American Security Project

Innovating Out of The Climate Crisis: Carbon Emissions

Briefing Note

Quick Facts

- The International Panel on Climate Change (IPCC) assesses that limiting overall global warming to 1.5° C will require not just steep emissions cuts but also carbon dioxide removal of 100-1,000 GtCO2 over the 21st century.
- Harnessing natural processes to store more carbon in forests, grasslands, and wetlands can contribute to this goal. Measuring the additionality and durability of carbon sequestration in natural systems can be difficult, however, and there are sometimes tradeoffs between using land for carbon storage rather than, e.g., food production.
- Chemical processes capture CO2 from smokestacks (point capture), limiting new carbon emissions into the atmosphere, or from ambient air (direct air capture), pulling existing CO2 from the atmosphere. Captured CO2 can then be stored in geological formations or utilized by industry.
- Carbon capture, utilization, and storage (CCUS) is one of the few ways to mitigate emissions from existing power generation facilities that would otherwise continue unabated, and from carbon-intensive manufacturing processes like steel and cement manufacturing.
- Carbon capture and carbon removal technologies have yet to meet expectations for delivering emissions reductions cost-effectively and at scale, however, leading some critics to question how meaningful a role CCUS might ultimately play in the fight against climate change.

Economic Competitiveness

- The Biden Administration has consistently framed the energy transition as an economic competitiveness issue. Carbon capture companies, for example must comply with prevailing wage and apprenticeship requirements to qualify for the maximum tax credits under the Inflation Reduction Act (IRA).
- Senior Biden advisors have centered climate resilience in a modern American industrial strategy—one designed both to nurture new green industries at home and to become a new "arsenal for democracy," but this time for the world's green energy transition.
- China currently dominates green energy supply chains, from chemical precursors of batteries to finished solar panels. Establishing U.S. leadership in nascent technologies like carbon capture and regaining market share in other clean energy industries is another clear aim of the Biden administration.
- The European Union has expressed concerns over the scale of the subsidies in the IRA, arguing that they unfairly privilege American companies over close trading partners like Brussels. U.S. and EU officials are working to address the EU concerns in a constructive way, and hope to avoid rifts among crucial allies in the context of Ukraine and other mutual security concerns.

By: Lindsay Iversen

Challenges & Opportunities

- The overwhelming majority of captured carbon—75 percent in the U.S., near 90 percent globally—is pumped into dwindling oil formations to boost production, a process known as enhanced oil recovery. Scientists are divided on its climate benefits, however, and many climate advocates oppose any measures that extend the use of oil and gas.

- To meet projected needs, carbon capture and storage (CCS) facilities will need to be built much more quickly than they have in the past. Of the some 150 projects proposed globally in the last 40 years, two-thirds have been cancelled or placed on indefinite hold. Just 20 or so are fully operational.

- The growth potential of the carbon removal industry is staggering. According to one estimate, capturing 30 percent of carbon emissions annually by 2050 would require building an industry equivalent to today's petrochemical industry. Another study found that just mineralizing carbon in cement could be a trillion-dollar industry by mid-century.

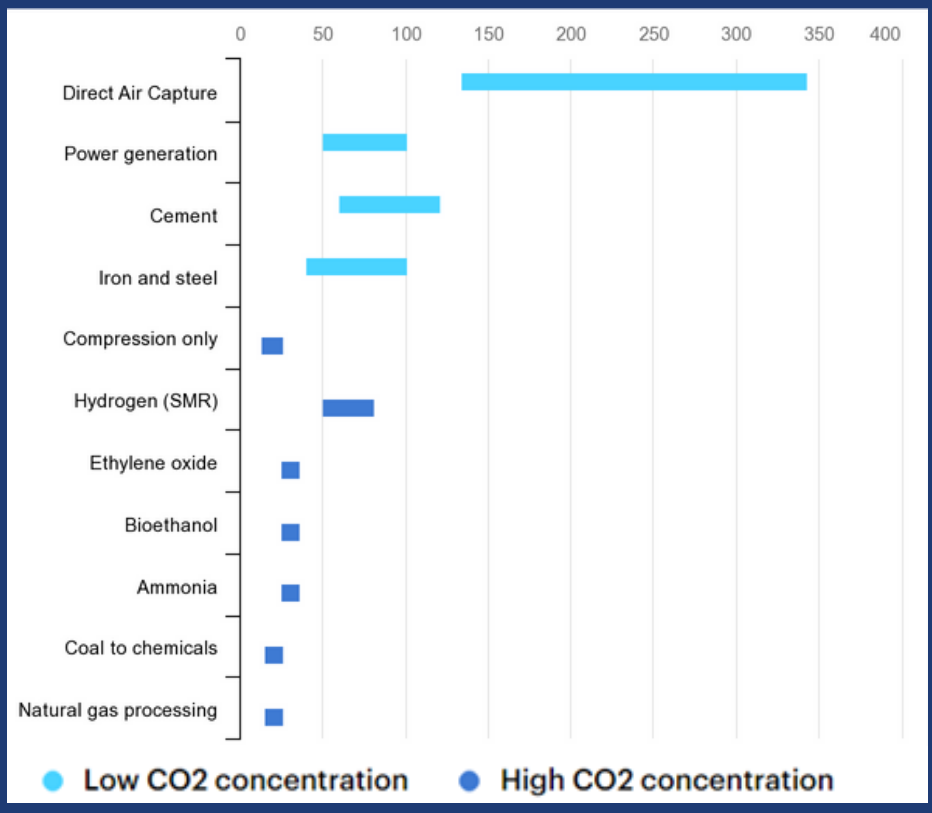
- Carbon capture and storage may reduce the costs of meeting ambitious emissions reductions targets by enabling hard-to-decarbonize industries to continue functioning. Without CCS, the costs of reaching a 2°C global warming limit could be more than 70 percent higher by 2100.

- Some scientists warn against over-reliance on carbon capture and carbon removal, noting that they are unproven technologies, especially at the scale needed. If they fail to live up to expectations, humanity could be locked into a higher-temperature pathway than if it had focused solely on emissions reductions.

- It is easier (and therefore cheaper) to capture CO2 from highly concentrated sources like ethanol manufacturing plants, which emit almost pure carbon dioxide. CCS on ethanol plants can cost less than $50/ton.

- Direct air capture, which must filter CO2 from ambient air concentrations of less than 1 percent, costs as much as $340/ton. The cost of fitting CCS systems to existing power plants and factories falls somewhere in the middle.

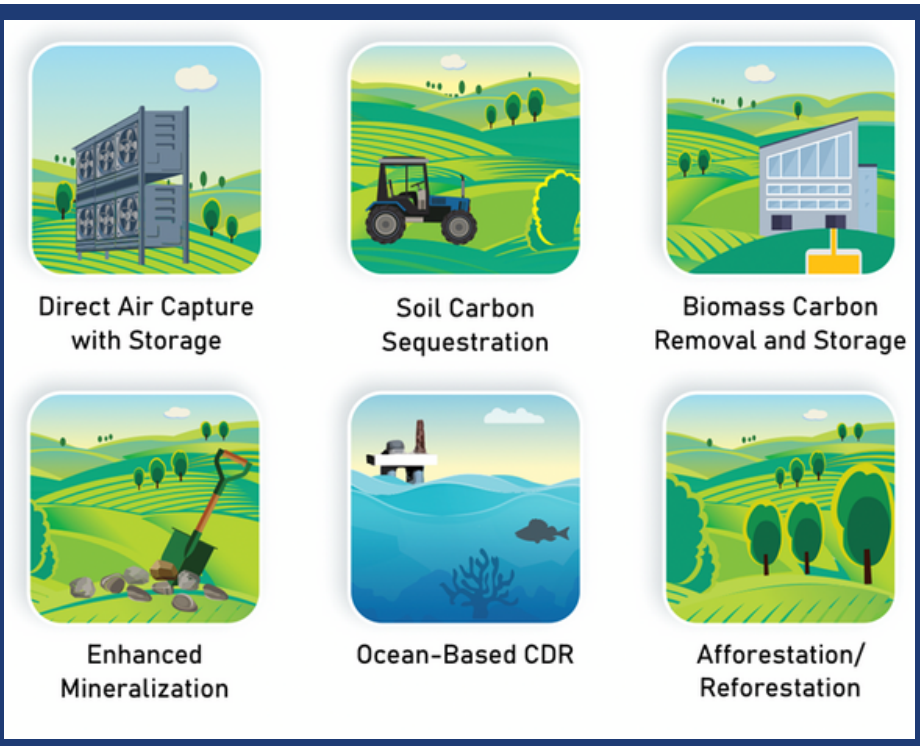
- To date, cost has been a major impediment to wider adoption of the technologies, though governments and private sector are working to change that.



International Energy Agency IEA 2023; Levelized cost of CO2 capture by sector and initial CO2 concentration, 2019., USD/ton, https://www.iea.org/data-and-statistics/charts/levelised-cost-of-co2-capture-by-sector-and-initial-co2-concentration-2019, License: CC BY 4.0

Technology & Innovation

- In November 2021, The Department of Energy (DOE) announced the Carbon Negative Earthshot: a decade-long program designed to spur the development of technologies that can remove carbon from the atmosphere and safely store it at gigaton scales, all for less than $100 per ton. DOE is pursuing a wide range of technologies under the umbrella of carbon dioxide removal (CDR), from accelerated weathering of rocks and storage in soils, forests, and oceans to direct air capture and biomass energy with carbon capture. CDR does not include point-source capture, which prevents carbon from entering the atmosphere, and instead focuses on removing carbon that's already there.



DOE Carbon Removal Earthshot Technologies

- Some 65 major companies, representing more than 10 percent of the Global Fortune 2000 by value, have now joined the First Movers Coalition, an advance purchase mechanism established by the United States and the World Economic Forum at the 2021 UN climate summit. In total, they have pledged more than $12 billion to bring new technologies to scale, including carbon removal, in hard-to-abate industries.
- Major tech companies, led by Stripe, Meta, Alphabet, and others, are collaborating on a similar $1 billion initiative focused exclusively on stimulating research and development of new carbon removal technologies, and to drive down their costs so other companies will adopt them. To qualify, new technologies must have the potential to store at least 0.5 gigatons/yr of carbon permanently, for less than $100 per ton.
- Climeworks, an incumbent carbon removal company, recently invested $650 million to build the world's largest carbon capture facility in Iceland. The plant dissolves captured CO2 in water and injects it into underground basalt formations. Within two years, the CO2 turns into stone, permanently sequestering the carbon.
- Several companies are working to inject captured CO2 into concrete mixes, where it will react chemically to turn into limestone. This process has the dual benefit of not only locking away the carbon but also making the concrete stronger, helping its marketability.
- Oceans already sequester some 30 percent of humanity's CO2 emissions, and innovators are exploring ways for them to capture even more. Approaches range from altering the chemistry of the ocean itself to stimulating phytoplankton growth (to capture CO2 through photosynthesis) and using electricity to remove carbon from seawater.

Policy and Regulatory Frameworks

- The 2021 Infrastructure Investment and Jobs Act (IIJA) allocated nearly $75 billion in funding for new and existing clean energy programs, including nearly $12 billion for carbon capture, storage, and transportation projects.
- IIJA funding includes $6.5 billion to DOE's Office of Fossil Energy and Carbon Management (FECM). Some $3.5 billion will support regional direct air capture hubs, where direct air capture technologies will be deployed at scale and, with luck, catalyze a local or regional network of carbon capture and utilization industries.
- IIJA funded $2.5 billion in carbon capture demonstration projects and pilots. This work is intended to speed innovations in technologies that can reduce emissions from existing fossil fuel-fired facilities and hard-to-decarbonize industries like cement and steel plants. It also grants $2.5 billion to improve carbon storage testing and validation.
- DOE's Loan Programs Office was awarded $2.1 billion under the IIJA to finance innovations in carbon transportation infrastructure—equivalent to $20 billion in lending capacity.
- The most important carbon capture provision in the 2022 Inflation Reduction Act (IRA) was a dramatic expansion of the existing tax credits for both point-source and direct-air carbon capture to as much as $85 per ton and $185 per ton, respectively, making more carbon capture projects economically viable.
- The IRA also allows more types of facilities to claim carbon capture credits, extends the window for them to become operational, enables developers to treat credits as cash, and permits the transfer of credits to third parties.
- Taken together, these provisions will make it easier for projects to attract financing and get built. One industry group estimates that the IRA alone could help the industry grow 13-fold by 2035.

This briefing note is part of ASP's *Innovating out of the Climate Crisis* programming, which seeks to explore innovations in technology and policies in key clean energy areas. These innovations will help facilitate our collective ability to adapt to climate change, ultimately leading to a more resilient nation.

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