

Carbon Capture Journal

CCS in Canada

CMC Research Institutes opens facilities to XPrize teams

CO2 Solutions' enzyme catalyst

Technical potential for CCS in Saskatchewan

Mar / Apr 2017

Issue 56



Business opportunities in carbon capture and utilisation

Climeworks captures CO2 directly from the atmosphere

A roadmap for CCS in Australia

Carbon8 Systems – CO2 re-use for building materials

Skytree – making CO2 air capture viable

Climeworks captures CO₂ directly from the atmosphere

Climate change is being driven by human activities. In order to slow its progress, the global community urgently needs 'negative emissions technologies'. This was once again clearly and urgently shown to be the case during talks at COP22 in Morocco. The technologies in question have to be mature and economically viable. Climeworks is a leading global contender here with its Direct Air Capture technology.

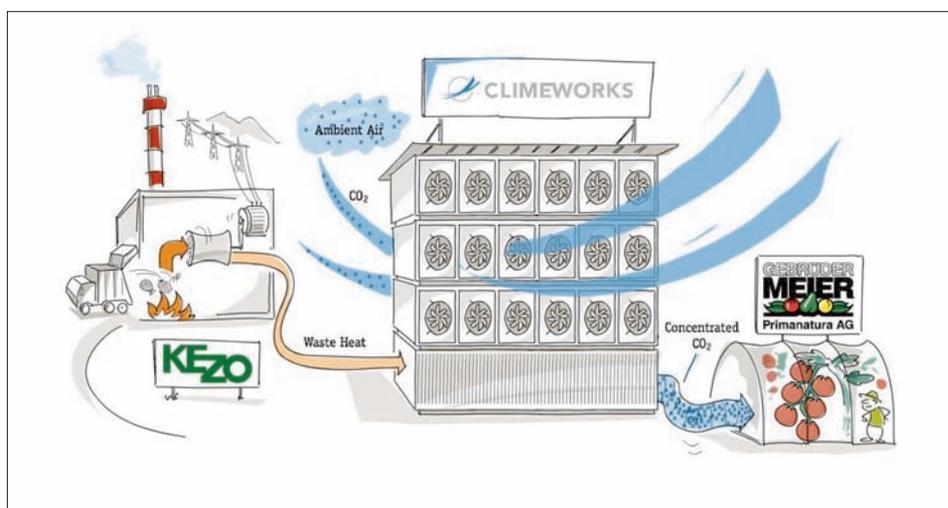
Climeworks is a cleantech company based in Zurich, Switzerland. Founders Christoph Gebald and Jan Wurzbacher have been working on their vision to close the carbon dioxide cycle and stabilise global CO₂ emissions since 2009. In November 2016, the company was in Morocco for COP22 where it presented its solutions to several hundred decision-makers from the worlds of politics and economics. This year, Climeworks is facing a number of key milestones on the journey to commercialising its own technological approach.

Climeworks' technology is a kind of CO₂ vacuum cleaner that extracts the gas directly from the atmosphere. The air is sucked in by a fan and then blown through a filter element. Sensors detect when the filter is full. This usually takes between two and three hours. The filter is then regenerated by heating it to 95 degrees Celsius. The CO₂ and moisture that have been captured are released during this process. The CO₂ is extracted and creates a high-purity product that can be marketed for a wide range of applications.

Recyclable filter

"The filter is, of course, re-used many times and lasts for several thousand cycles," reveals Wurzbacher. The rest of the 'Direct Air Capture' technology is made of steel and processed components that can be used for many years. The filter material was originally developed in close collaboration with the ETH Zurich and the Swiss Federal Laboratories for Materials Science and Technology (EMPA).

The Climeworks team then went on to refine the technology further. One of the filter materials that was developed is made of cellulose, which "works like a sponge due to its large surface area," explains Wurzbacher. The cellulose is modified with amines, which bind the CO₂ in conjunction with the moisture in the air.



A Climeworks installation and a schematic of the process

This bond is dissolved at temperatures of around 95 degrees.

A key benefit of the cellulose material is that it

is cheap to source and can also be easily disposed of as biomass. "We have over 500 material samples stored in our lab," reports Wurzbacher. Further research is being carried

out to bring down costs and raise efficiency levels even more.

2017 milestone: First commercial plant

The team at Climeworks has grown to 40 people and they have set themselves a particularly important goal for 2017: The company wants its first commercial CO₂ capture plant to go on stream during the first half of the year in the town of Hinwil (Switzerland). This plant will then filter 900 tons of CO₂ out of the atmosphere per year and feed it into a nearby greenhouse. Eighteen collectors and four forty-foot containers will be required for this. "The first plants will cost between one and two million euros," explains the Managing Director.

The conditions on-site in Hinwil are perfect for the plant. The containers will be positioned on the roof of a waste incineration and processing plant. This facility will provide the thermal energy to power the modules. A large greenhouse operator is also located close to the site and will use the captured carbon dioxide to enhance tomato and lettuce growth.

Until now, the CO₂ had to be transported long distances by truck to the site. The Climeworks modules will supply fresh CO₂ around the clock from mid-2017 on. Adding CO₂ in this way ensures a consistent concentration inside the greenhouse, which, in turn, increases plant growth by up to 30 percent.

The cost benefits compared to conventionally produced CO₂ vary significantly from region to region. "Market prices fluctuate greatly and lie between 100 and several hundred euros per ton," elaborates Wurzbacher. In Germany, for example, there is a steady supply of CO₂ across the country from ammonia production. This means that market prices are low. "However, the situation is very different in many other regions of the world. On islands, for example, CO₂ has to be shipped in via difficult routes."

Opening up new markets

Using CO₂ as a raw material for carbonating mineral water and soft drinks is another interesting application for the cleantech company. "Our CO₂ is produced de-centrally to extremely high purity levels and is therefore particularly beneficial for hygiene-sensitive sectors," reports Valentin Gutknecht from Climeworks. From their talks with the drinks industry, the Climeworks managers know that in this sector too the ability to produce CO₂



Climeworks' CO₂ extractors use a recyclable filter and can easily be scaled up

on site using ambient air is also a particularly interesting option for more isolated locations.

In the food sector, CO₂ is used for safely packaging fresh meat and vegetables as it prevents bacteria from forming and stops oxidation. CO₂ can also be used as dry ice for transport purposes.

Power-to-liquids with atmospheric CO₂

Using carbon dioxide in climate neutral fuels, however, would have a much greater impact on the problem of climate change. In Dresden, Climeworks partner Sunfire has been testing the viability of creating synthetic fuels from water, green energy and CO₂. Premium car manufacturer Audi has already taken the first three tons of this synthetic fuel. The synthetically produced alternative fuel is much more environmentally friendly than its conventional counterparts. It has a CO₂ savings potential of between 30 and 85 percent.

"Sunfire and Climeworks' technologies fit very well together and we have been developing them in close collaboration for years," continues Wurzbacher. "We need waste heat to be particularly efficient and Sunfire produces excess steam".

It remains to be seen if, this year, the political landscape will change sufficiently for this alternative fuel to be accepted as a viable alternative – one that does not compete with food production and can be generated entirely in the respective manufacturer's region. "We hope that Switzerland will position itself as a leader here compared to other European countries," explains Wurzbacher.

Generating negative emissions

Climate conferences in past years and IPCC reports have clearly shown that, on its own, reducing CO₂ emissions will not be enough to meet the 1.5-degree goal set by the global community in Paris. "In order to capture CO₂ from the atmosphere continuously and on a large scale, the price per ton of carbon dioxide has to be less than 100 euros," explains Wurzbacher. "Our goal is to come in below this crucial threshold". To achieve climate goals, the world needs to take a combined approach comprising on the one hand, an aggressive reduction of emissions and, on the other, technologies capable of capturing CO₂ retroactively from the atmosphere.

One of the key benefits of Climeworks' technology is that it is easily scalable and does not require any water, only electric or thermal energy, which can be produced, for example, from solar thermal energy and photovoltaics.

"Of course, we would need a large area to install 25,000 containers in the future. But due to the nature of this technology, we can do this in areas with very little natural vegetation, for example in deserts close to the equator and combine this with underground storage there," adds Wurzbacher. "After all, it doesn't matter where we take CO₂ from atmosphere. What's important is that we do it as cost-effectively as required and with as little impact as possible".

More information

www.climeworks.com

