Silver bullet or smokescreen? A Deep Dive into artificial carbon sequestration

In Hengill, a volcanic ridge east of Reykjavik, a white steam cloud blurs the outline of a metal power plant. Its four units each contain two metal boxes that whir with fans. These are sucking in the air to trap carbon dioxide, using a sponge-like filter called solid sorbent that binds with the carbon. Once the sponge is saturated, the interior is heated to 100 degrees Celsius, then the carbon is squeezed out and injected deep into an underground basalt rock formation. Within two years, it turns to stone.

Temps de lecture : minute

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Welcome to the Orca plant, the world's first direct air capture and storage facility in Iceland. Its creator and operator, *Swiss firm Climeworks,* is a poster child amongst a growing number of companies developing carbon dioxide removal (CDR) technology to clean up the atmosphere.

As global interest and funding for carbon sequestration solutions grows, futuristic scenes like this may become more commonplace. Depending on who you ask, these solutions are either a silver bullet to the climate crisis, or a ploy by the fossil fuel industries to allow them to continue oil and gas production.

In this first half of a two-part series, read on for the myths and realities of artificial carbon sequestration, its burgeoning appeal among investors and political bodies worldwide, and its position in the decarbonisation toolkit.

Modern-day Mythologies

Roland Barthes wrote in *Mythologies* that “The cultural work done in the past by gods and epic sagas is now done by laundry-detergent commercials.”

Modern-day myths now manifest in tech solutions for the climate crisis. This time around, the gods are the tech giants, political institutions, and fossil fuel companies. And the epic saga is stitched together from newspaper clippings, academic papers, IPCC reports, policy documents, press releases, opinion pieces, and social media.

The writers – the modern-day mythmakers – are the climate communicators, scientists, activists, academics, journalists, business leaders, influencers, and press teams, collectively responsible for shaping the narrative. Artificial carbon sequestration, some say, is a moonshot. Others warn of it being used as a smokescreen. The truth is likely somewhere in between.

As gaps between climate tech, activism and governments widen, and public awareness and perception is still new, it’s more important than ever to share the right story.

And it starts with language – specifically how we define the different methods of carbon sequestration, sometimes also known as “negative emissions” technology.

The difference between Carbon Dioxide Removal, Carbon Capture and Storage, and

Carbon Capture, Utilisation and Storage

Carbon Dioxide Removal (CDR) and Carbon Capture and Storage (CCS) are often conflated, yet there is a key difference.

While CDR technologies focus on extracting CO_2 from the atmosphere, CCS aims to capture it directly at the source, such as the exhaust of a power plant. CCUS, on the other hand, repurposes this captured CO_2 for industrial uses – turning it into products like plastic, concrete, and biofuel. However, this final method is highly energy-intensive and costly.

Definitions of CDR, CCS and CCUS

- Carbon Dioxide Removal (CDR): Extracting CO_2 from the atmosphere. Climeworks is a prime example.
- Carbon Capture and Storage (CCS): Directly capturing carbon at the 'point-source', like at the exhaust of a power plant.
- Carbon Capture, Utilisation, and Storage (CCUS): Capturing and converting CO_2 into industrial products.

CDR is effectively a massive clean-up project to restore the atmosphere to pre-industrial levels of CO_2 in the coming century. In almost all of the models mentioned in the 2022 IPCC report that hold the Earth to 1.5°C warming, CDR plays a vital supporting role in the transition.

It is important to note here that *almost all successful CO_2 removal* (99.9%) has been achieved through natural CDR on land – the creation of new forests, restoration of previously deforested areas, increases in soil carbon, and use of durable wood products.

A very small amount of current CDR (2.3 megatonnes of CO_2 a year, *roughly the emissions of 150,000 US citizens*) comes from new CDR methods. As coastal and *forest ecosystems* ('lungs of the earth') remain

under threat, political bodies and tech investors are increasingly turning to novel CDR techniques, such as bioenergy with carbon capture and storage (BECC), biochar, direct air capture and storage (DACS), enhanced rock weathering, and coastal wetland (‘blue carbon’) management.

Following the money

Even in a slow investment period, CCS solutions have continued to gain traction. From 2020 to 2022, global investments in new CDR capabilities hovered around $200M and in the last twelve years, $4B has been directed into publicly funded research and development.

This commercial support is matched by the international political stage. Between the US Energy Department earmarking $1.2B for tech to vacuum carbon out of the air, China leading the way on carbon capture patents (filing *73% of total patents* globally), and the UK promising £20B for carbon capture (concurrent with the announcement of 100 new North Sea oil and gas licences), emerging economies from across the world from *Brazil* to *Thailand* are also investing in CCS technology.

In 2022, *Thailand launched its first CCS project at an offshore gas field*. Meanwhile, in Brazil, *state-owned oil and gas giant Petrobras* has been reinjecting carbon into offshore oil fields in what it describes in its climate change report as “the largest offshore CO_2 reinjection program in the world”.

This reinjection increases pressure in the reservoir to bring more oil to the surface and extend the life of the fields, while making it safer and more cost-efficient to transport the natural gas to shore. In short, any funding given to this specific CCS project increases the company’s oil and gas production, and by extension, its profits.

Key dates and events in 2023:

- April 11 2023: Svante, a leading point source carbon capture technology developer, secured £218M in Series F funding in a deal led by Chevron Technology Ventures
- April 26 2023: Plans for a Norwegian carbon capture project at the Klemtstrud Waste Plant were temporarily halted due to projected cost overruns
- May 3 2023: Built environmental energy systems company, Redaptive, raised £250M in Series E funding from CBRE Group, CPP Investments, Honeywell, and Linse Capital
- May 2023: Climeworks, a startup that extracts carbon from the atmosphere, signed a $200M deal with JP Morgan Chase
- May 17 2023: The US Department of Energy committed $251M to support 12 carbon transportation and storage projects throughout the US
- June 20 2023: Two VCM organisations announced their collaboration to ensure market integrity for the voluntary carbon market
- July 18 2023: Renewable natural gas and biofuel company *Aemetis* awarded the first permit by the state of California to drill a CO_2 sequestration characterisation well

While investments indicate promise, the history of artificial carbon sequestration suggests a more complex picture.

Carbon Capture's chequered past

Despite the rising interest from investors and governments, CCS has a history pocked with overpromising and underdelivering. For two decades, promises of operational CCS facilities have been made yet the UK, for example, is yet to see one up and running.

For environmental writer and activist, George Monbiot, “Carbon capture and storage has been promised for 20 years. It has never materialised and never will. Its sole purpose is to create the impression that oil and gas drilling is compatible with a habitable planet. Any politician promoting it is working for the fossil fuel industry.”

According to the Global CCS Institute, CCS technology has sequestered 40 million metric tonnes of CO_2 each year. That’s less than 1% of total global GHG emissions. *This report by the University of Oxford* argues that for “the CDR gap to be closed, there need to be a rapid growth of these new CDR technologies” while underlining that “this does not lessen the need for deep cuts to emissions.”

CCS, as a technology, is undeniably nascent and requires significant investment for effective large-scale deployment. Acquiring assets, such as transportation pipelines and geological storage resources, requires hundreds of millions of pounds to appraise, build, develop, and manage.

However, the rise in VC funding matched with advancing capabilities and global industry standards may help solve the operational, socioeconomic and reputational challenges that CCS and CDR once faced.

For *Jennifer Wilcox*, professor of chemical engineering at Worcester Polytechnic Institute, “We are beyond the point where negative emissions technologies, alone, without any other reductions in carbon emissions, could save us… These technologies can buy us time.”

A lottery ticket with consequences

Besides its efficacy debate, CDR and CCS pose environmental and humanitarian concerns. These range from increased risk of underground tremors, earthquake triggers, groundwater contamination, potential CO_2

leaks and the impact on ocean acidification, to the safety of underground transportation and storage.

Most solutions rely on pipelines to take CO_2 from its point source or direct air capture facility to its final storage site. These are often routed through rural, indigenous communities and wetlands, leading to potential displacements and local ecological impact. When pipelines burst, they don't explode. They push everything that they're buried under to the surface, including any hazardous materials lying in the soil.

In the case of the Mississippi CO_2 pipeline rupture in 2020, weeks of heavy rain broke a pipe weld and sent a plume of CO_2 rolling towards the local village. Of the 100 residents, almost half (45 people) were hospitalised and many continue to report long-term respiratory issues.

A key part in both getting buy-in and protecting local residents for large-scale CCS and CDR projects is through integrating environmental justice frameworks, including local communities early in the decision-making, and ensuring that key infrastructure is built to withstand intensifying physical climate risks.

So, with these challenges and the potential in mind, what does the future of artificial carbon sequestration look like?

The future of Artificial Carbon Sequestration

Amid the epic of press releases, funding rounds, and COP28 announcements, one thing is for sure: artificial carbon sequestration will play a role in the transition to renewable energy, yet there is a risk that political bodies or oil and gas companies – those with 'skin in the game' – will position CCS and other CDR solutions as an endorsement to keep drilling, rather than as part of a broader transition to renewable energy.

The modern-day myth makers must therefore carefully and continuously distinguish and contextualise carbon capture and removal technologies if we are to avoid tarring all solutions with the same oil-stained brush.

To be continued...

In the second half of this series, we will run a deep-dive on natural carbon sequestration methods, including rewilding, ocean-based biochar, and landscape-level regenerative agriculture.

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