Introduction to Carbon Management

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Background on Carbon Management

Carbon management encompasses a range of technologies that capture CO_2 emissions from facilities or the atmosphere and transport the emissions for storage or conversion into products.

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What are Carbon Capture and Direct Air Capture?

- **Carbon Capture** separates CO_2 from industrial or power plant emissions. Carbon capture equipment can be added on to existing facilities or built into new ones during planning.
- **Direct air capture** removes existing CO_2 from the atmosphere.

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What is Carbon Transport?

- Once captured, CO_2 is compressed and transported to geologic formations for permanent storage or to where it can be converted or reused for beneficial use.
- Over 5,000 miles of carbon pipelines operate in the US and trucks also transport CO_2 short distances.

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What is Carbon Reuse?

Beneficial conversion and use of captured CO_2 emissions occurs when the carbon oxides are used as a building block to produce lower carbon-intensive fuels, chemicals, materials, or products such as concrete.

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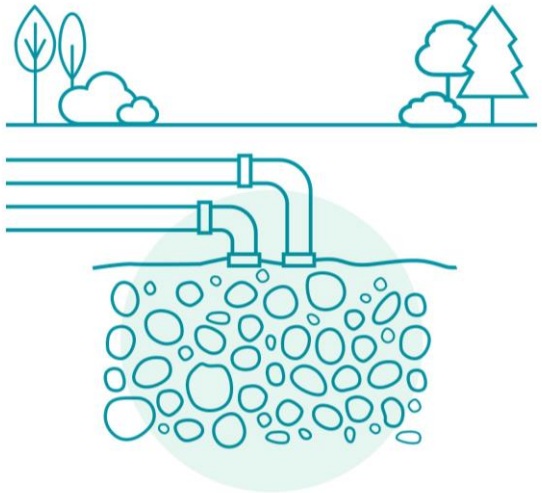
What is Carbon Storage?



- Safe, permanent storage of captured CO_2 occurs in deep geologic formations, mainly saline formations and depleted oil and gas fields.
- Permanent geologic storage also occurs through injection of captured CO_2 for enhanced oil recovery.

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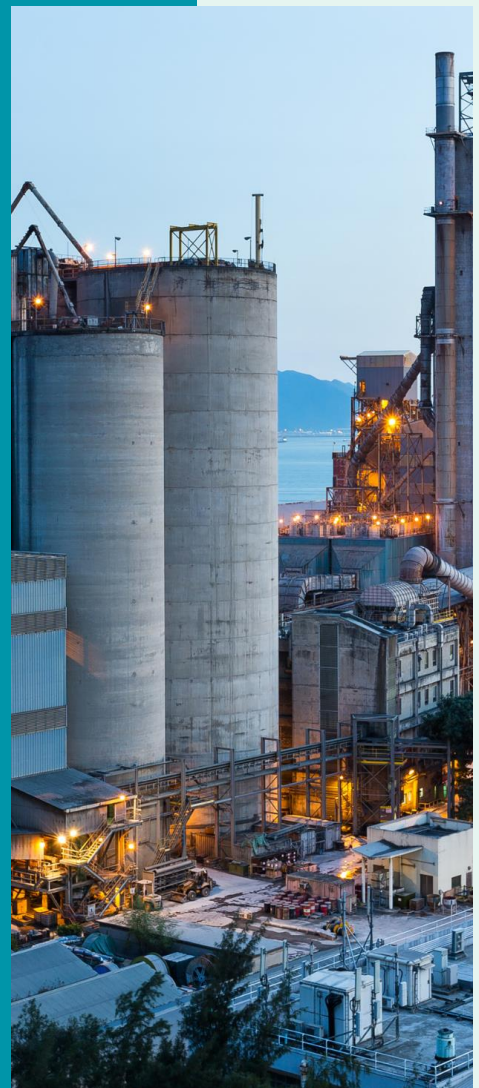
Carbon Management's Role in Reducing Global Emissions

- The International Energy Agency **predicts over 2,000 carbon capture facilities are needed** globally, capturing 2.8 gigatons of CO_2 annually, to prevent the worst potential effects of climate change.
- Even in scenarios that rely on high levels of renewable energy and electrification, the Intergovernmental Panel on Climate Change estimates that globally, **carbon management technologies will be needed to capture a total of 2 gigatons of CO_2 in the industrial sector by 2030**.



Carbon Capture and Air Quality

Research shows that carbon management technology can help reduce air pollution.

In addition to capturing 90% of the CO_2 emitted from a site, carbon capture technology can lead to health benefits by also reducing other air pollutants like nitrous oxides, sulfur oxides, and any condensable particulate matter.

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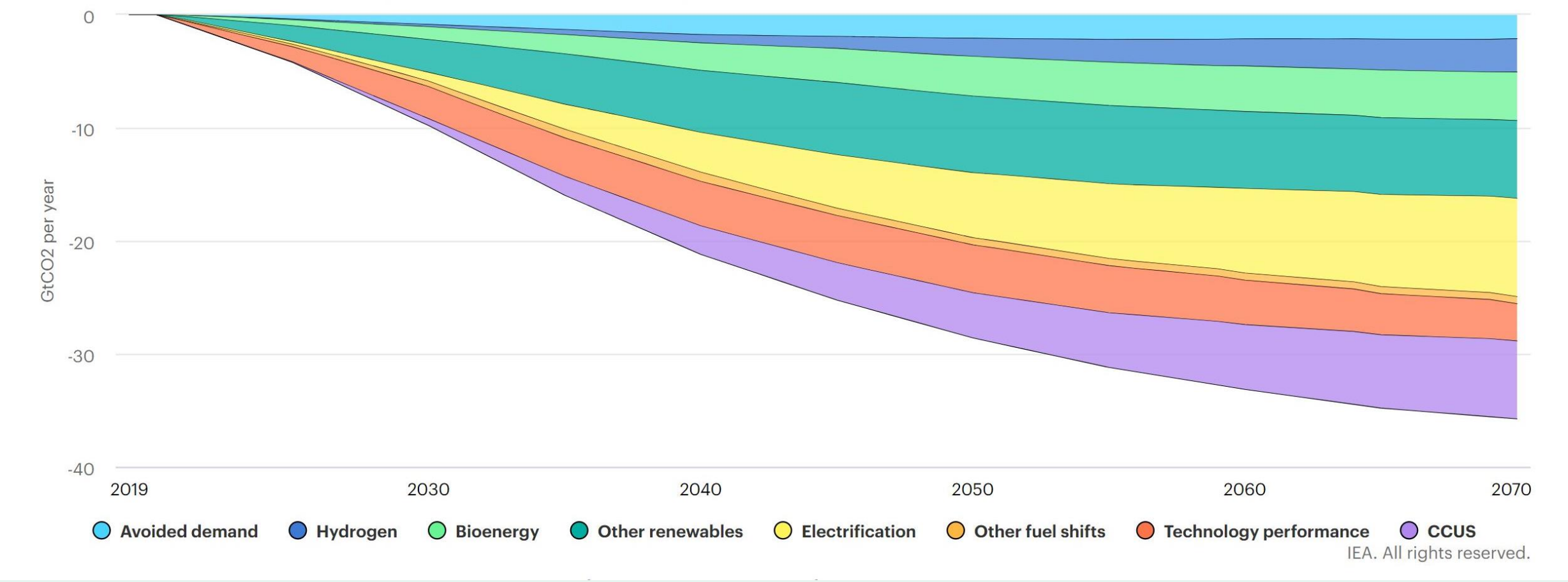
Energy Sector Emission Cuts: What's Needed?



Source: IEA Energy Technology Perspectives: [2020 Technology needs for net-zero emissions report]

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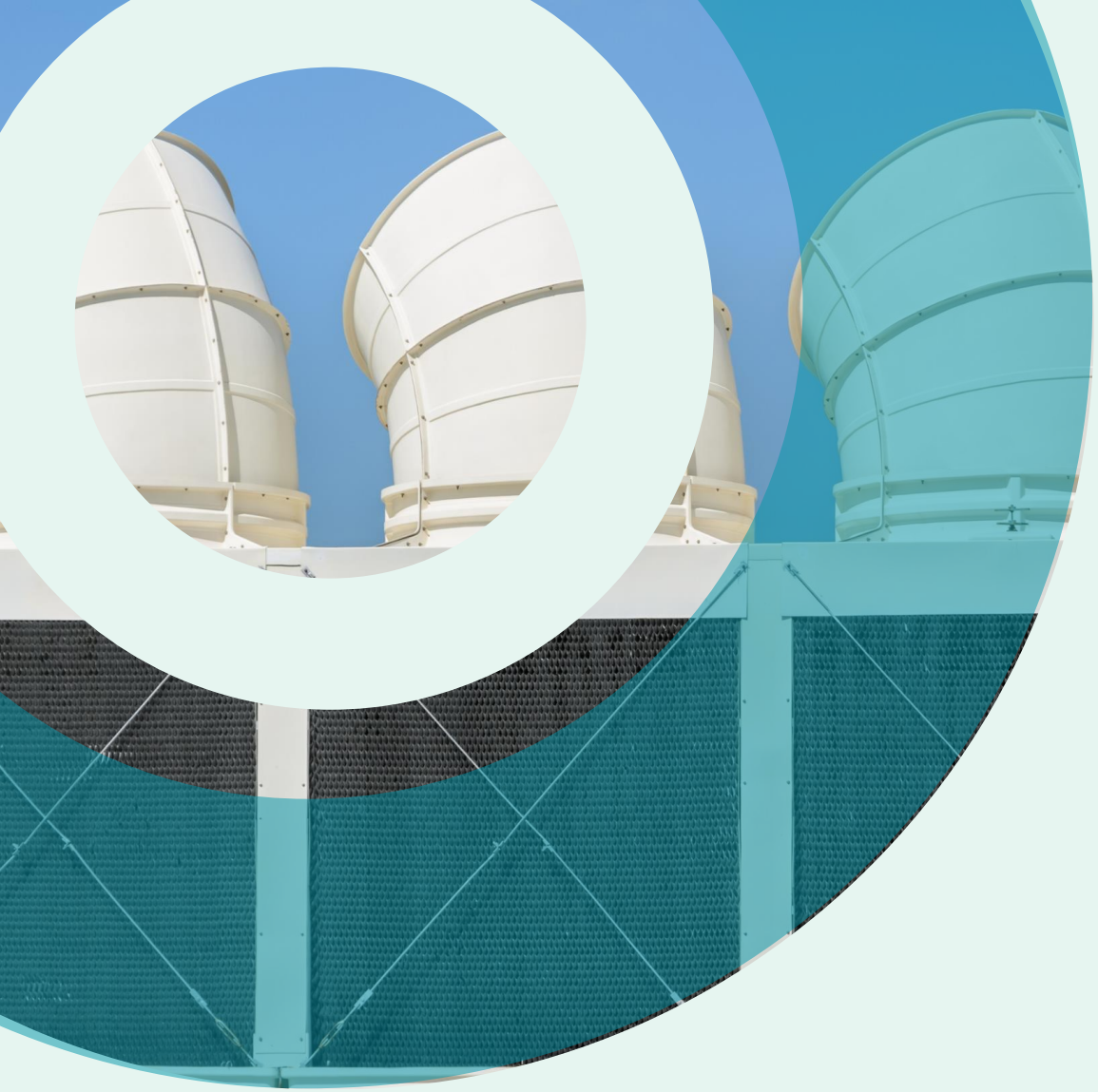

Carbon Management is Crucial to Industrial Decarbonization

- Roughly **one-third of US and global carbon emissions** come from industrial sectors.
- Over half of industrial emissions **occur in just three sectors**: steel, cement, and basic chemicals.
- Carbon capture is not optional: **over half of emissions from certain sectors are inherent to the chemistry of key industrial processes** and cannot be eliminated through efficiency or decarbonization of energy inputs.

Cement production example: $CaCO_3 \rightarrow CaO + CO_2$

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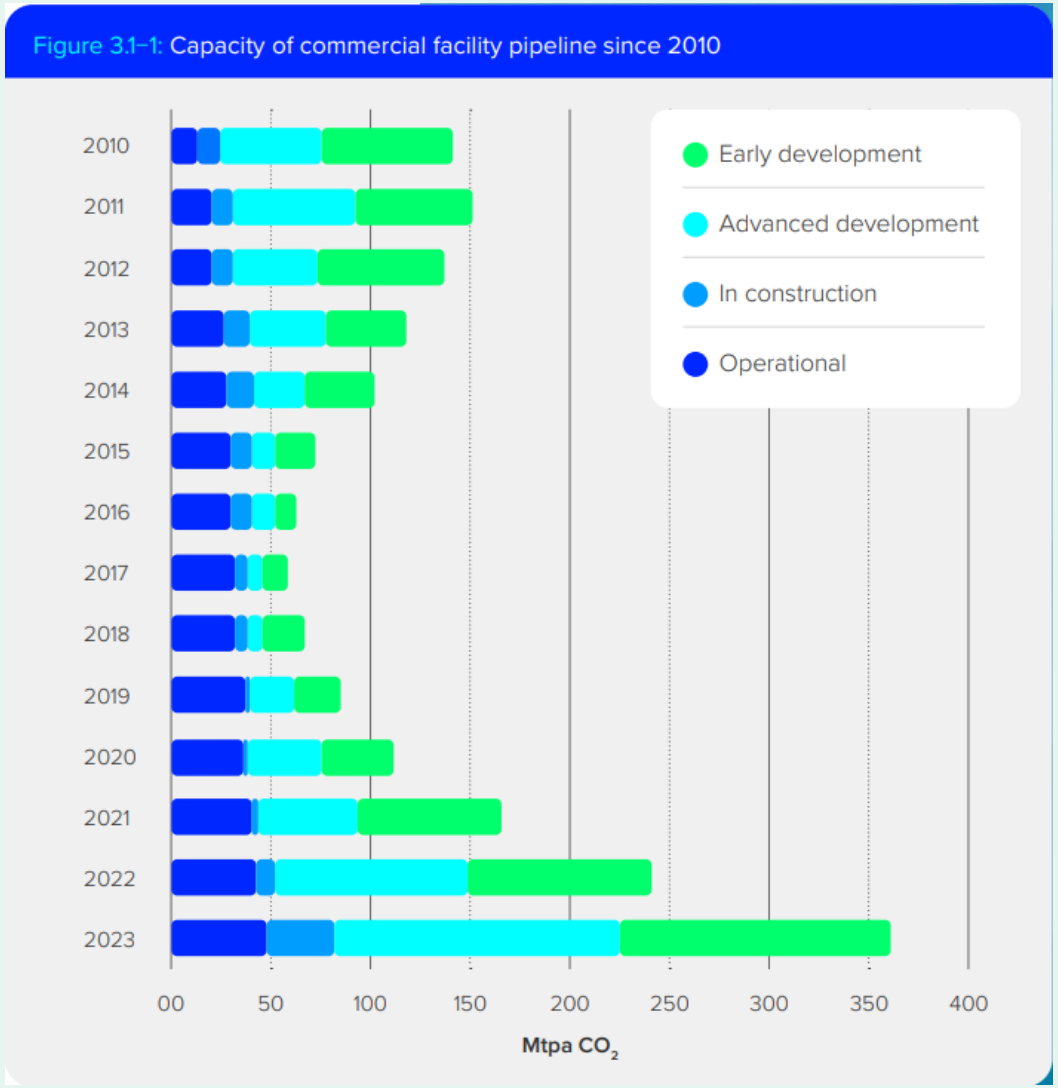
Carbon Capture: Global Perspective

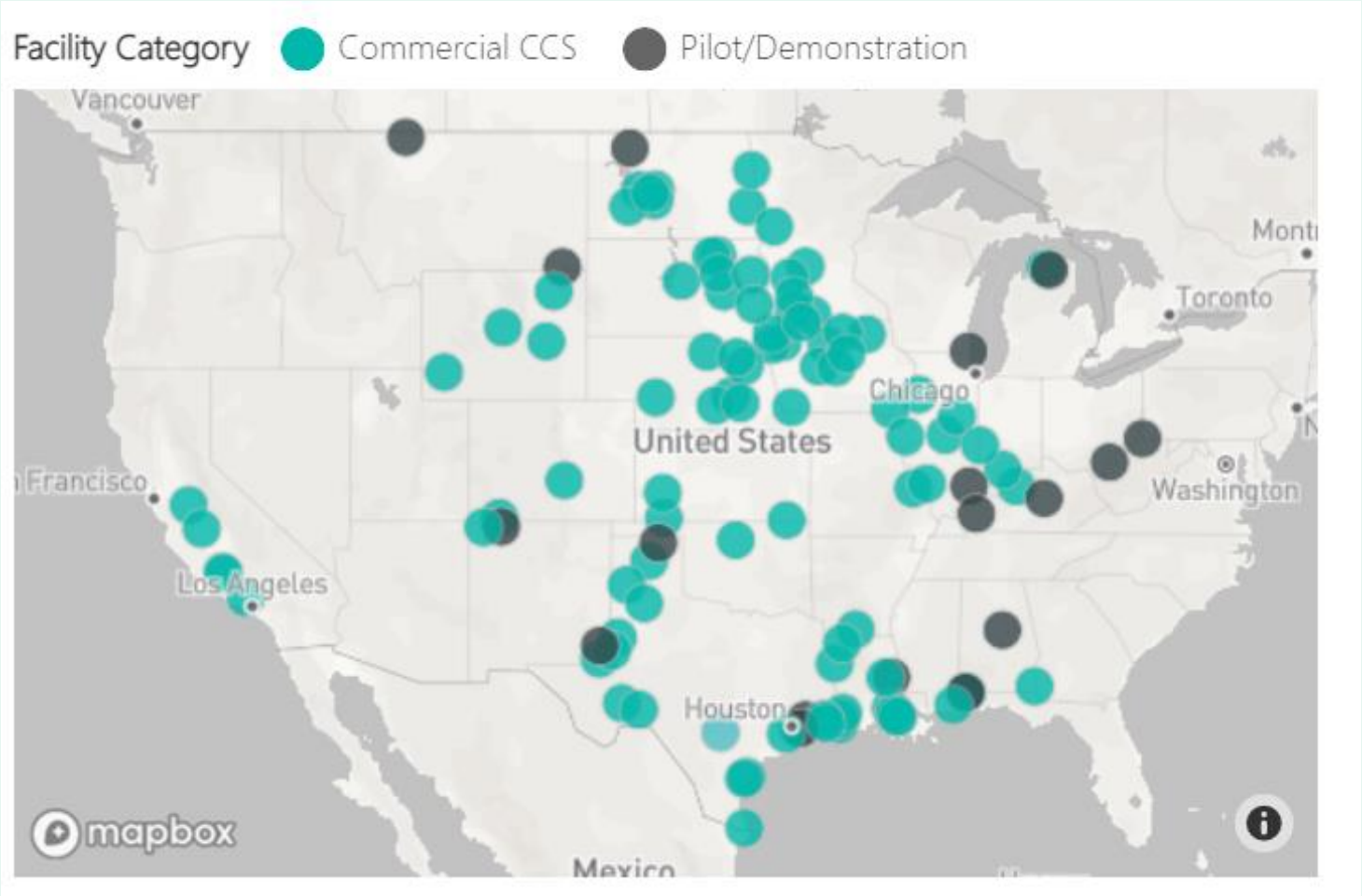
- According to the Global CCS Institute, there are 392 projects in the pipeline, as of July 2023, a 102% year-on-year increase.
- Capture capacity increased 50% from 2022.
- There are 41 projects currently operational and an additional 26 under construction.

Source: Global Status of CCS 2023, Global CCS Institute



Carbon Capture: US Perspective

- 14 commercial-scale US facilities with the capacity to capture and store approx. 20 million metric tons of CO_2 per year, representing nearly half of the global deployment of the technology to date.
- Over 5,000 miles of U.S. CO_2 transport infrastructure.



Carbon Management: Why Now?

Expanded tax incentives and climate policy initiatives have incentivized carbon management project development across the US

What is the 45Q tax credit?
Section 45Q of the US tax code provides a tax credit for carbon management projects that capture CO_2 from eligible industry and power facilities, as well as directly from the atmosphere.

When can it be used?
The 45Q tax credit can be claimed when a project has securely stored the captured CO_2 in geologic formations or oil and gas fields or reused it as a feedstock to produce low-embodied carbon products such as fuels, chemicals, and building materials.

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Carbon Capture: US Opportunities
Industrial and Power Facilities

Section 45Q Tax Credit for CO_2 Storage

- Geologic Saline:$85/ton
- EOR Storage: $60/ton

Minimum Capture Thresholds

- Industrial Facility: 12,500 tons CO_2
- Power Plants: 18,750 tons CO_2

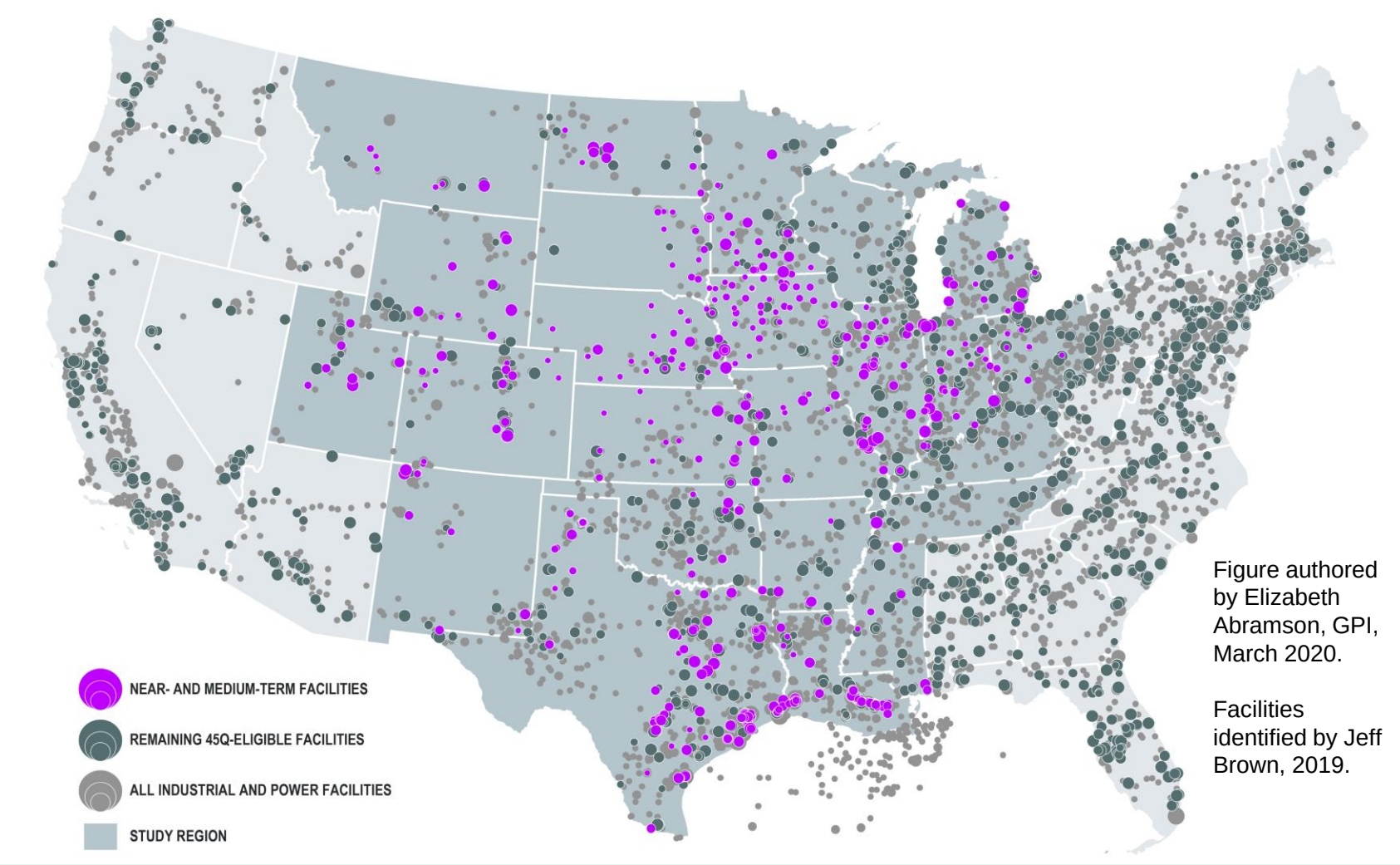


Figure authored by Elizabeth Abramson, GPI, March 2020.

Facilities identified by Jeff Brown, 2019.

The US has Nearly 50 Years Commercial Carbon Capture Experience at Scale

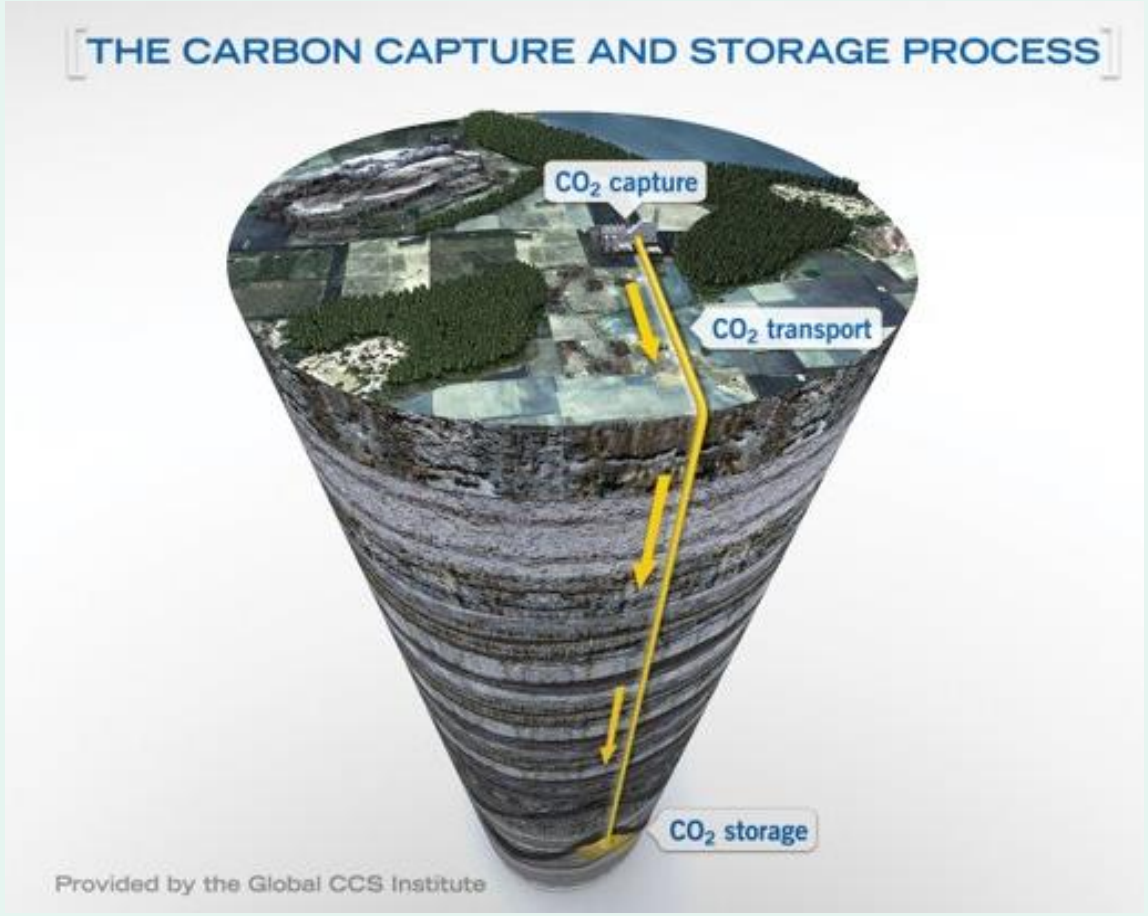
1972:	Val Verde Gas Processing Plants in Texas
1982:	Koch Nitrogen Company Enid Fertilizer Plant in Oklahoma
1986:	Exxon Shute Creek Gas Processing Facility in Wyoming
2000:	Dakota Gasification's Great Plains Synfuels Coal Gasification Plant in North Dakota
2003:	Core Energy/South Chester Gas Processing Plant in Michigan
2009:	Chaparral/Conestoga Energy Partners' Arkalon Bioethanol Plant in Kansas
2010:	Occidental Petroleum's Century gas processing plant in Texas
2012:	Air Products Port Arthur Refinery Hydrogen Production in Texas
2012:	Conestoga Energy Partners/PetroSantander Bonanza Bioethanol Plant in Kansas
2013:	ConocoPhillips Lost Cabin Gas Processing Plant in Wyoming
2013:	Chaparral/CVR Energy Coffeyville Fertilizer Gasification Plant in Kansas
2014:	SaskPower Boundary Dam Coal Power Plant Post-Combustion Capture Retrofit in Saskatchewan
2015:	Shell Quest hydrogen production at bitumen upgrader in Alberta
2016:	Emirates Steel's Mussafah direct reduction iron plant in the United Arab Emirates
2017:	NRG Petra Nova Coal Plant Post-Combustion Retrofit in Texas
2017:	Archer Daniels Midland large-scale ethanol capture in Illinois

Figure 7-8. Current CO_2-EOR Operations and Infrastructure[112]

U.S. regions with large-scale CO_2 pipeline systems currently in operation	Miles of Pipeline
Permian Basin (W. TX, NM, and S. CO)	2,320
Rocky Mountains (N. CO, WY and MT)	810
Gulf Coast (MS, LA and E. TX)	740
Mid-Continent (OK and KS)	480
Other (ND, MI, Canada)	215

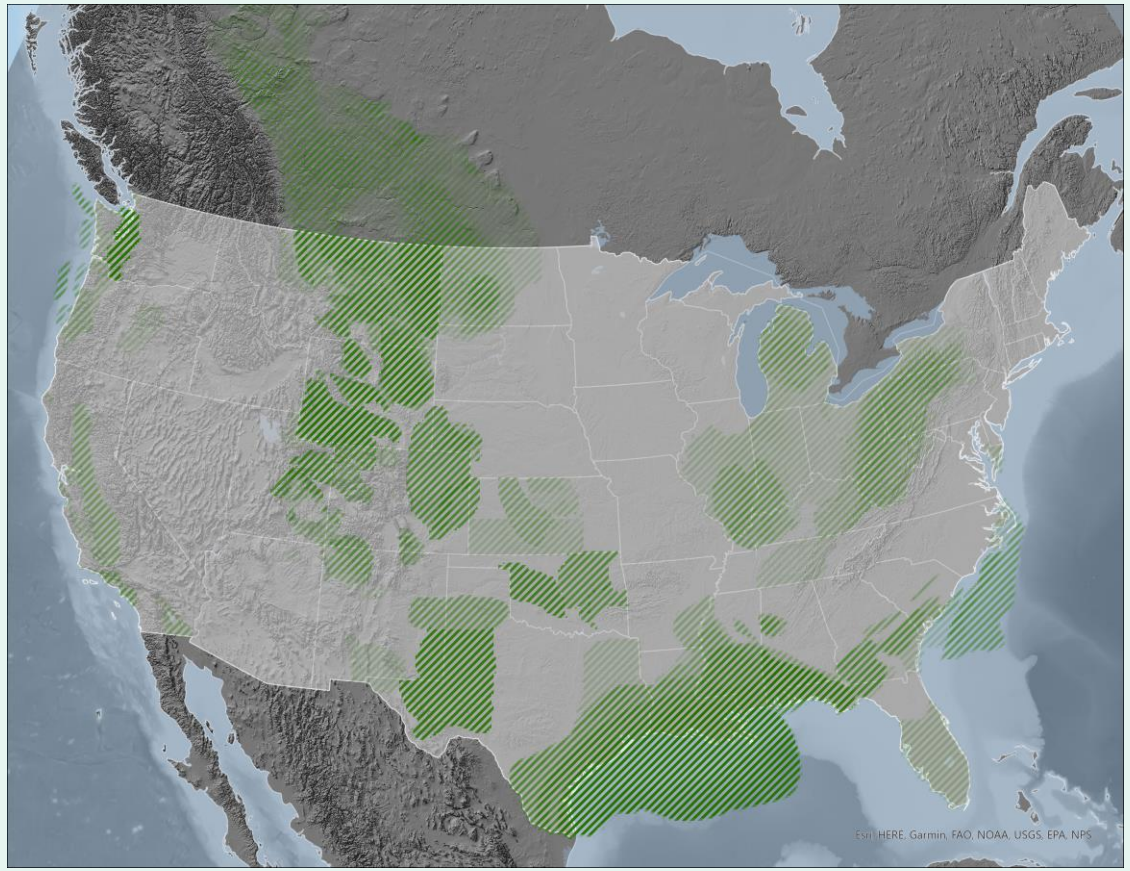
The current CO_2 pipeline system has been built to deliver CO_2 for CO_2-EOR to oil fields in the Permian Basin of west Texas and eastern New Mexico. This system spans across more than a dozen U.S. states and into Saskatchewan, Canada.

Geologic Storage in the US



Source: Global CCS Institute, 2022 Global Status of CCS Report

Saline Storage Potential in the United States



Source: DOE NATCARB, 2015, darker lines indicate higher storage potential

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Carbon Management is a Jobs Creator

If carbon capture is deployed at **532 industrial facilities and power plants in 28 states** across the Midwest, Great Plains, Gulf Coast, and Rockies regions, it could:

Support **86,000 project jobs**

Support **56,500 ongoing operational jobs** (annually, for a 15-year period)

create **$340 billion in private investment**

Capture **858 million metric tons of CO_2 per year**

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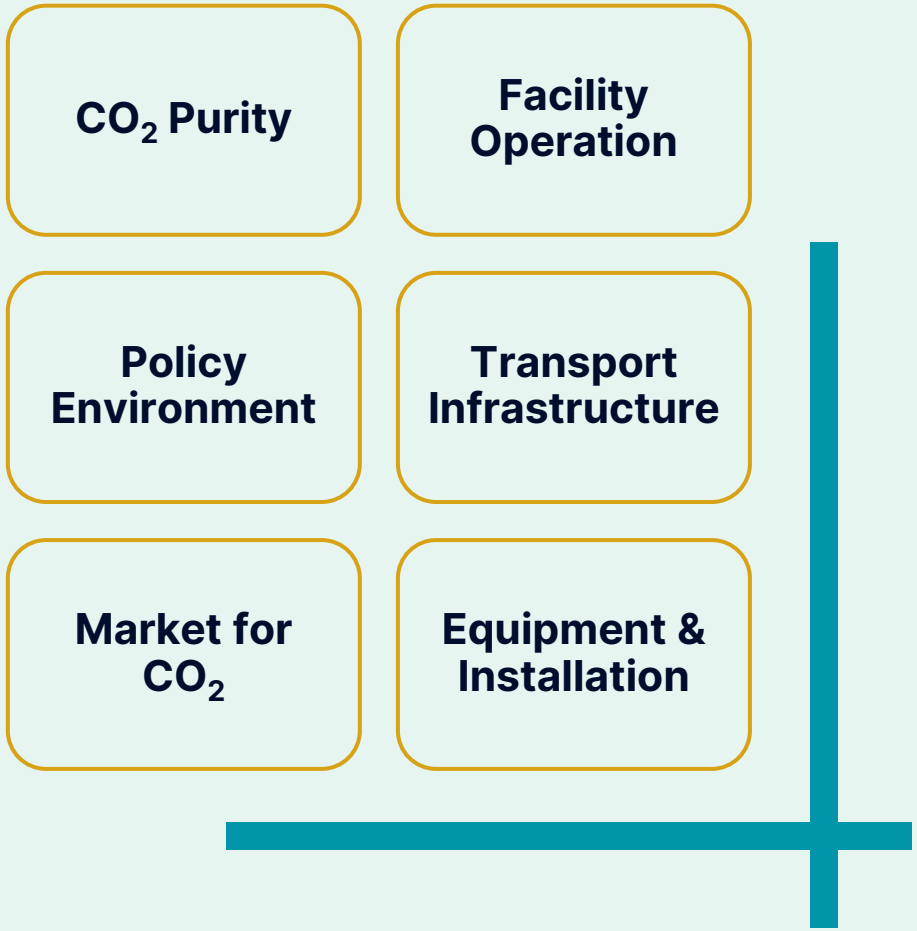
Carbon Capture is Cost-Effective

Cost Factors



- Carbon capture can be cost-effective today on a per-ton basis as part of a portfolio of other low- and zero-emissions reductions.
- Additional project deployment will lower costs further.
- Current cost ranges (not including transport and storage):
  - ~$30–$40 per metric ton in industrial sectors with highly concentrated CO_2 emissions
  - ~$90–$120 per metric ton for industrial facilities with mid-tier CO_2 concentrations
  - ~$90–$110 per metric ton for coal-based power plants

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Have More Questions?

Scan the QR code to go to our website at carbonactionalliance.org if you want to learn more or find our contact information.

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