# Carbon Capture Technology: Cleaning up our skie

By **David W. Smith** - January 15, 2016

*Can carbon capture save the planet? Innovative start- ups have invented tech that could ha huge impact on climate change. Commercial realities and government diffidence remain the biggest obstacles to large-scale deployment, writes David W. Smith.*

The idea of capturing carbon dioxide straight from the air sounds like it comes from a scienc novel in which mad scientists save the planet from meltdown by inventing gigantic carbon hoovers. The reality is more complex because of the need for the companies to commercialis the process to avoid going out of business. But the idea that air capture is possible on such huge scale that it mitigates climate change is fundamentally correct.

Direct carbon capture was actually invented decades ago and has been used in submarines a outer space to clean air. What is new is using it to turn carbon into products. Though the technology is being deployed for small-scale commercial purposes, it could be scaled up hug according to Dominique Kronenberg, an engineer with Swiss-based carbon capture start-up Climeworks.

## *"THE SCALE WOULD HAVE TO BE INCREASED*

*10,000 OR 100,000 TIMES TO MAKE A DIFFERENCE TO CLIMATE CHANGE, WHICH WOULD COST BILLIONS OF DOLLARS," SAYS KRONENBERG.*

*"WE'D ALSO NEED TO TEAM UP WITH CARBON STORAGE COMPANIES AS WE ONLY DO CAPTURE. THERE ARE SOME ISSUES WITH STORAGE, TOO, OVER WHAT HAPPENS TO THE CARBON WHEN IT'S BURIED IN THE GROUND LONG-TERM AND THERE'S NO COMMERCIAL MARKET FOR THIS YET."*

Climeworks is one of a handful of companies pursuing direct air capture. The others include Canada's Carbon Engineering, which is backed by Bill Gates, and the US-based Global Thermostat. When these three were founded a few years ago, the expectation was that governments would take aggressive action on climate change, making it easier to benefit frc state subsidies and investment. So far, that hasn't happened and all three face stiff commer challenges.

The chemistry they use is similar, but Climeworks and Global Thermostat use solid filter mat to extract carbon, whereas Carbon Engineering places its faith in liquid removal. With the Climeworks process, once CO2 is absorbed, the filter material is heated to 100 degrees. At t temperature, CO2 is released and extracted as a pure gas.

Climeworks has so far found two ways to make money. The first is installing the equipment i commercial greenhouses, where increasing concentration of CO2 helps vegetables and plant grow. Its 50-tonne prototypes are being scaled up and a commercial-scale plant will produce 1,000 tonnes of CO2 a year for a greenhouse in Zurich. A second commercial application is creating carbonic acid to provide bubbles in fizzy drinks. A drinks bottling site could create around 1,000 tonnes a year.

RENEWABLE FUELS

Neither of these commercial uses, however, will make a blind bit of difference to climate cha
A step closer would be supplying carbon dioxide to create renewable fuels.

*"WE'RE WORKING ON A PARTNERSHIP WITH THE GERMAN COMPANY SUNFIRE TO RECYCLE IT INTO A CARBON-NEUTRAL E-DIESEL," SAYS KRONENBERG.*

*"THE CARBON RETURNS TO THE ATMOSPHERE, SO IT'S A CLOSED CARBON CYCLE, RATHER THAN CREATING MORE CO2 BY BURNING FOSSIL FUELS. THERE COULD BE HUGE MARKET OPPORTUNITIES FOR THIS."*

To make renewables in such quantities, however, would almost require government tax concessions. "It's cheaper to pump oil out of the ground, but in most countries the fuel com just 30 per cent of the price. The rest is from taxes and other add-ons. If the technology hel meet carbon targets, governments could provide a subsidy per tonne of CO2," says Kronenb

Carbon Engineering claims its liquid method is already commercially viable. The company recently opened a test facility in Squamish, British Columbia, that extracts carbon dioxide us giant fans. That carbon goes through a series of chemical processes and emerges as pellets, which can be used to make carbon-neutral fuels, or be stored underground.

Carbon Engineering's direct air capture system uses wet chemistry to scrub CO2 from the ai liquid hydroxide solution is brought into contact with ambient air in a device called an "air contactor". Chemicals react with the CO2 from the air to form carbonate. Then several piece equipment process that carbonate and release the CO2 within a closed vessel. Once the wat vapour condenses out, all that is left is pure CO2.

The company has begun continuously operating its pilot plant in Squamish. It intends to sca its technology by building a commercial plant with the potential to deliver 10,000 barrels of synthetic fuel per year using recycled carbon dioxide. "A commercial design using Carbon

Engineering's technology could achieve capacities up to 1,000,000 tons of captured CO2 per Whether that plant were used to sequester the CO2 or to produce carbon-neutral fuels, it wo be mitigating emissions from roughly 250,000 cars," says Geoff Holmes, Carbon Engineering business development manager.

The ability to manufacture low-carbon fuels that are fully compatible with today's cars and infrastructure is technically possible with CO2 captured from the air, he says.

*"WITH THE EVOLUTION OF THESE MARKETS THIS MAY BE AN ATTRACTIVE WAY TO POWER CARBON-NEUTRAL TRANSPORTATION, ESPECIALLY CONSIDERING THE GLOBAL MARKET FOR TRANSPORTATION FUELS NETS AROUND US$3 TRILLION PER YEAR," HE SAYS.*

Another start-up, the Texas-based Skyonic, uses its SkyMine technology to capture carbon f refineries and power plants. The technology removes carbon from flue gases and transforms into solids like baking soda, hydrochloric acid and bleach. Chief financial officer Scott Gardne says the company recently built a commercial-scale facility in San Antonio.

*"THIS IS NO LONGER A NICE IDEA ON A POWERPOINT PRESENTATION. GETTING AN ECONOMIC RETURN IS THE BEST WAY TO MOTIVATE BEHAVIOUR CHANGE WORLDWIDE. TRYING TO DO THAT WITH A CARBON TAX IS PUNITIVE. WE WANT TO COMMERCIALISE IT AS WE PREFER THE CARROT TO THE STICK APPROACH. OUR PROCESS DOESN'T RELY ON*

*SUBSIDIES, OR CARBON CREDITS, TO BE ECONOMICALLY VIABLE."*

Skyonic has built a commercial facility at Capitol Aggregates cement factory in San Antonio, Texas.

*"THE PROFIT WILL COME FROM SELLING THE HYDROCHLORIC ACID AND BLEACH. IT'S A CARBON NEGATIVE PROCESS AS THERE ARE A LARGE AMOUNT OF INDIRECT OFFSETS THAT ALLEVIATE CARBON EMISSION. WE REDUCE ALL EMISSIONS, INCLUDING SULPHUR NITROGEN, AND PARTICULATE MATTER, WHICH IS A MAJOR ISSUE IN CHINESE CITIES."*

SOLID INVESTMENT

Canadian start-up Inventys has developed a method of carbon capture that is two-thirds che than existing technologies, it claims. Inventys' gas separation process uses a solid material primarily of activated carbon to capture and then decouple the carbon emissions. The compa designed the material to look like a honeycomb with activated carbon making up the walls.

*"LOTS OF ATTENTION HAS BEEN GIVEN TO SOLVENT-BASED SYSTEMS, BUT WE USE SOLIDS TO REMOVE CARBON FROM FLUE GASES WHICH WE BELIEVE GIVES US A COMPETITIVE ADVANTAGE," SAYS CO-FOUNDER DARRYL WOLANSKI.*

*"SO FAR WE'VE DEMONSTRATED IT AT A SCALE EQUIVALENT TO FOUR OR FIVE CARS, BUT WE'RE SCALING IT UP NOW BY AN ORDER OF MAGNITUDE FOR OUR NEXT PILOT PROJECT IN CANADA, TO OPEN IN 2016.*

*"WE USE THE CARBON FOR ENHANCED OIL RECOVERY TO CREATE A NET ZERO LOW CARBON FUEL. ON ONE HAND WE'RE TAKING OIL FROM THE GROUND WHICH WILL END UP IN THE ATMOSPHERE, BUT WE'RE USING THE CO2 WE HAVE RECOVERED TO DO THAT SO IN AN INDIRECT WAY IT BECOMES A LOW-CARBON FUEL."*

One of the world's largest carbon capture projects began last October when the Canadian ut company SaskPower launched its US$1.3 billion Boundary Dam project near Estevan, Saskatchewan.

The 110-megawatt coal plant had already begun capturing carbon dioxide in tests, but at th point it ramped up operations to around 90 per cent capture.

The project transformed the aging Unit Three at Boundary Dam Power Station into a reliable long-term producer of 120 megawatts (MW) of base-load electricity, capable of reducing greenhouse gas emissions by one million tonnes of CO2 each year.

Mike Monea, SaskPower's president at Carbon Capture Initiatives, says it is the equivalent o taking more than 250,000 cars off the roads annually.

The captured CO2 is sold and transported by pipeline to nearby oil fields where it will be use enhanced oil recovery. Any remaining CO2 will be stored in the Aquistore Project, which will

demonstrate that storing CO2 deep underground is a safe solution.

Assuming the project is successful, SaskPower will retrofit other Boundary Dam coal units w the same controls. The cost will be 30 per cent cheaper next time. The technology could alsc used in the cement, and natural gas industries.

*"WE HAVE SHOWN THE FEASIBILITY OF CARBON CAPTURE ECONOMICALLY, WHICH MEANS IT COULD HAVE A BIG INFLUENCE GLOBALLY," SAYS MONEA.*

*"VISITORS FROM 40 COUNTRIES HAVE COME TO SEE HOW IT OPERATES. WE'RE SETTING UP A KNOWLEDGE-SHARING CONSULTANCY SO WE CAN SHOW THE WORLD HOW WE BUILT IT. CANADIAN GOVERNMENT REGULATIONS FORCE COAL PLANTS TO MEET STRICT ENVIRONMENTAL REGULATIONS AND THAT'S THE KIND OF APPROACH WE NEED TO SEE FROM MORE GOVERNMENTS."*

WHAT IS CARBON STORAGE?

After carbon is captured, it is compressed until, at pressures of around 100 atmospheres, it into a dense liquid. It can then be injected into porous rock layers a kilometre, or more, underground where it can be retained by overlying layers
of impermeable rocks for tens of thousands of years.

The CO2 is piped to a suitable site for storage underground, also known as geological sequestration. Possible storage sites include "saline aquifers", which are vast underground w containing rock formations, unmineable coal seams and depleted oil and gas wells.

The North Sea, with its mature hydrocarbon fields and saline aquifers, offers an attractive storage location for CO2 produced by the UK's gas and coal-fired power plants. The estimate storage capacity in the UK is at least 20 gigatonnes (Gt), compared to total UK emissions of almost 0.6 Gt per year.

There are environmental concerns about underground storage, however, and many question to answer. Opponents worry about what would happen if the CO2 leaked out underground. E proponents point to the success of the Sleipner gas field, the world's first demonstration of carbon dioxide capture and underground storage, which has been in operation in the North S for nearly 20 years without any detectable underground leakage.

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