Negative Emissions Technologies and Climate Change

Metacog Patent Research

Issue: 4

1. Introduction

In October 2018, the Intergovernmental Panel on Climate Change (IPCC) released a paper highlighting that global temperatures will rise by 1.5° C by 2030 and 2° C by 2050. The observable effects of such rapid temperature change can be corroborated with the shrinking ice sheets, glacial retreats, rise in sea level, etc. One of the most significant contributors to climate change is the rise in greenhouse gases and in the recent years various mitigation methods, such as negative emissions technologies, are being employed to decrease the contributory factors. In this edition, we'll discuss negative emissions technologies, specifically focusing on the potential and outreach of major players in the carbon capture sphere.

> ***"Ours can be the first generation to end poverty – and the last generation to address climate change before it is too late."***
>
> Ban-Ki Moon, UN Secretary-General 2007-2016

2. Negative Emissions Technologies

Negative Emissions Technologies are methods that physically and chemically remove greenhouse gases (such as carbon dioxide (CO_2)) or other gases from the atmosphere. Examples of such methods include, afforestation, carbon capture and storage, direct air capture, biochar, and soil organic carbon. Of these, the carbon capture schemes will be discussed now.

> ***"Climate change presents a classic system problem. The spatial scale is global; the time scale dwarfs normal human concerns."***
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> John D. Sterman and Linda Booth Sweeney, "Cloudy skies: assessing public understanding of global warming"

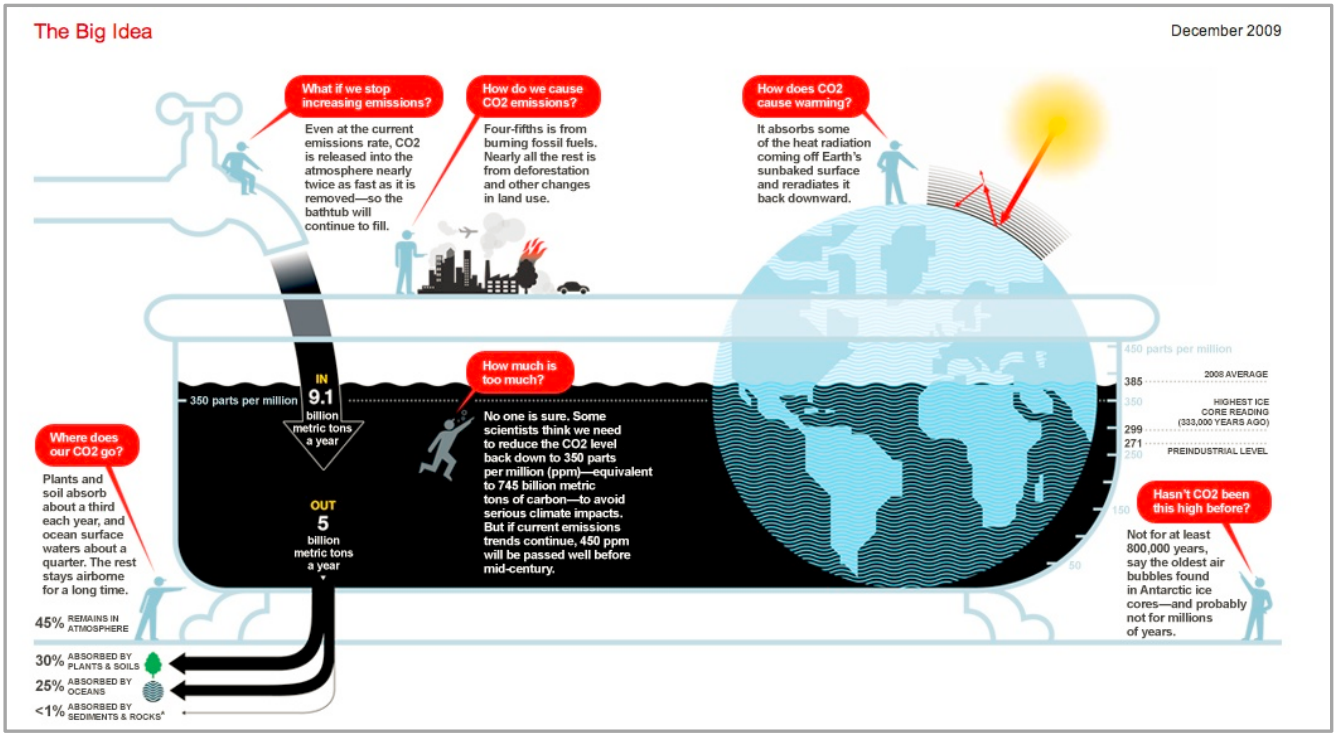


Figure 1: Carbon Bathtub, National Geographic Magazine, December 2009

2.1. Carbon Capture and Storage (CCS)

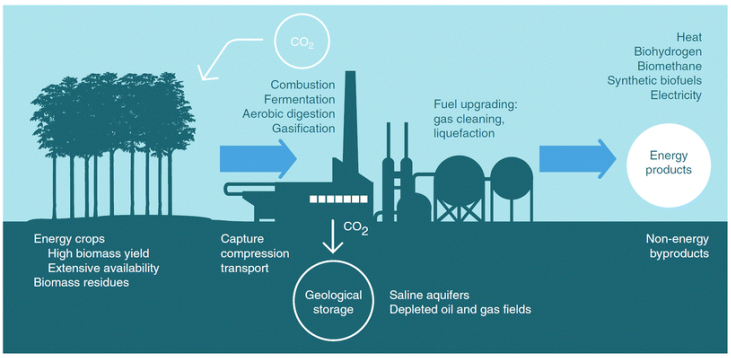


Figure 2: Concept of bioenergy with carbon capture and storage (BECCS), courtesy of Nature

In the Carbon Capture and Storage scheme, waste CO_2 is captured from the use of fossil fuels in electricity generation and industrial processes (such as plants and factories). The captured CO_2 is then transported to a storage site and deposited underground, thereby preventing it from entering the atmosphere. Some prominent projects in this sector include UK Carbon Capture and Storage Research Centre, Boundary Dam Carbon Capture Project, and Weyburn-Midale CO2 Monitoring and Storage project.

2.2. Direct Air Capture (DAC)

Direct Air Capture technologies capture CO_2 through engineered chemical reactions from the air and store it underground. A prominent company in this technology space is a Switzerland based company – Climeworks. They opened world's first commercially operational plant capturing CO_2 from the atmosphere near Zurich. The plant captures about 900 tons of CO_2 annually. The gas is then sent through an underground pipeline to a greenhouse to help grow vegetables.

Climeworks system captures atmospheric carbon with a filter, wherein air is drawn into the system and the CO_2 within the air is chemically bound to the filter. The filter material is made of porous granulates modified with amines, which bind the CO_2 in conjunction with the moisture in the air.

Climeworks also discloses that it sells the captured CO_2 and the customers utilize it in carbonated drinks, for producing carbon-neutral hydrocarbon fuels, and in agriculture.

Patent:

US 10,232,305 by ClimeWorks

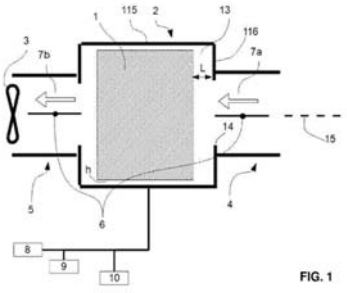
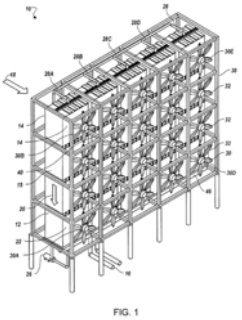


FIG. 1 shows a sectional view of a vacuum unit for a DAC process.

2.3. Air to Fuel (A2F)

Patent:

US 9,095,813 by Carbon Engineering



The carbon capture facility can be built up in modules, such as for example illustrated in FIG. 1.

Carbon Engineering has developed a system for synthesising a mixture of petrol and diesel using only CO_2 and hydrogen, wherein CO_2 is captured from the air (Direct Air Capture), and hydrogen is split from water with clean electricity. The generated output is drop-in compatible with today's infrastructure and engines.

In this scheme, first CO_2 is captured and purified. Next, clean electricity is used to electrolyze water and generate hydrogen. Lastly, CO_2 and hydrogen are thermo-catalytically reacted to produce syngas, and reacted again to produce hydrocarbons.

3. Virgin Earth Challenge

In 2007, Richard Branson instituted a Virgin Earth Challenge for a prize of $25 million. The challenge is to invent new and commercially viable ways of demonstrating "*...greenhouse gas removal activities that can take more greenhouse gases out of the air than they emit*". Thus far there are 11 finalists and the prize is yet to be claimed. The finalists include Biochar Solutions (USA), Biorecro (Sweden), Black Carbon (Denmark), Carbon Engineering (Canada), Climeworks (Switzerland), COAWAY (USA), Full Circle Biochar (USA), Global Thermostat (USA), Kilimanjaro Energy – Carbon Sink (USA), Smart Stones (Netherlands), and The Savory Institute (USA).

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