CLIMATE DECISION MAKING CENTER
Carnegie Mellon University

Snatching Carbon dioxide from the Atmosphere

New air capture method could reduce the harmful effects of carbon dioxide emissions from vehicles

Habits are hard to break. And that's true of our centuries-old dependence on coal to heat and light up our homes.

Burning fossil fuels such as coal and oil releases carbon dioxide, the main culprit behind global warming. Carbon-free energy sources such as wind and solar power could combat this warming, but they account for only 6 percent of the total energy consumed in the United States. It will be years before we move away from traditional carbon-based energy sources and use enough clean energy to make a difference.

Until that happens, research has shown that we could stabilize rising temperatures by removing carbon dioxide from the atmosphere. Climate Decision Making Center researchers are exploring a new and unique way to do that. It's called air capture, because the researchers use a chemical to absorb CO_2 directly from air.

The towering, two-stories high prototype setup of the CDMC's carbon dioxide air capture system at the University of Calgary, Canada

Most current methods are designed to trap CO_2 from the gaseous waste products of power plants and industries. But cars and trucks that run on gasoline are one of the biggest emitters of the harmful gas. Air capture can be used to capture the CO_2 emitted from these vehicles. Many experts have predicted that clean vehicles powered by hydrogen or electricity won't become mainstream for another two or three decades. "Air capture would at least buy us time to transition to carbon-free vehicles," says Joshuah Stolaroff, a doctoral student working on the CDMC project.

Stolaroff, along with Professors David Keith and Greg Lowry have developed an experimental air capture system in the laboratory that uses sodium hydroxide as a sorbant, a chemical that absorbs gas, in this case CO_2 from air. A solution of the sorbant is sprayed through a reaction chamber. These droplets react with air and remove carbon dioxide. The resulting solution is

chemically treated to separate the CO_2, which is compressed for storage, and the sodium hydroxide, which is reused. The researchers have built a 21 feet tall prototype system that they're testing at the University of Calgary in Canada.

A real system would be even bigger—an open tower about 390 feet (120 meters) high and about 330 feet (100 meters) in diameter. The sorbant would be sprayed from the top while air is blown down through it. The chemical reactions would be the same as those in the lab.

All the chemicals involved in this design are inexpensive, abundant and relatively benign, says Stolaroff. The processes are well understood because they are used in chemical manufacturing and the pulp and paper industry, so the system can be made with existing technology. It could be made larger in order to capture a significant fraction of CO_2 emissions, he adds.

Cars spit out carbon dioxide, which causes global warming. The air capture system will help absorb this gas.

An important advantage of the air capture system is that it removes the need for expensive carbon dioxide transportation. Typical carbon capture plans for power plants involve separating CO_2 from flue gas—the gas mixture resulting from burning fuels—compressing it, and transporting it in pipelines to a storage site, where it can be stored safely in the ground or in containers.

But the air capture system could sit anywhere, Stolaroff says, ideally right next to a storage site, absorbing CO2 from air and putting it away, since the gas has nearly the same concentration around the globe. "You could, for instance, put all the towers in Antarctica and capture the entire world's emissions," he says.

Stolaroff doesn't believe that his system will replace carbon dioxide capture from stationary sources such as power plants. It would help with vehicle emissions, and in addition, it could be ramped up in case global warming turns out to be more disastrous than we have expected it to be and we want to attack the problem more quickly.

The researchers estimate that the system will cost upwards of $240 for every ton of carbon that it removes. This is much higher than the current and potential future tax for carbon emissions. But it could be much smaller than "the costs of other strategies that people are serious about, like hydrogen-fueled cars and solar PV," Stolaroff says.

And there's no reason why air capture couldn't be improved, using a new material or a new process on existing materials, he adds. "There is every reason to expect that with time and a modest research investment, the system could be much cheaper," he says.

The prototype air capture system could be the first step towards immediate carbon dioxide reduction, as we slowly adapt to cleaner energy sources.

The Climate Decision Making Center (CDMC) is an interdisciplinary collaboration between scientists at eight research institutions spanning the U.S., Canada and Germany. The center is anchored in the Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA. It is funded by the National Science Foundation and was formed to develop and demonstrate a set of new decision analysis tools for addressing problems which involve high, and often irreducible levels of uncertainty.