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The True Cost of CCS

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Key Messages

1. Carbon capture has been done for decades. But there have been expensive failures and wasted resources.

2. **Most importantly, there is no evidence that the existing and proposed technologies for capturing CO_2 at commercial scale will capture all or almost all of the CO_2 from a facility and will do so year-in and year-out for decades — that is what CCS must do to be an effective tool for decarbonization.**

3. The history of carbon capture began with the processing of natural gases which had high concentrations of CO_2 (~18%-53%). This made it easier to capture and less energy was needed. Today, new technologies are attempting to capture CO_2 from much less concentrated streams in other industries. For example, flue gases from an NGCC contain only 4%-7% CO_2.

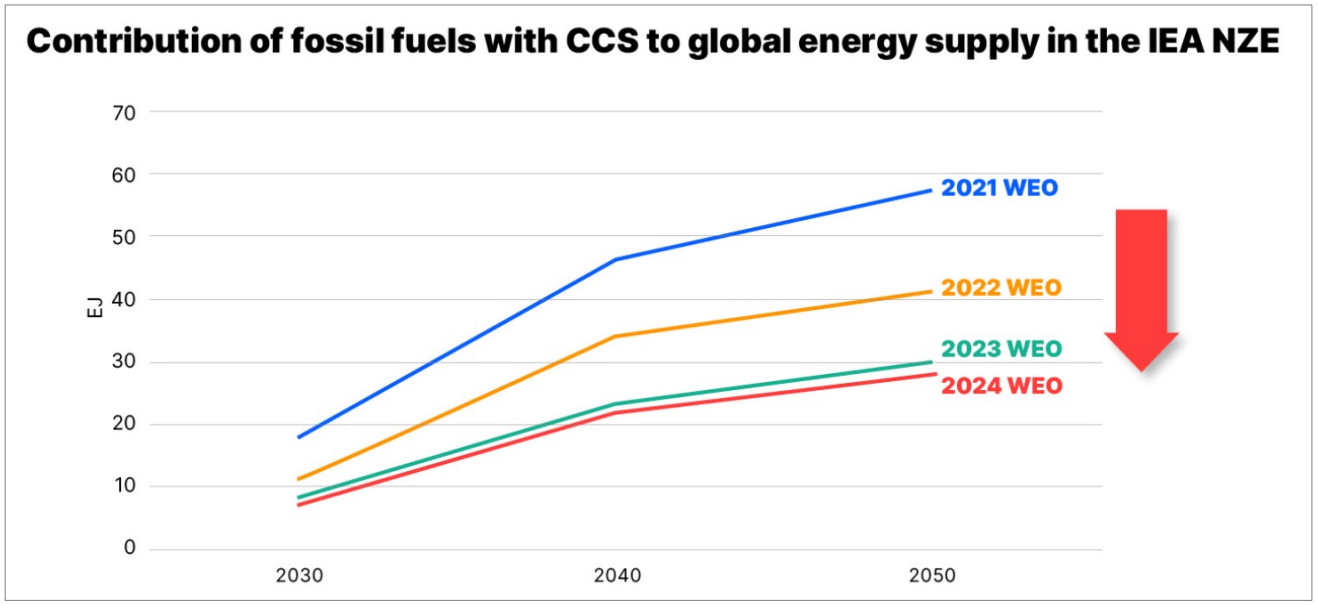
Key Messages

4. It is not true that using captured CO_2 for enhanced oil recovery is an effective means of decarbonization. EOR produces additional oil which, when burned or used as petrochemical feedstock, creates more CO_2.

5. Retrofitting fossil-fired generators for CCS and producing hydrogen from methane (natural gas) will consume large amounts of additional water.

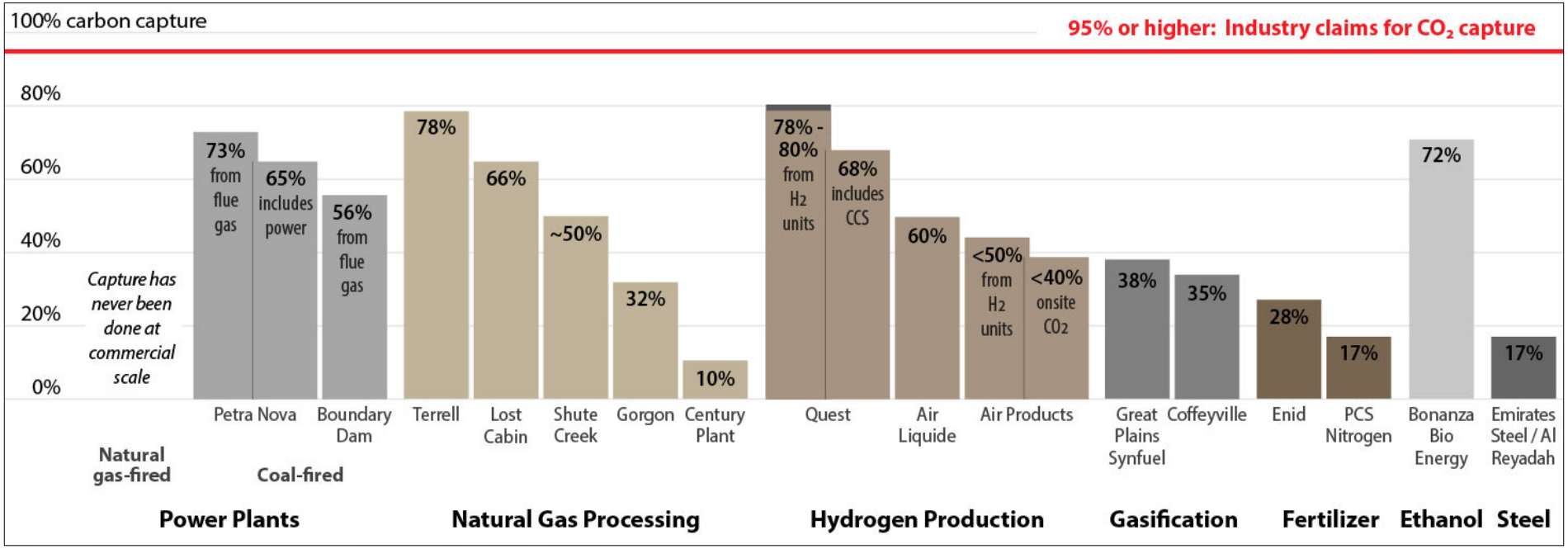
6. The actual cost of capturing CO_2 will be far, far higher than currently expected.

Expectations for How Much CCS Will Contribute to Decarbonization Are Going Down



Source: IEA, World Energy Outlook 2024 (added November 2024) 2023, 2022 & 2021, Net Zero Roadmap, Net Zero Roadmap – 2023 Update. (IEEFA)

There's No Evidence that Existing Commercial-Scale CCS Projects Have Captured Close to 95% of Their CO_2



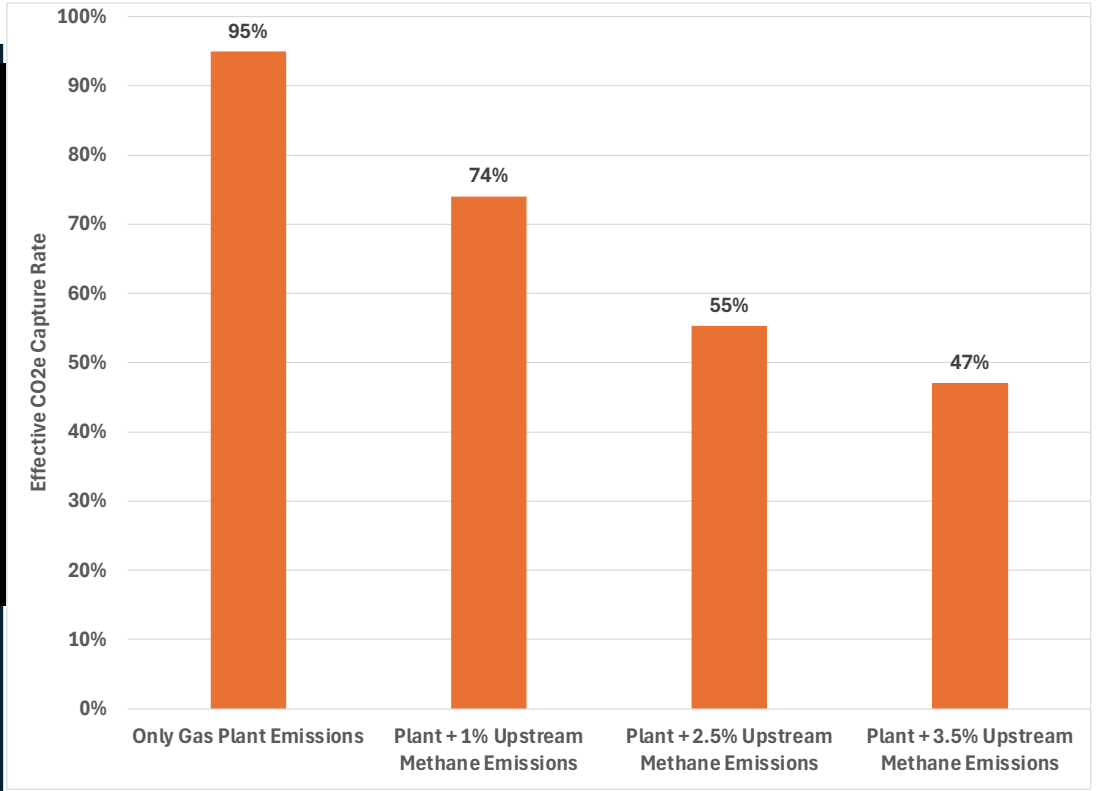
Sources: Company reports, IEEFA analysis: Blue Hydrogen: Not clean, not low carbon, not a solution.

Important to Look at Life Cycle Emissions of Fossil-Fired Power Plants

It is important to consider the entire life cycle of a proposed hydrogen or power plant project with carbon capture. This includes upstream and, if there are any, downstream CO_2equivalent emissions.

Not just the capture rate at the proposed facility.

In this chart, “upstream” refers to methane emissions between the well and the power plant.



Capture Data Highlights - Reality vs. Hype

On what evidence then do the government and CCS promoters decide that carbon capture facilities will achieve CO_2 capture rates ≤95%?

1. Literature reviews and discussions with project developers and capture technology vendors.

2. The results of small-scale testing of new and evolving capture technologies — on the order of 1%-5% of the CO_2 emissions from commercial-scale projects. ***Actual experience has shown that scaling up is a significant risk.***

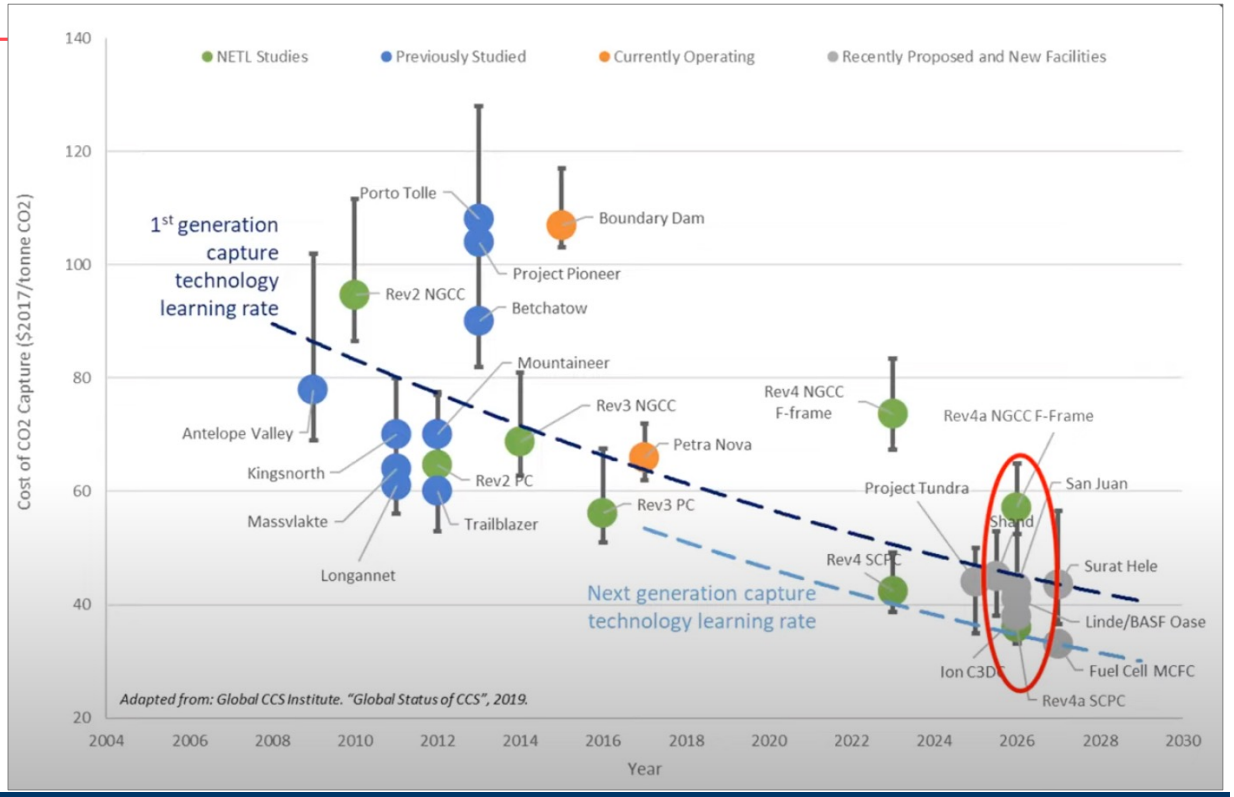
W.A. Parish coal-fired power plant with Petra Nova carbon capture project. (Wikipedia.com)

U.S. DOE CO_2 Capture Cost Projections from 2020

1st generation capture projects (blue) had actual capture costs between $60 and $110 per metric ton, in 2017 dollars.

Next generation project (in gray) were expected to have capture costs about 50% lower than those 1st generation projects.

Next generation projects (gray) anticipated to have capture costs about 50% lower than those 1st generation projects

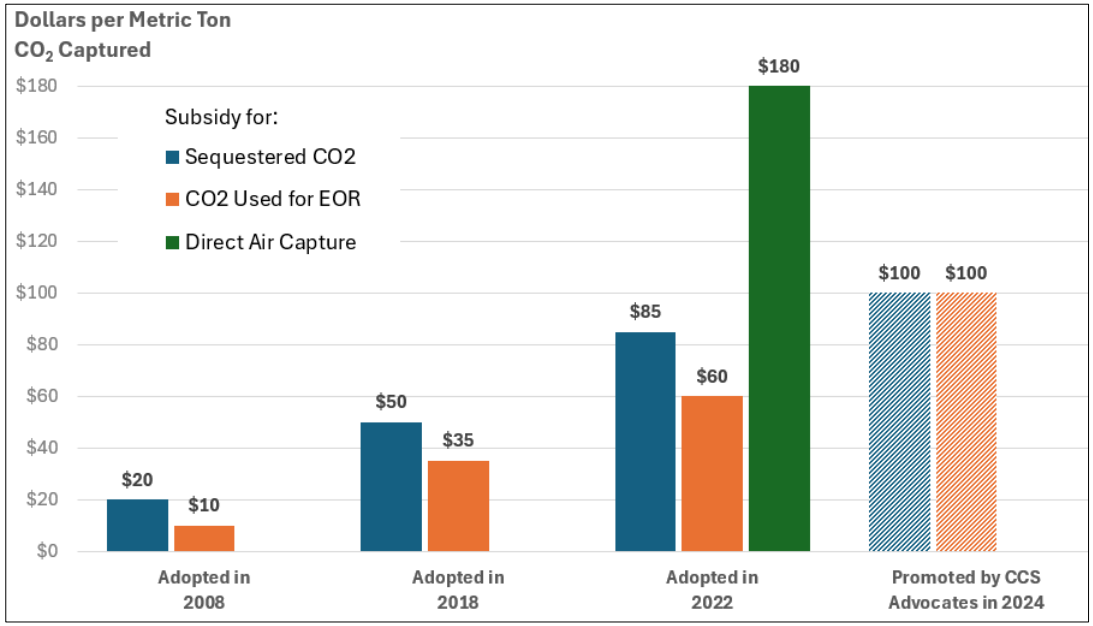


Rising Federal 45Q CCS Tax Subsidies

The Inflation Reduction Act (2022) increased 45Q tax credits significantly.

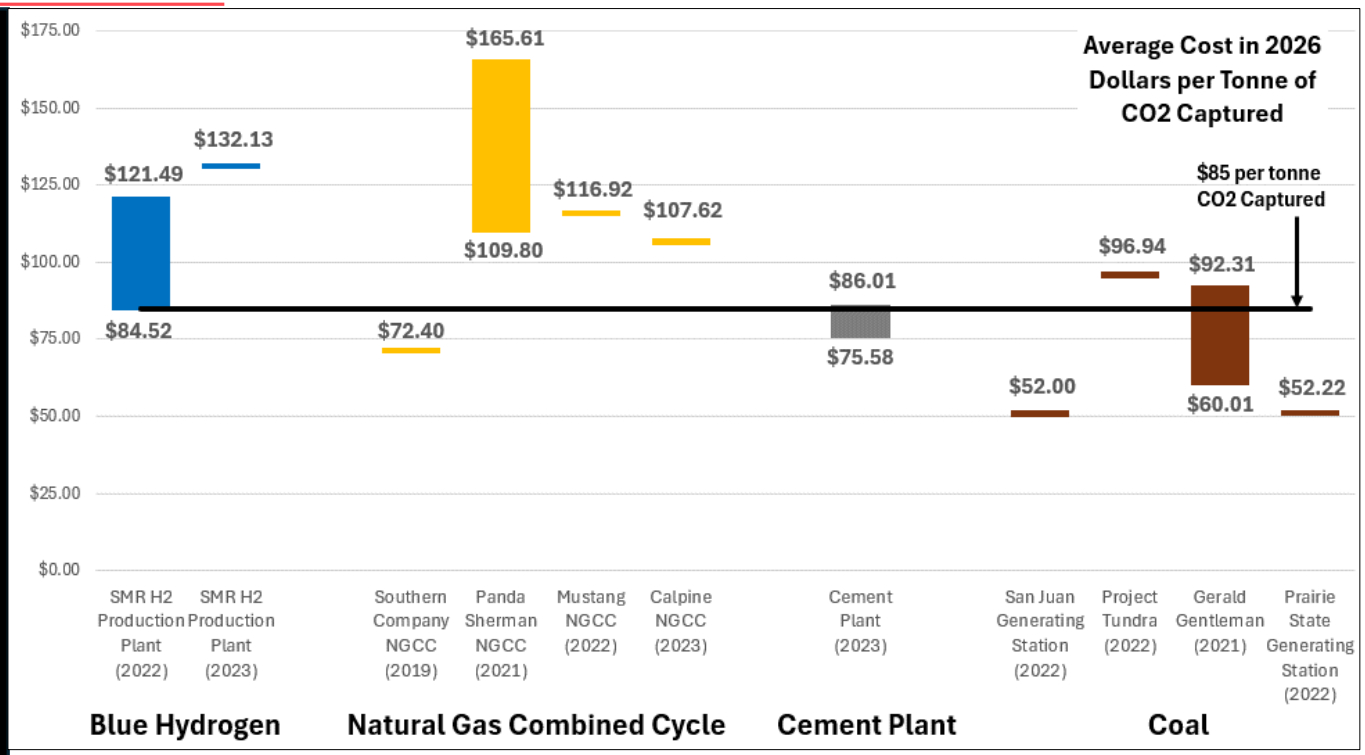
Despite huge increases, industry and advocates still think the subsidies for carbon sequestration and EOR are not enough to make it feasible financially.

CCS proponents are pushing for further increases in 45Q funding and parity between credits for permanently storing CO_2 and using it to extract more oil and gas.



Results of DOE-Funded Pre-FEED & FEED Studies on Carbon Capture

Note: Some studies did not include costs for transport and storage of captured carbon dioxide

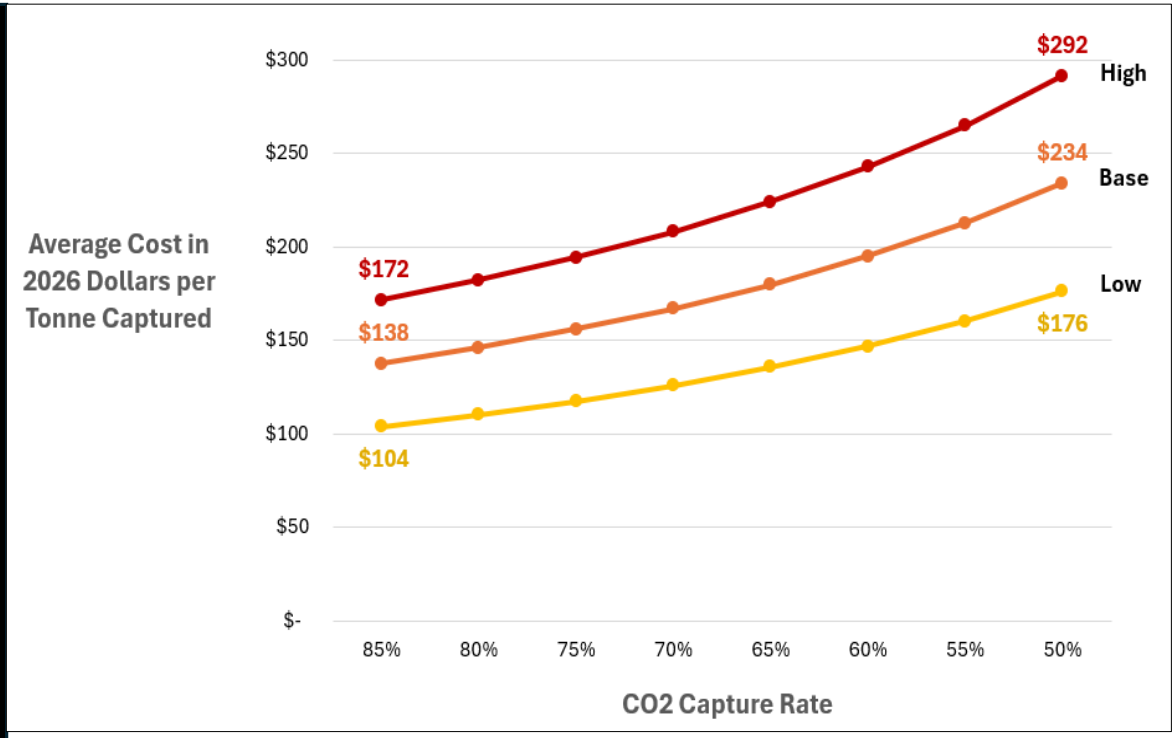


Potential Volatility in CO_2 Capture Costs – Natural Gas Combined Cycle Power Plant

High capital and O&M costs result in higher cost per metric ton CO_2 captured.

Coupled with lower capture rates, the cost per metric ton can rise steeply.

The “high” and “low” cases represent cost estimates +/- 15% of the base case for annual capital cost and +/- 50% for O&M.



Why CCS Capture Costs Are Going Up

1. Increasing construction costs due to delays and rising commodity prices (e.g. structural steel, concrete, etc).

2. Increasing O&M expenses including higher power prices due to natural gas price spikes

3. Lower-than-expected CO_2 capture rates leads to higher costs per tonne of CO_2 captured.

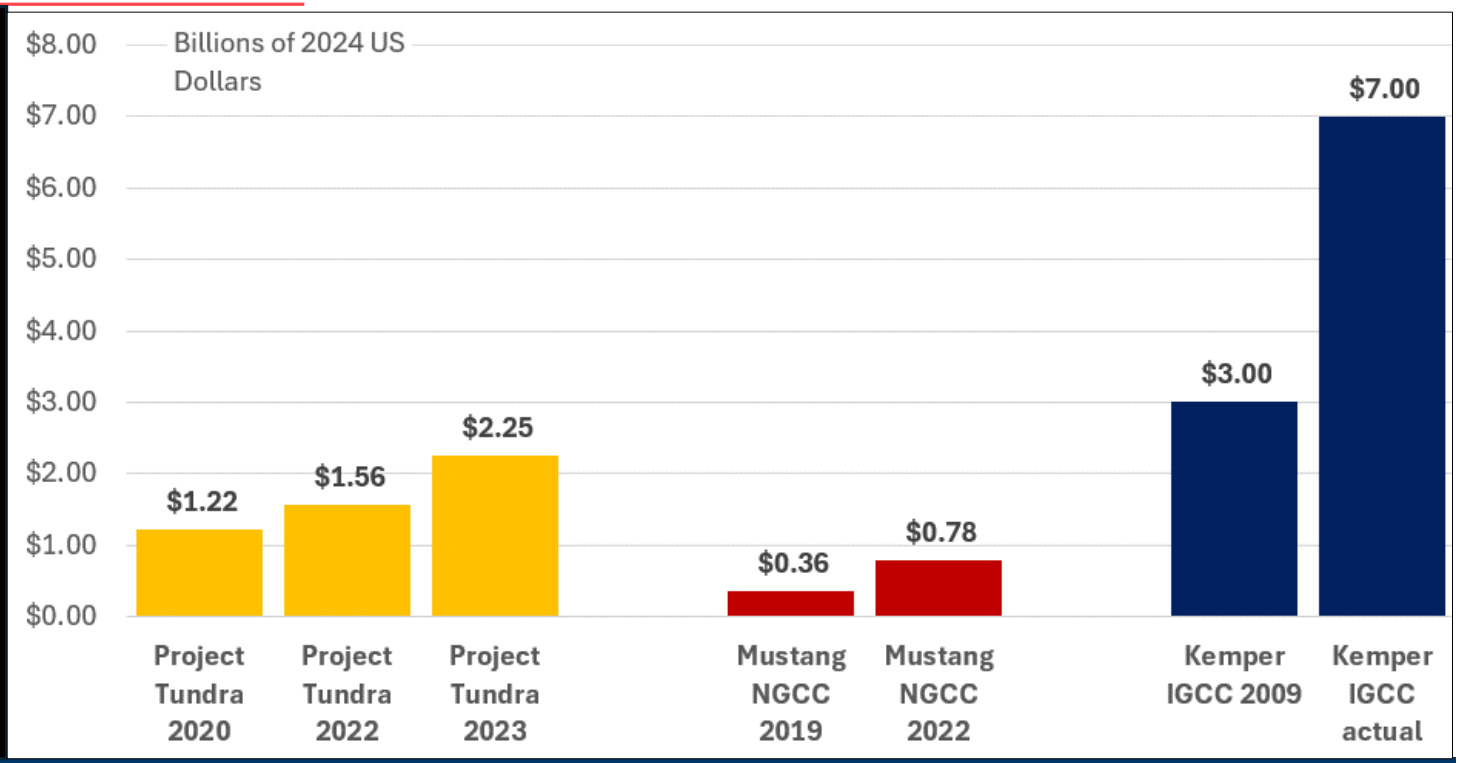
Carbon Capture's Soaring Estimated Construction Costs

Examples:

Project Tundra and SJGS (San Juan Generating Station: Coal-fired power plants with proposed post-combustion CO_2 capture.

Mustang: Natural gas-fired combined cycle power plant which studied adding post-combustion CO_2 capture.

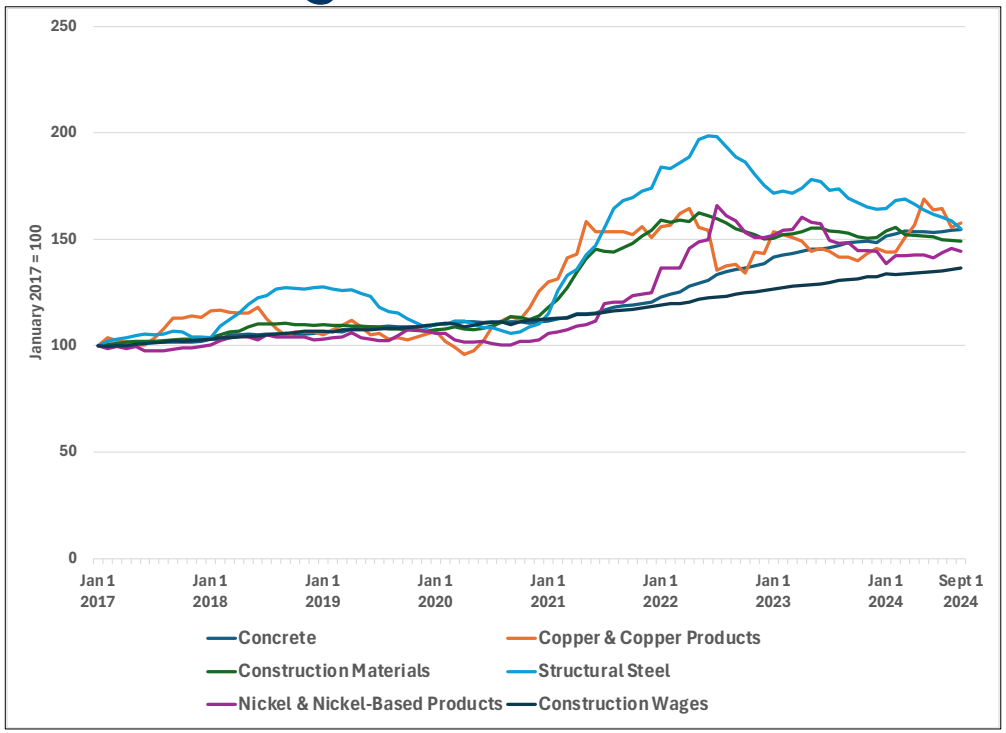
Kemper Project: Pre-combustion CO_2 capture. Never worked properly. Carbon capture portion of plant demolished in 2021.



Why Are CCS Construction Costs Going Up? Rising Commodity Prices and Wages

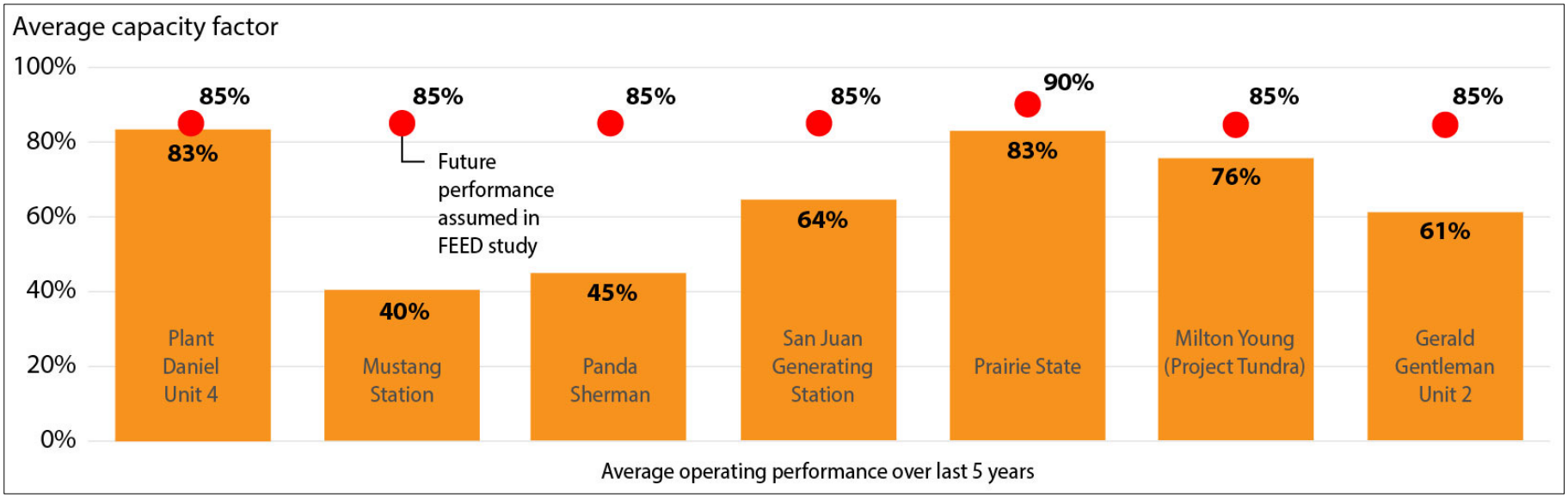
Between January 2017 and September 2024:

- Construction material producer price index rose by 49%
- Structural steel producer price index by 55%
- Concrete producer price index by 55%
- Construction wage index rose by 36%
- Copper and copper product producer price index rose by 58%
- Nickel and nickel-based project producer price index rose by 44%



Source: Federal Reserve Bank of St. Louis

With 45Q Subsidies Fossil Plant Owners May Want to Run Their Power Plants More



***Capacity Factor**: A measure of how much power the plant actually produces versus how much it would have produced if it had operated at 100% power for all of the hours of the time period being looked at – month, year, or series of years.*

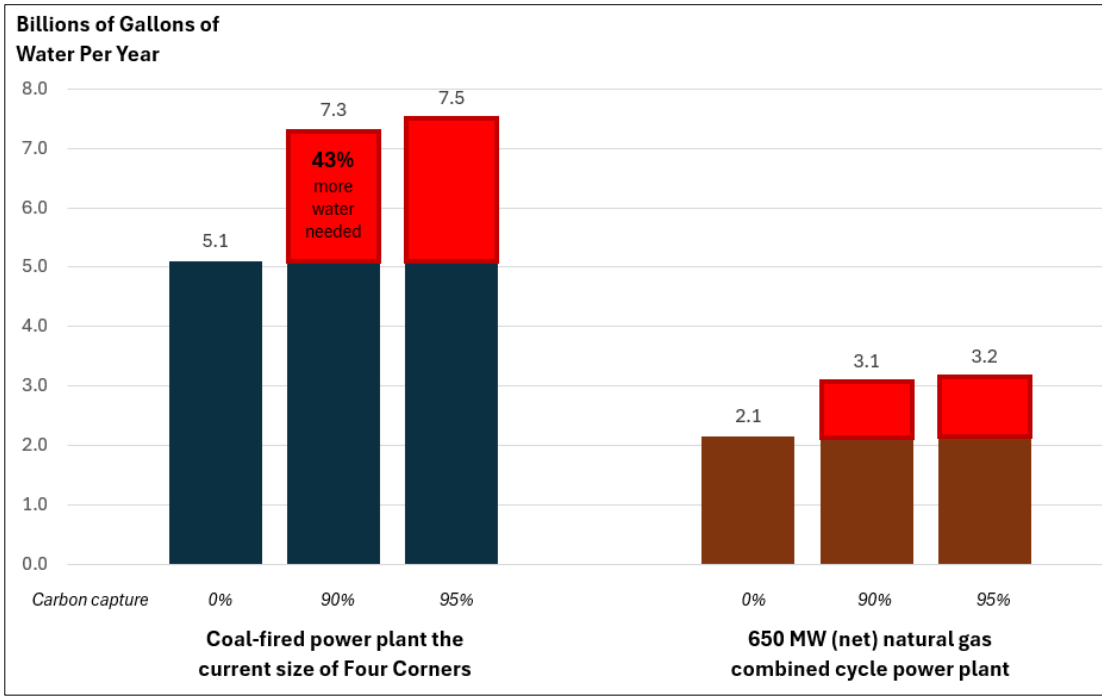
Increased Water Demand with Carbon Capture – Coal and Gas-Fired Power Plants

Adding carbon capture to a power plant increases the amount of water required.

A coal-fired power plant capturing ~90% of its CO2 emissions would need ~43% more water.

Natural Gas Combined Cycle (NGCC) plants with 90% carbon capture would requirement almost 50% more water

Source: Cost and Performance Baseline for Fossil Energy Plants – Volume 1 – Revision 4A: Bituminous Coal and Natural Gas to Electricity, DOE/NETL 2023-4320, October 2022



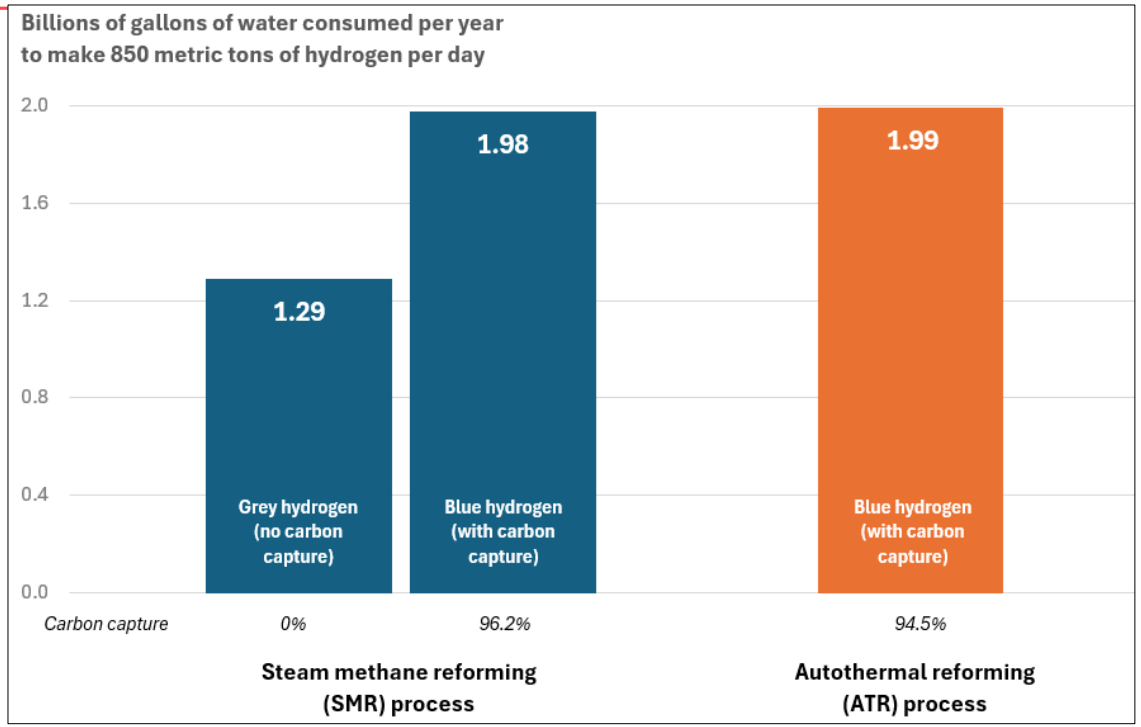
Increased Water Demand with Carbon Capture – Production of Hydrogen from Methane

Water demand for hydrogen production is substantial.

Including carbon capture in a hydrogen production system increases the water demand by 35% compared to gray hydrogen.

A large blue hydrogen production plant with carbon capture (producing 850 metric tons of hydrogen from methane per day) would use nearly 2 billion gallons of water in a year.

Source: Comparison of Commercial State of the Art Fossil-Based Hydrogen Production Technologies, NETL-DOE, April 2022



For More Information

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