March 2022

Understanding the Differences Between CARBON CAPTURE & CARBON DIOXIDE REMOVAL

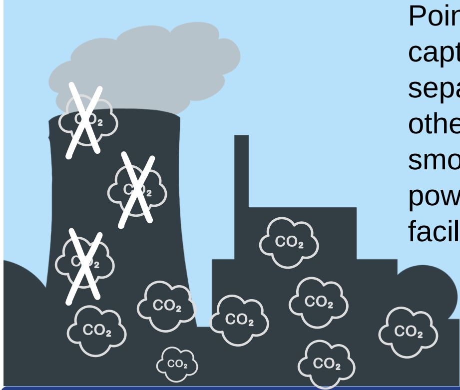
Carbon capture and carbon dioxide removal are two distinct approaches to addressing carbon pollution. Both approaches will be important for achieving net-zero emissions by 2050 or sooner by addressing carbon pollution in hard-to-decarbonize sectors.

What problem does it address?

CARBON CAPTURE: CO2 emitted from industrial processes, as well as fossil fuel power plants.

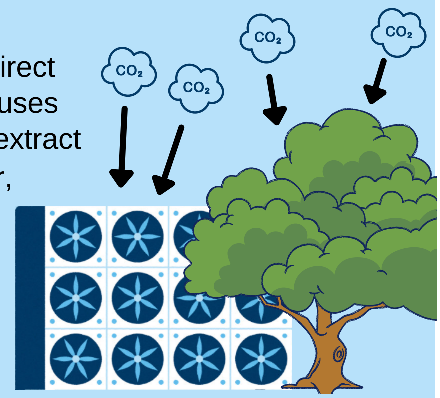
CARBON DIOXIDE REMOVAL: CO2 that is already in the atmosphere, regardless of the source.

How does it work?



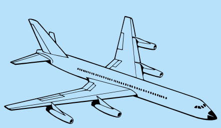
CARBON CAPTURE: Point-source carbon capture technologies separate CO2 from other gases in the smokestacks of power and industrial facilities.

CARBON DIOXIDE REMOVAL: Solutions include technologies like direct air capture, which uses chemical filters to extract carbon from the air, as well as natural carbon sinks like forests, soil, and ocean deep water and sediments.

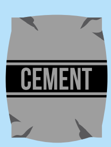


What happens to the CO2 after it's captured?

Utilization



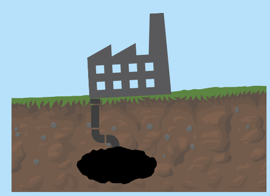
Combined with hydrogen to produce low-carbon fuels for hard-to-decarbonize sectors like aviation and shipping.



Transformed into durable construction materials through emerging pathways such as enhanced mineralization.

Storage

Stored in natural carbon sinks, such as forests, soil and the ocean. Policies that can improve the permanence of these solutions are being developed.



Stored in deep, sedimentary geological formations in accordance with EPA guidelines. A vast majority of captured carbon will need to be secured this way, mostly in saline formations. Storage may also initially occur in depleted oil & gas reservoirs or through enhanced oil recovery practices that are modified to ensure long-term storage.

Least Ready to Deploy → **Most Ready to Deploy**

For more details >>>

CARBON CAPTURE	CARBON DIOXIDE REMOVAL

What are the specific technologies or solutions?

CARBON CAPTURE

Post-combustion: When fossil fuels are burned to produce energy, the resulting CO_2 emissions can be captured in a smokestack of a power or industrial plant by materials like solvents & sorbents.
CO_2 capture rate: 85-90%

Oxy-fuel combustion: Fossil fuels are combusted in a high-oxygen environment, producing a stream of CO_2 emissions that are easier to capture.
CO_2 capture rate: 90-100%

Pre-combustion: Before fossil fuels are combusted in a power plant or industrial facility, the fuel is gasified, and technologies like solvents & sorbents separate CO_2 from the gas.
CO_2 capture rate: 85-90%

CARBON DIOXIDE REMOVAL

Natural climate solutions: Enhancing natural carbon sinks through strategies like soil & forest restoration, sustainable agricultural practices, avoided land and seascape conversion, wetland restoration, and seaweed farming in the ocean.

Bioenergy with carbon capture & storage (BECCS): Converting biomass to bioenergy and capturing the associated CO_2. Because biomass is a carbon sink, burning it can be a carbon-neutral process, so capturing the associated emissions qualifies as CO_2 *removal.*

Direct air capture with (DAC): Passing ambient air through a chemical filter to remove CO_2.

Nascent strategies: New solutions like enhanced mineral weathering, ocean alkalinity enhancement, and electrochemical capture of CO_2 from seawater.

How mature are these technologies or solutions?

CARBON CAPTURE

Carbon capture technologies like chemical absorption & physical separation have been used commercially since the 1970s. These projects have been moderate scale until recently, and other carbon capture technologies are still in the pilot & demonstration stages.

Point-source carbon capture is poised to grow substantially this decade, **as technologies existing or in development today have the capacity to sequester 500 million to 1 billion tons annually in the U.S.**

CARBON DIOXIDE REMOVAL

Natural climate solutions: Natural carbon sinks have been cycling carbon for millennia, but the magnitudes are still uncertain and monitoring & verification systems are still being developed.

BECCS: A handful of commercial BECCS facilities with dedicated geologic storage exist today, but haven't yet been proven at wide scale.

DAC: Technologies are being deployed at a small scale globally, but haven't yet been proven at wide scale.

What does this approach currently cost?

CARBON CAPTURE

For **industrial processes** which produce concentrated streams of CO_2, the current costs of carbon capture can range from $20-90 per ton, depending on how concentrated the CO_2 stream is.

For activities like **power generation & steel production**, where CO_2 emissions are more dilute, costs range from $75-120 per ton.

CARBON DIOXIDE REMOVAL

Natural climate solutions can be as cheap as $0 per ton of CO_2 removed, though it is challenging to verify & ensure that removal is permanent.

BECCS ranges $30 to $400 depending on the type of bioenergy, capture technology and storage method.

DAC ranges from $100 to $1,000 per ton depending on a variety of factors, including the energy input and the utilization or storage pathway.