. But we're definitely a step in the right direction," he says.