CLEAN AIR TASK FORCE

Carbon Capture & Storage

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Arkansas EEI Industry Sector Workshop

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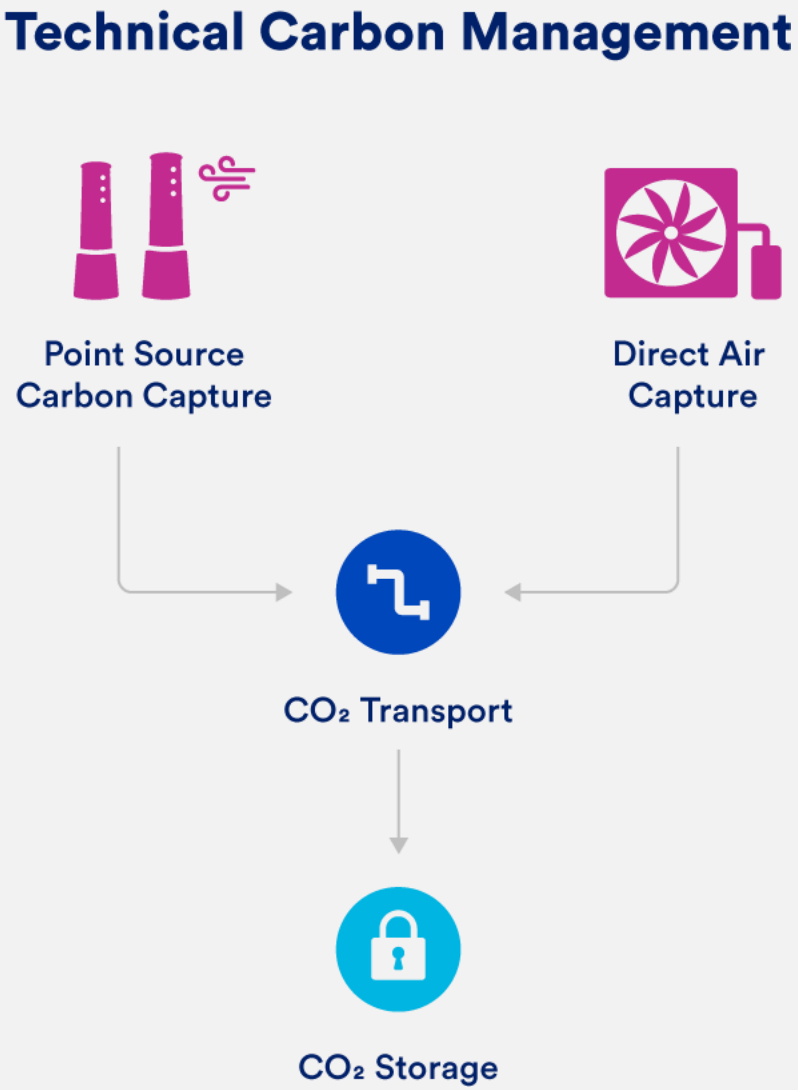
Overview

- What is Carbon Capture?
- How CCS Works
- CCS Economics
- The Status of CCS in the United States
- Arkansas CCS Opportunities
- Questions

What is Carbon Capture?

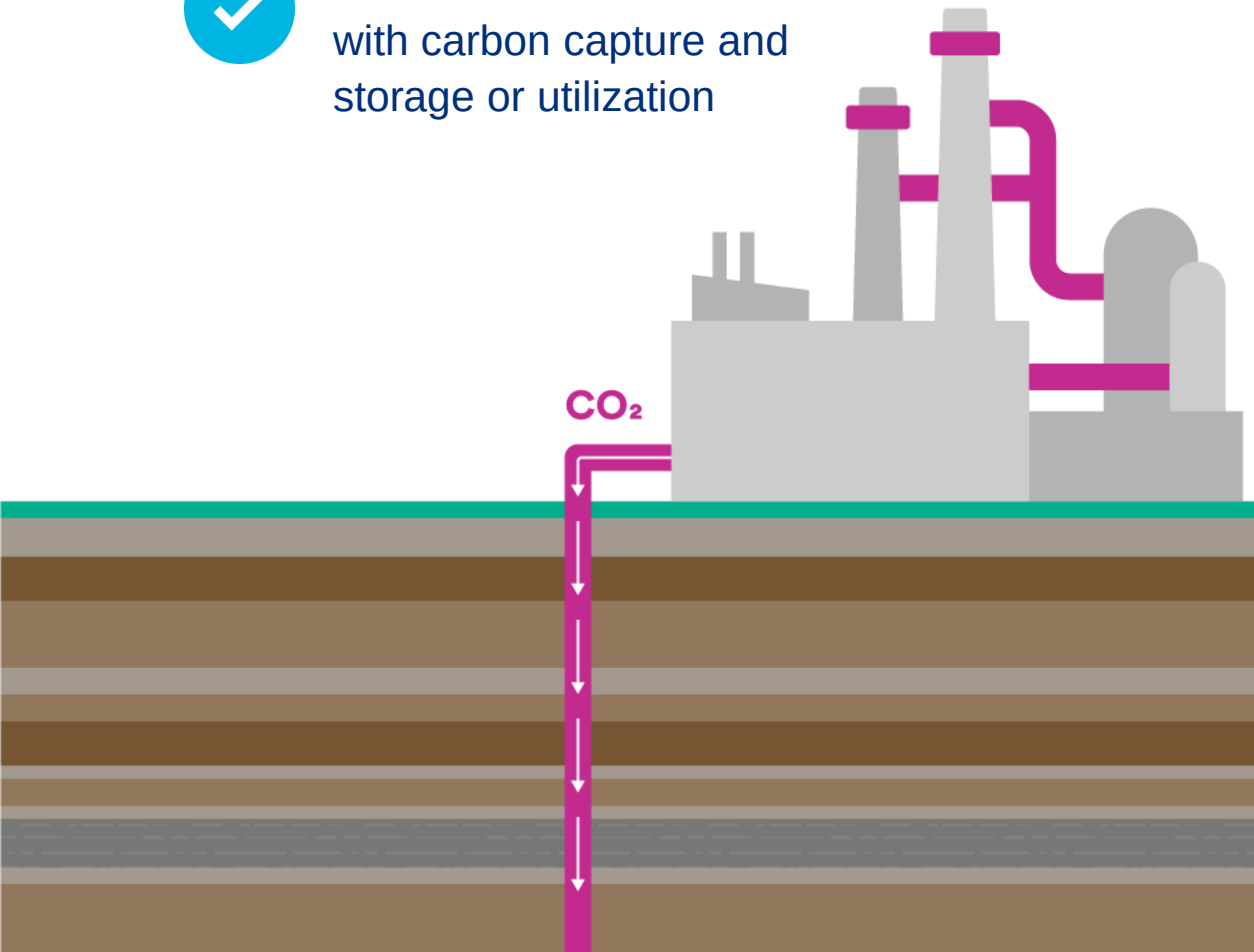
Carbon Capture is a suite of technologies that capture, transport and store CO_2 from energy-intensive industries and the air. It addresses both the:

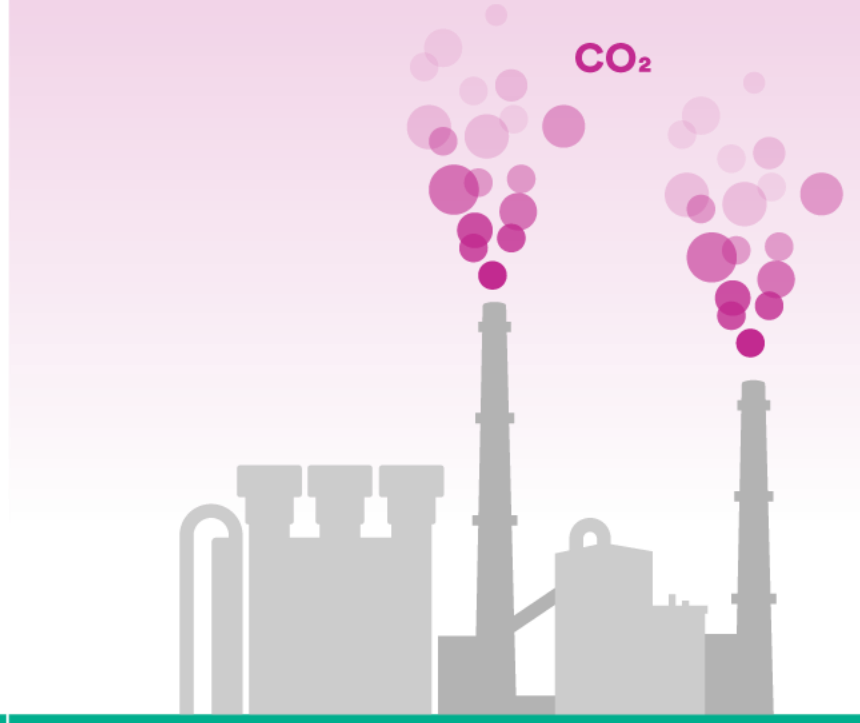
- Flow of new CO_2 by capturing emissions from industrial facilities and power plants
- Stock of legacy CO_2 by capturing CO_2 directly from the atmosphere
- All connected to transport and storage



How Point Source Capture Works

Industrial Facilities with carbon capture and storage or utilization



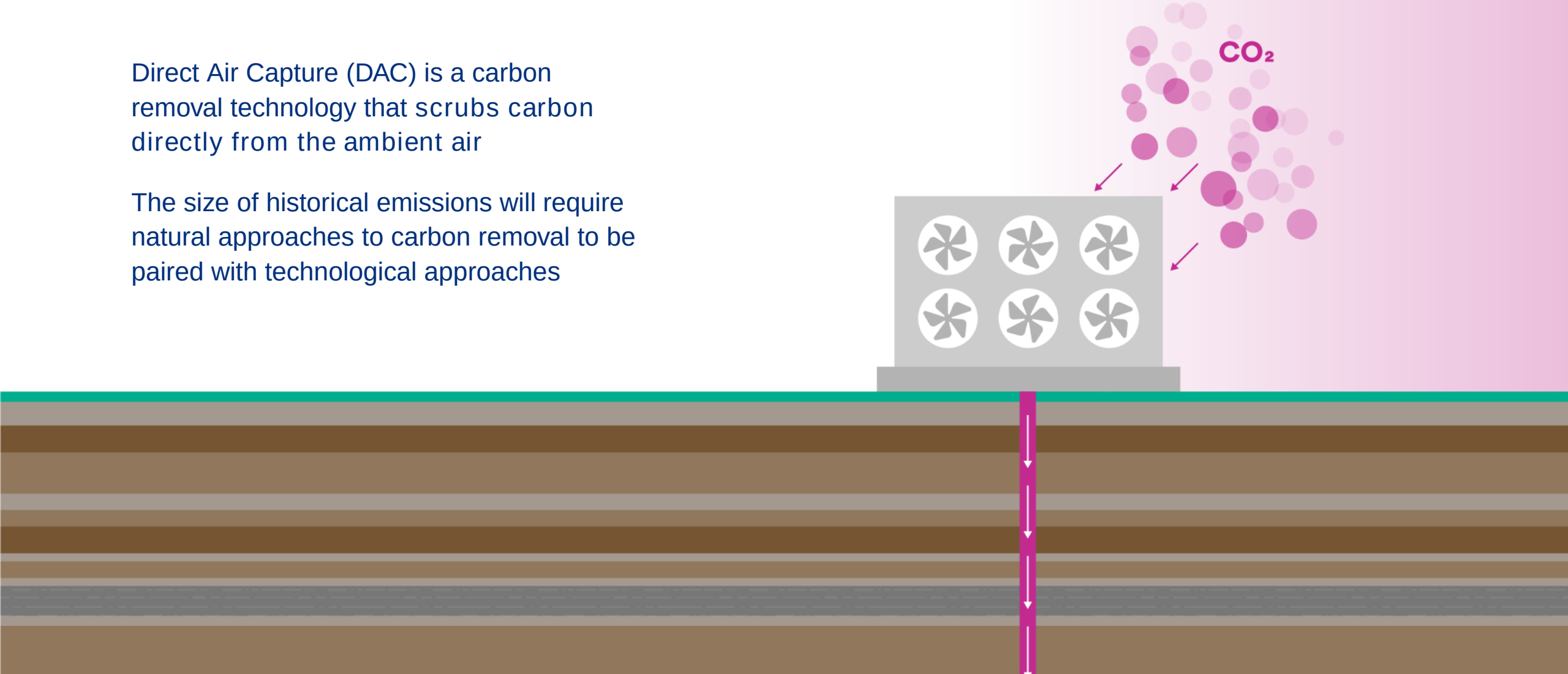


Industrial Facility without carbon capture and storage

How Direct Air Capture Works

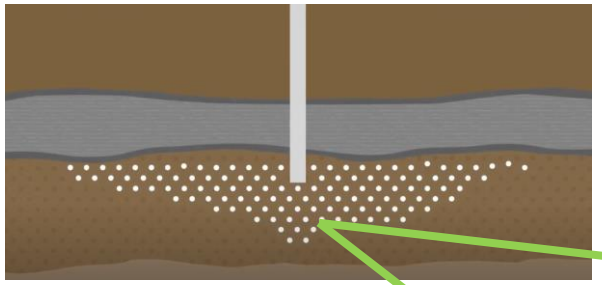
Direct Air Capture (DAC) is a carbon removal technology that scrubs carbon directly from the ambient air

The size of historical emissions will require natural approaches to carbon removal to be paired with technological approaches



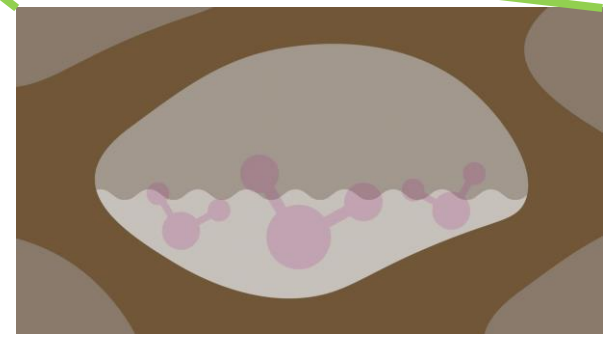
How CO_2 storage works

- A location with suitable geology is carefully chosen
- Usually in oil or gas-bearing formations or saline aquifers (brine)

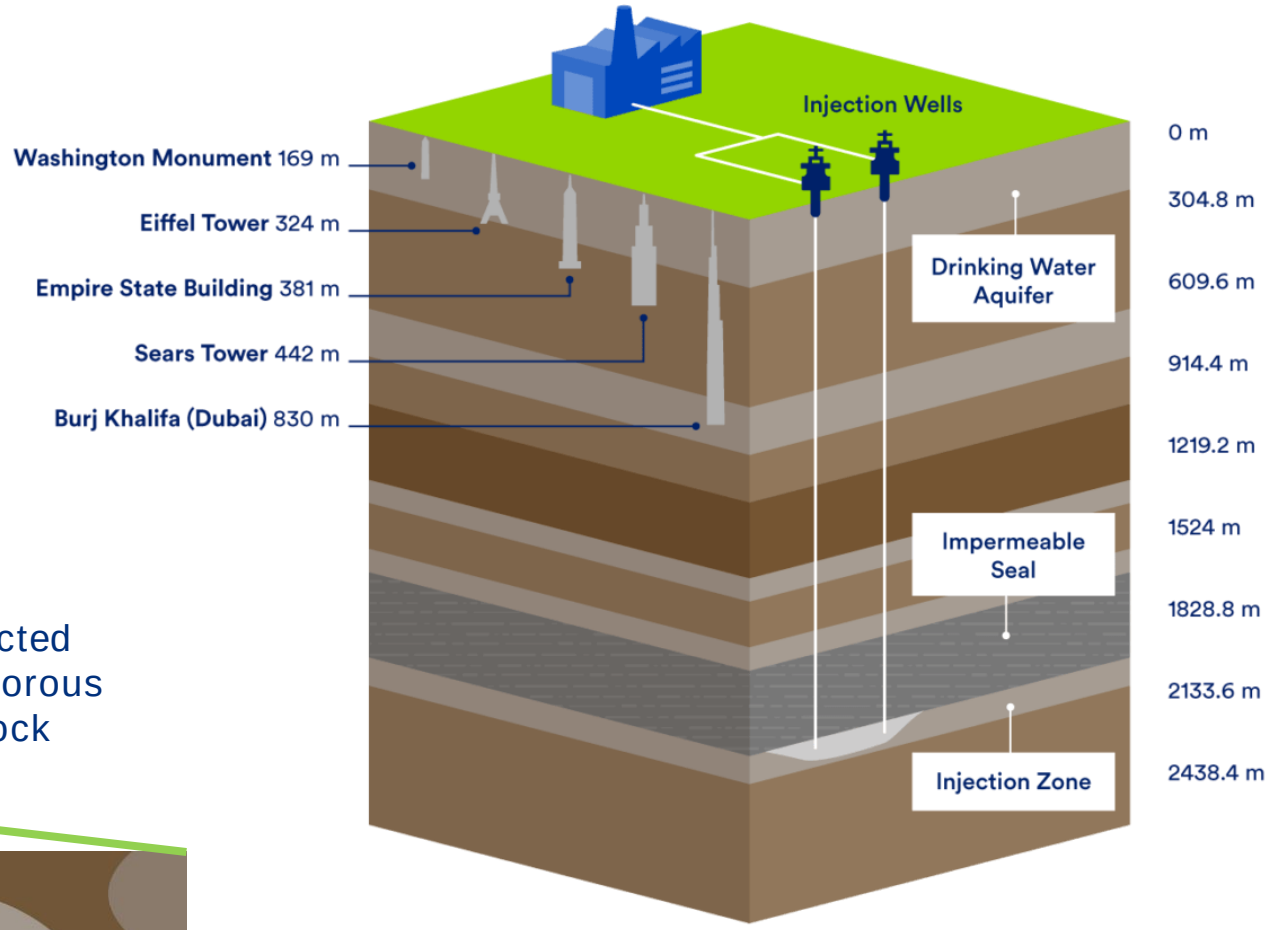


CO2 is injected deep into porous reservoir rock

Impermeable rock layers above the reservoir prevent CO2 from leaking

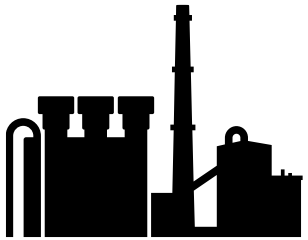


Injected CO2 dissolves in brine and may eventually turn to rock



Why is Carbon Capture important?

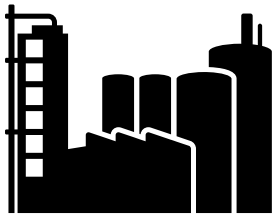
Carbon capture, removal, and storage has an essential role in capturing emissions from key industries



STEEL & IRON PRODUCTION

CHEMICAL PRODUCTION

WASTE DISPOSAL



CEMENT PRODUCTION

=

~20%

OF EMISSIONS

CCS Economics

CCS projects have 3 main cost categories:

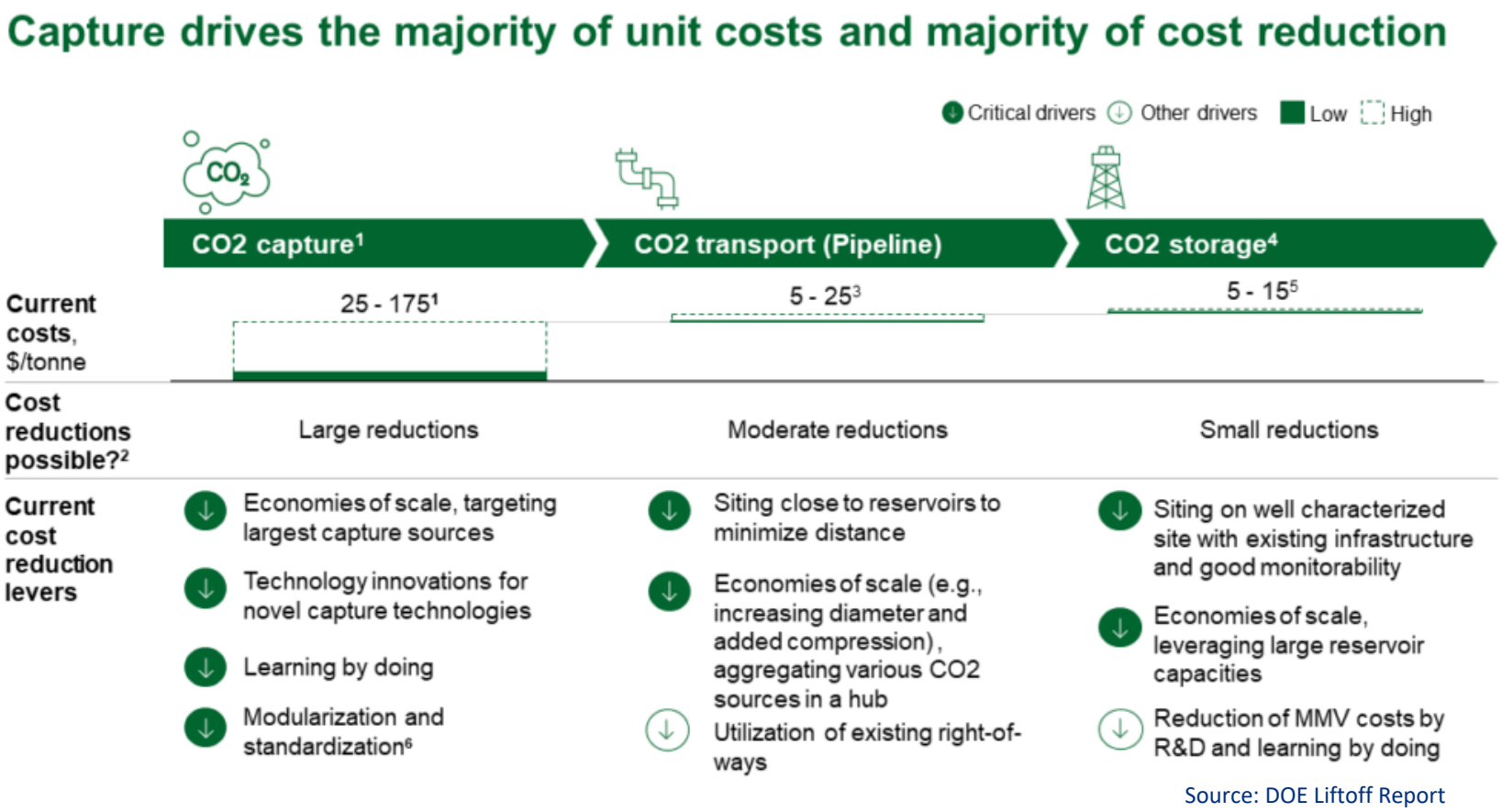
- Capture
- Transportation
- Storage

IRS Section 45Q Tax Credit incentivizes CCS.

- $85/ton of CO2 captured from point sources and stored in geologic formations
- $60/ton of CO2 utilized for EOR or other end-uses

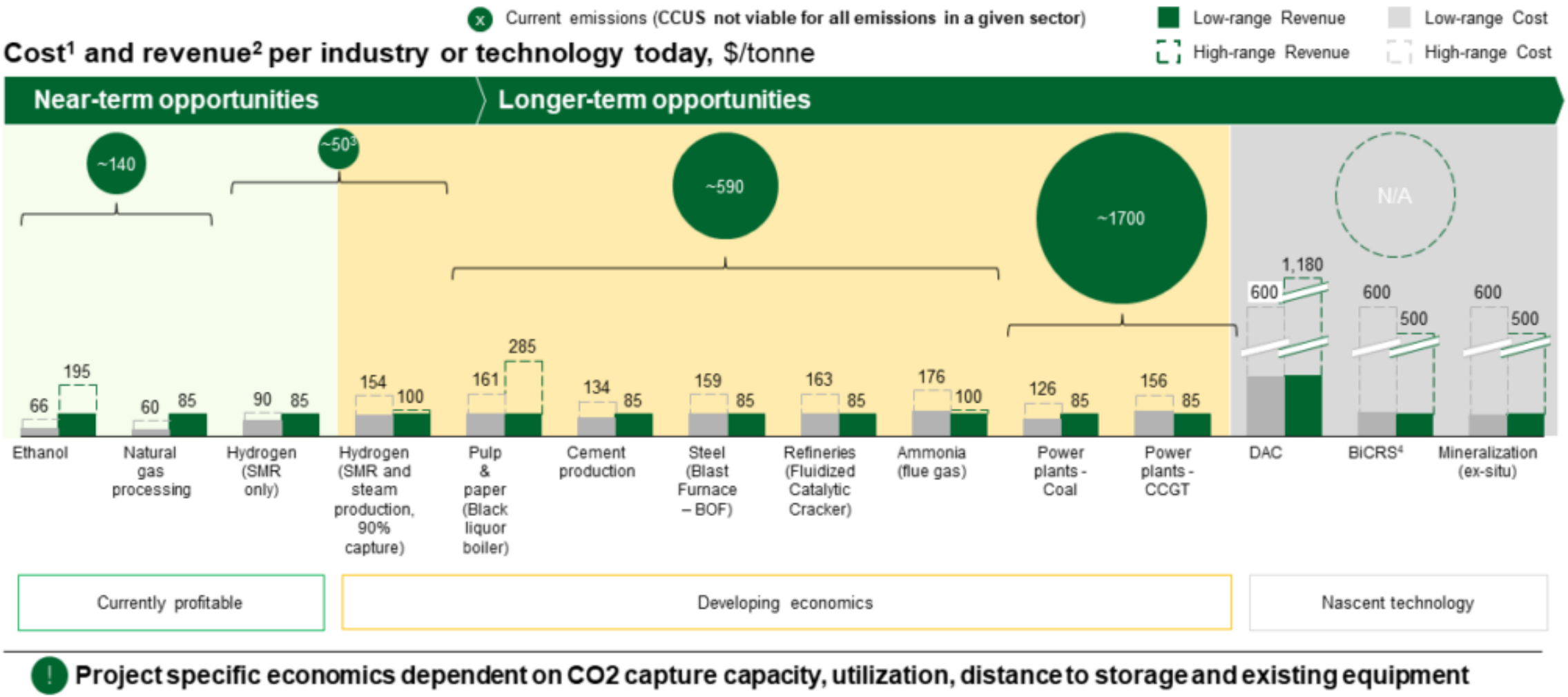
There are sectors where CCS is currently economically viable under $85 45Q

- Sectors with high-purity CO2 streams that have low capture costs (e.g., ethanol, hydrogen, natural gas processing)
- Cement and power sectors become economically viable under $85 45Q assuming access to cost-effective T&S



Source: DOE Liftoff Report

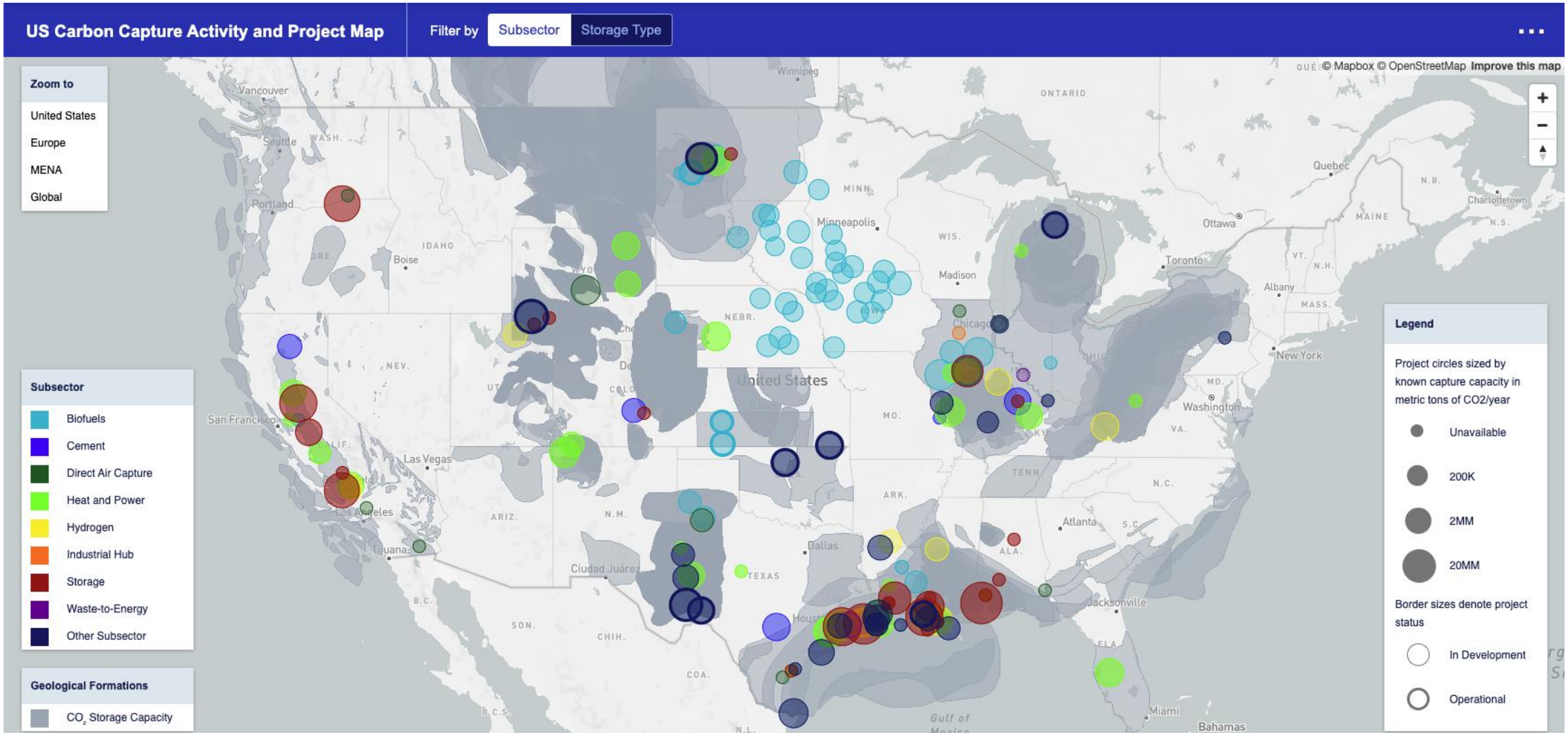
CCS Economics



Project specific economics dependent on CO2 capture capacity, utilization, distance to storage and existing equipment

Source: DOE Liftoff Report

What is the current state of CCS in the US?



www.catf.us/ccsmapus/

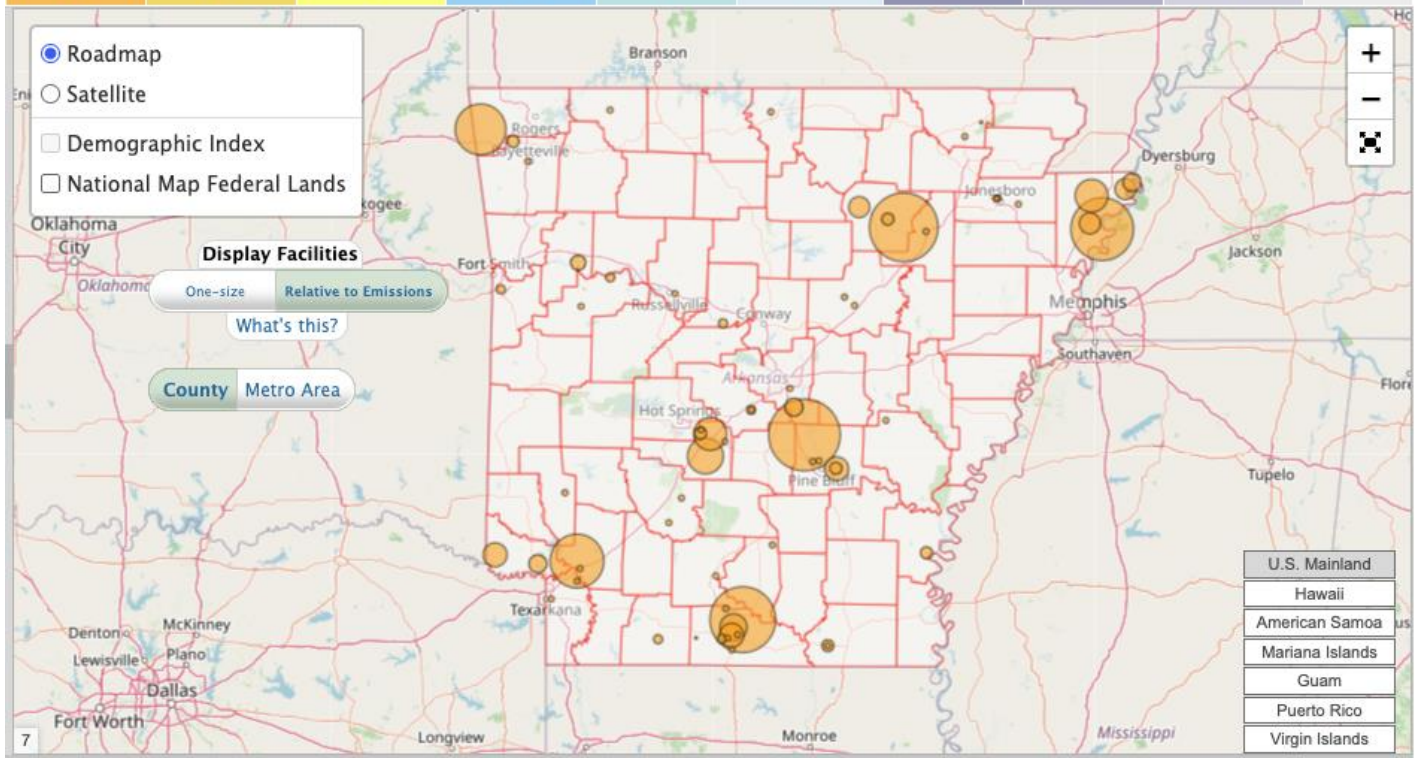
Arkansas Carbon Capture Opportunities

Arkansas hosts **67 industrial and power plants** that meet 45Q emission thresholds, totaling **39 million t/yr CO2**

Large stationary sources of CO2 are distributed across the state, with the largest sources being power plants

Generally, sources in the southern part of the state are near geologic storage potential whereas sources in the northern part would likely need pipeline transportation. Despite eligibility for 45Q, not all of these facilities will make sense to retrofit with carbon capture

Power Plants	Petroleum and Natural Gas Systems	Refineries	Chemicals	Other	Minerals	Waste	Metals	Pulp and Paper	Total Reported Emissions What's this?
32	0.1	0.7	1.3	0.7	1.3	0	1.6	1	39
17	4	2	10	17	5	0	8	6	67



Source: EPA FLIGHT Tool

Jobs and Economic Impact

Rhodium Group analysis estimates that Arkansas could create an annual average of up to **2,270 project jobs** over a 15-year period and **802 ongoing operations jobs**

- Deployment of CCS at 6 industrial and power facilities
- 9.5 million metric tons of CO2 captured annually
- Generate up to $5.5 billion in private investment

The study is based on near- and mid-term capture opportunities in Arkansas, focusing on cement, ammonia, and fossil power plants

The job estimates reported are in-state jobs directly associated with CC retrofits and do not include indirect and induced jobs

Source: Great Plains Institute

How CO_2 Storage Works In Arkansas

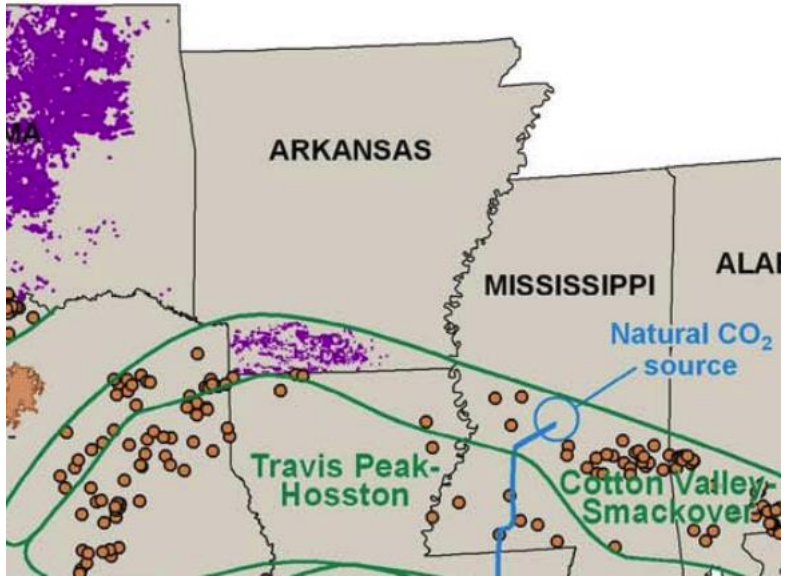
Saline storage potential in Arkansas has an estimated capacity of ~21B tonnes of CO_2 (NETL), but commercial storage capacity must be verified

Greatest potential is in deep saline formations in the Southern part of the state

El Dorado CCS Project is the first planned CCS project in Arkansas that will capture CO2 emissions from the El Dorado ammonia production facility and store them in deep geologic formations underneath the plant

Further geologic characterization will be required to validate commercial storage potential in the state

Source: Newfield Exploration Company



Source: TX Bureau of Economic Geology

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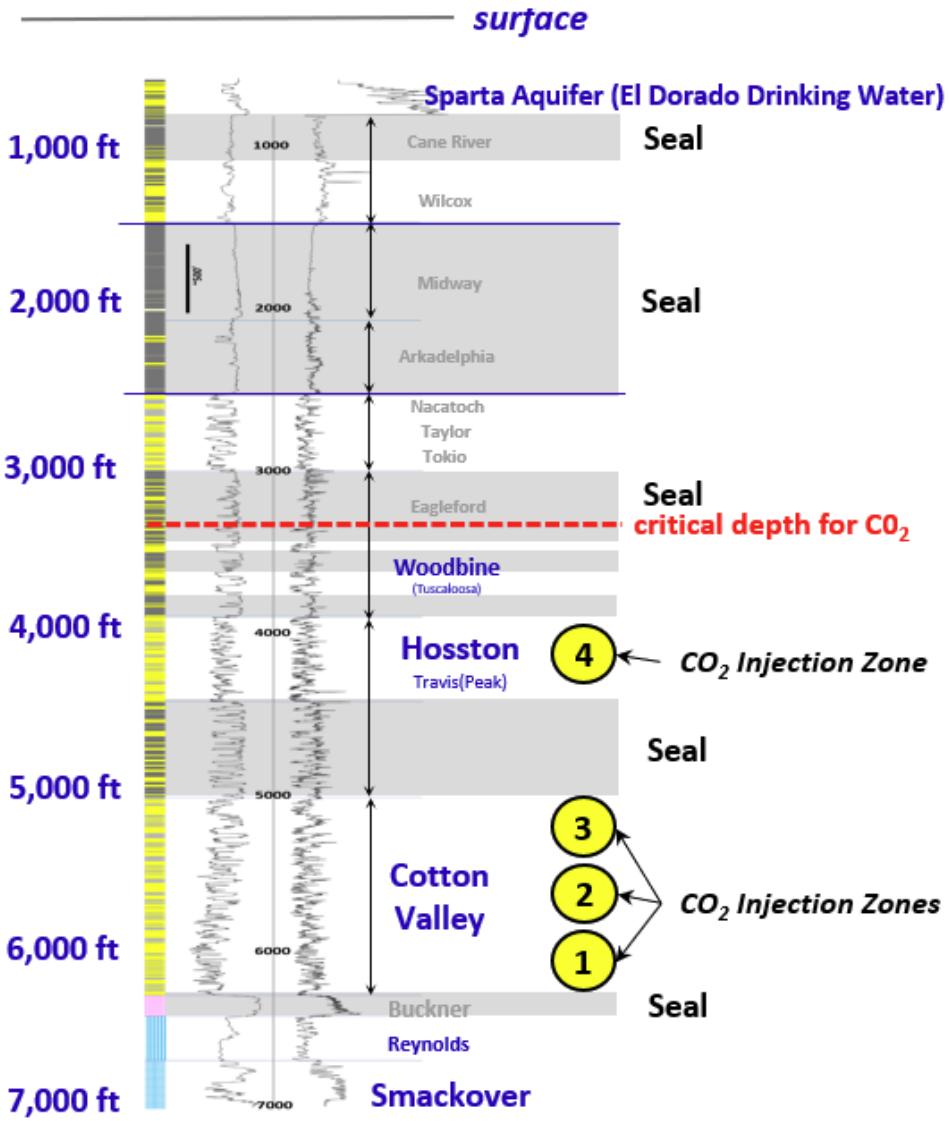
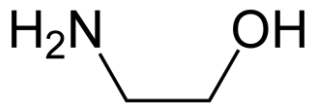


Source: LSB Industries

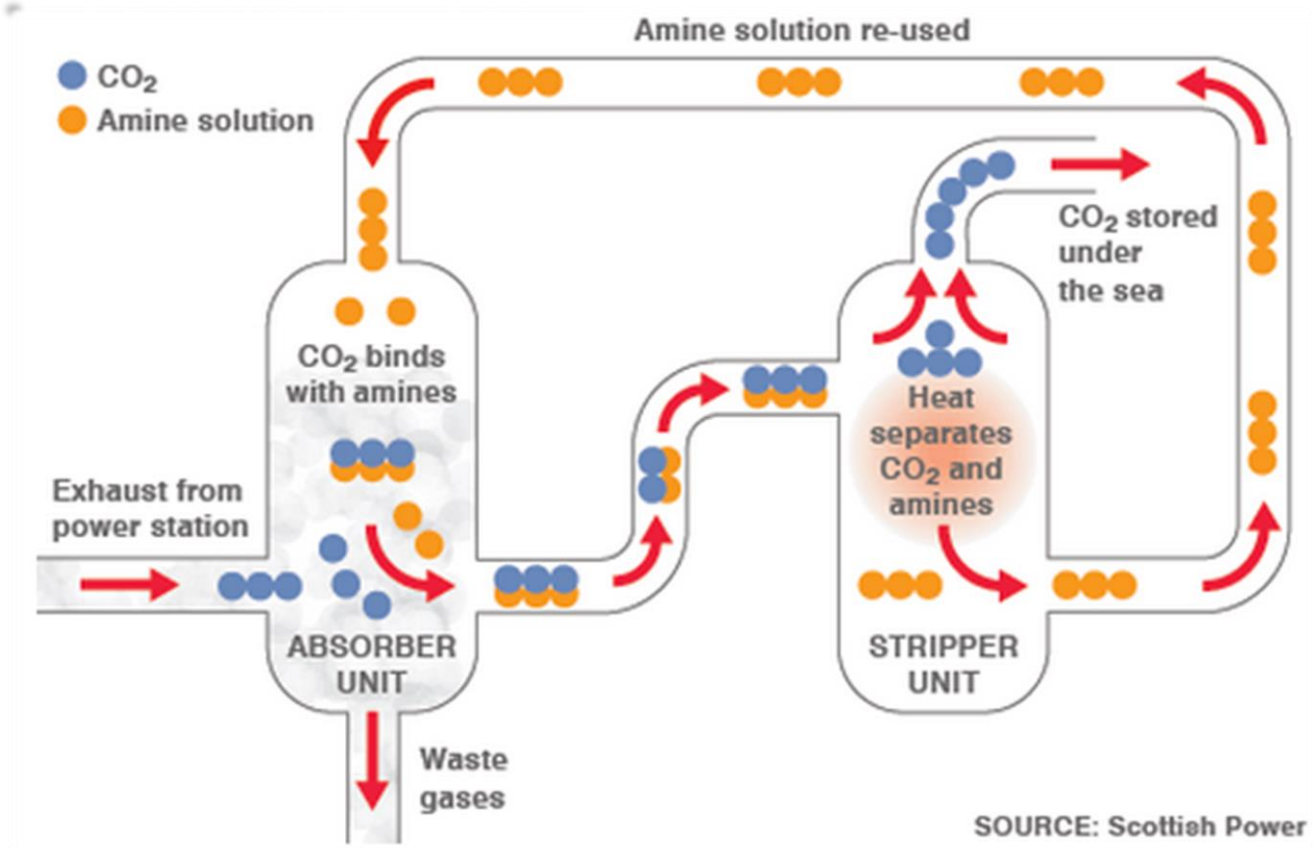
Questions?

How does carbon capture work?



Monethanolamine (MEA)

- The most suitable separation technology depends on the CO2 source
- For low CO2 concentrations (5-20%), typical of power plants, cement, and steel blast furnaces, many leading technologies use an amine solution which reacts with CO2
- The chemical releases pure CO2 when it is heated: heating the solvent = energy cost
- This technology can capture up to 99% of the CO2 (but 90% is often chosen)



Amine absorption for 1.4 Mt CO_2/year