

# Carbon Capture Utilization and Storage (CCUS)

Briefing to

# **Empower Our Future**

Presented by  
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March 21, 2023

# Outline of presentation

1. **Carbon** - Where is it? The ground, the stacks, the land, the air.
  2. **Carbon Capture** – The stacks, the land, the air. The scale. The cost.
  3. **The Pipes** –Who regulates them? What are the issues?
  4. **The Goal** – Public money for more oil extraction -  
Enhanced Oil Recovery
  5. **Injection** – Who regulates the wells? What could go wrong?
  6. **Politics** – The 45Q system - Congress approves waste of time and  
money on CCUS.
  7. **Pending in Colorado** – Brief mention of SB23-016; HB23-1210
- 6:45 - Questions and Answers.**

## A reminder of what many of you know:

- The daily Keeling Curve of CO<sub>2</sub> in the atmosphere is measured at Mauna Loa, Hawaii.
- On March 18, 2023, NOAA reported that we are at 420ppm.
- The pre-industrial world was at 280ppm.
- The world's average CO<sub>2</sub>e growth is about 2.5 ppm/year.
- The MIT EN-ROADS global model forecasts that the status quo will result in a 6.4 degree Fahrenheit increase by 2100.



# What we often hear regarding CCUS:

Given the urgency of the climate crisis...

Should everything be on the table?

Should we capture carbon that would otherwise be pumped in to the air?

Do we have the time to make CCUS work?

Should we provide financial incentives to pull carbon from the stacks and out of the air?

These sound like good things to do. Right?

Before we say yes.....

**Consider Priorities and Distractions**

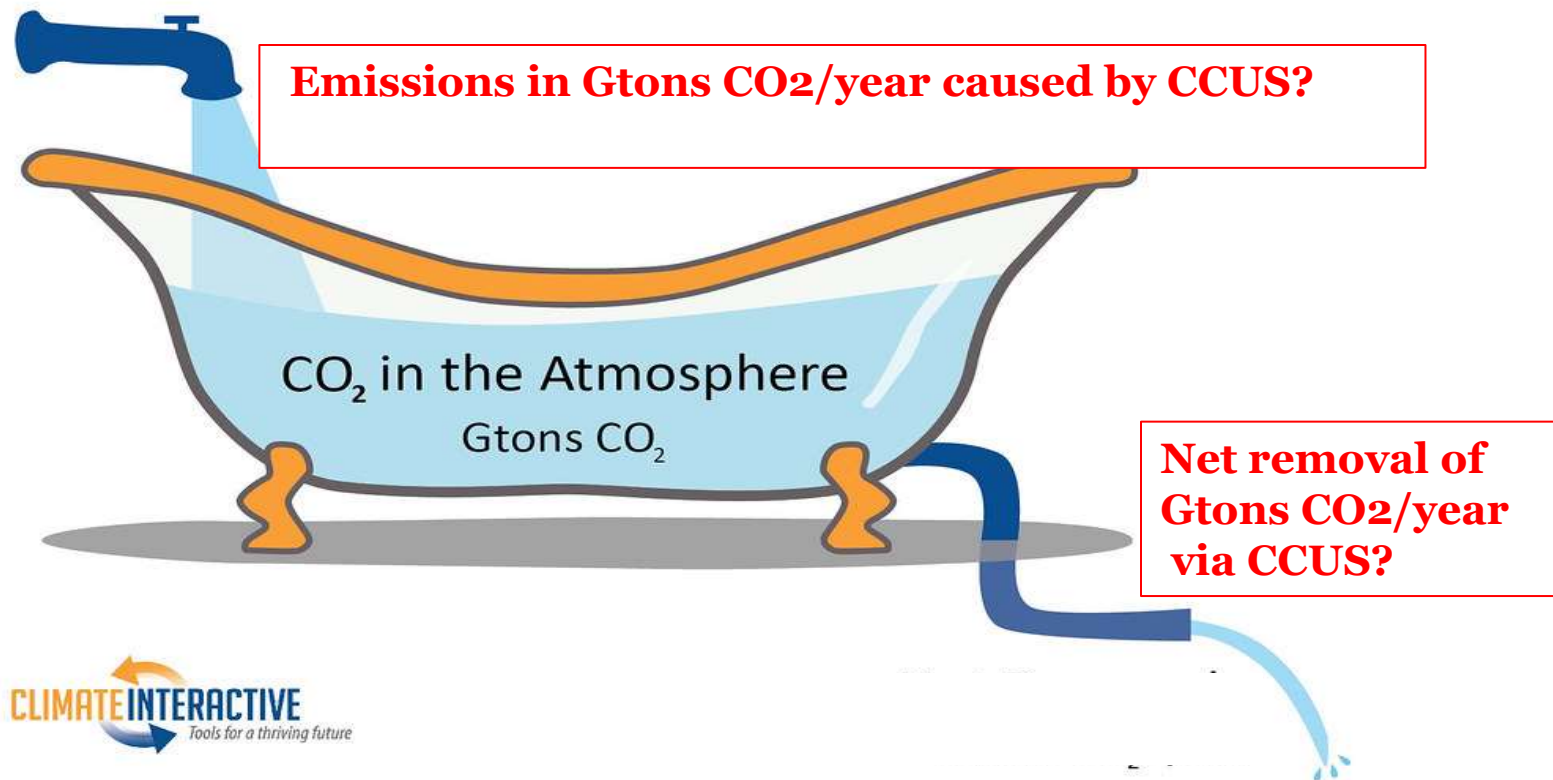
**Consider Scale and Price**

# Consider Priorities and Distractions

## Consider Scale and Price

How many gigatons of CO<sub>2</sub>e are going into the atmosphere?  
How much CO<sub>2</sub>e can be removed via CCUS, and at what \$ cost?

What would be the net effect of CCUS on  
additions or decreases of CO<sub>2</sub>e in the atmosphere?



# Carbon - where is it? *As you know...*

- It is in the **ground** – keep it there.  
That should be the over-riding goal.
- It is in the **stacks** –  
Electric power plants, petrochemical plants,  
ethanol plants, cement plants, steel plants, etc.
- It is attached to the **land**  
Agriculture, livestock, deforestation, etc.
- But worst of all – it is in the **atmosphere**  
(The atmosphere is used as an open sewer to pollute with impunity).

# Carbon is in the stacks

**ClimateTrace** pinpoints the exact location and tons of CO<sub>2</sub>e from 79,815 point sources around the world.

<https://climatetrace.org/>



# Compare CO<sub>2</sub> concentrations in the **stacks** to what is in the **air**.

## **Composition of CO<sub>2</sub> in flue stacks:**

- Ethanol  
(Very high concentration- some sold to food and beverage industries)
- Coal-fired plant 12-15%  
(High concentration. Tried to pull it out - but no dice)
- Gas-fired conventional gas boiler 7 - 10%  
(Less concentration, but give it a try. Nope - that didn't work either)
- Gas combined cycle plant 3 - 4%  
(Even less concentration. That doesn't work either. Maybe spend more money?)

**Composition of CO<sub>2</sub> in the air:** 0.042% (Wait. What?)

# Where else is the carbon?

Exactly where it should not be - **in the atmosphere.**

420ppm of CO<sub>2</sub> equals an atmospheric concentration of **.042%.**

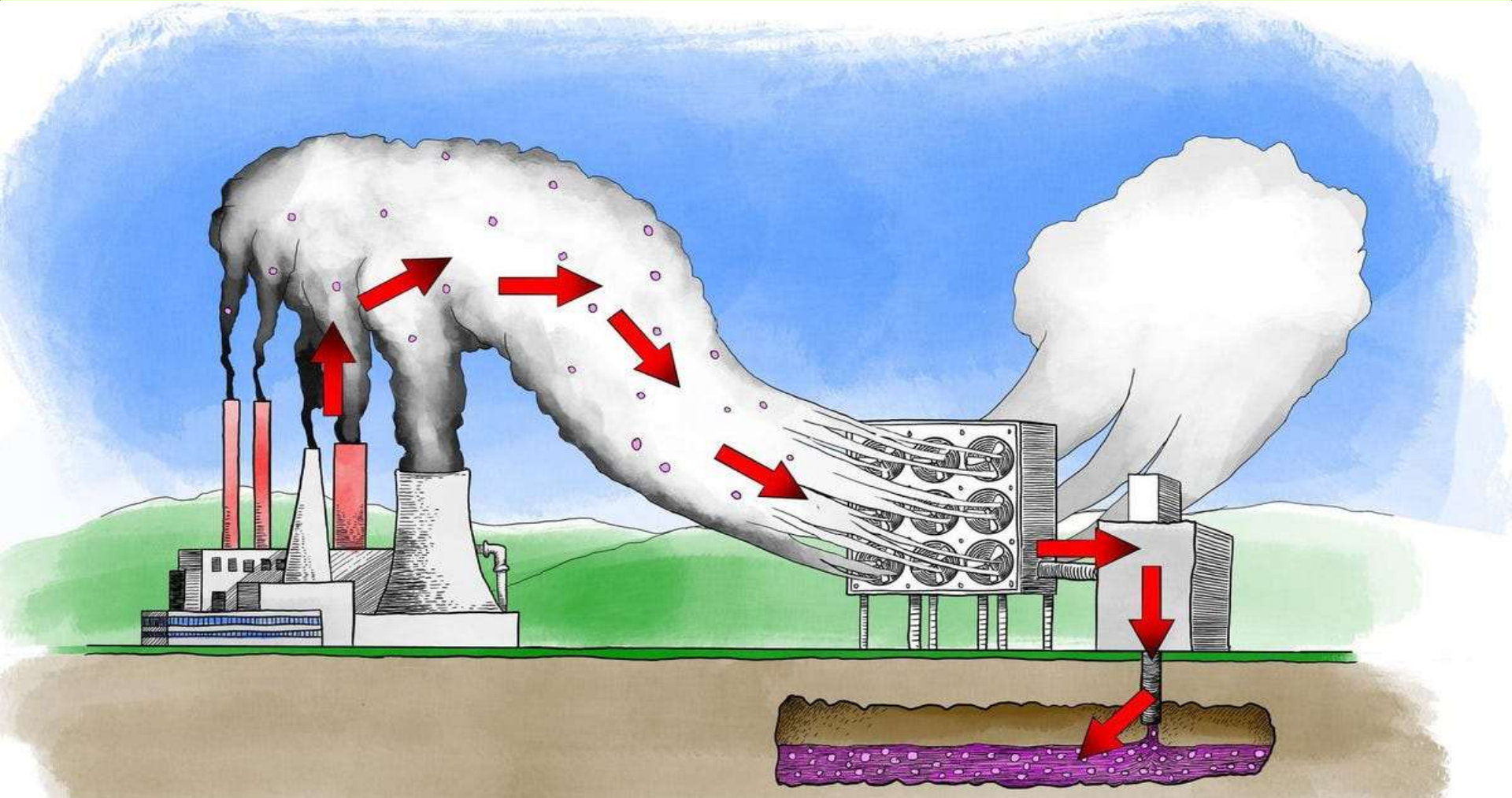
Not exactly the ideal target for capturing carbon.  
And how much time do we have to figure this out?  
And if money that is planned to be spent on this –  
where else could it go?



**We've heard of this.**

“Let's do **something** about the legacy carbon that, after all, you and I, and the rest of the world, put up there.”

How about Direct Air Capture?



- CCUS
- Parasitic power
- Opportunity costs
- Moral hazard

All described in detail by  
Stanford Engineering  
Professor  
Mark Jacobson.

**MARK Z. JACOBSON**

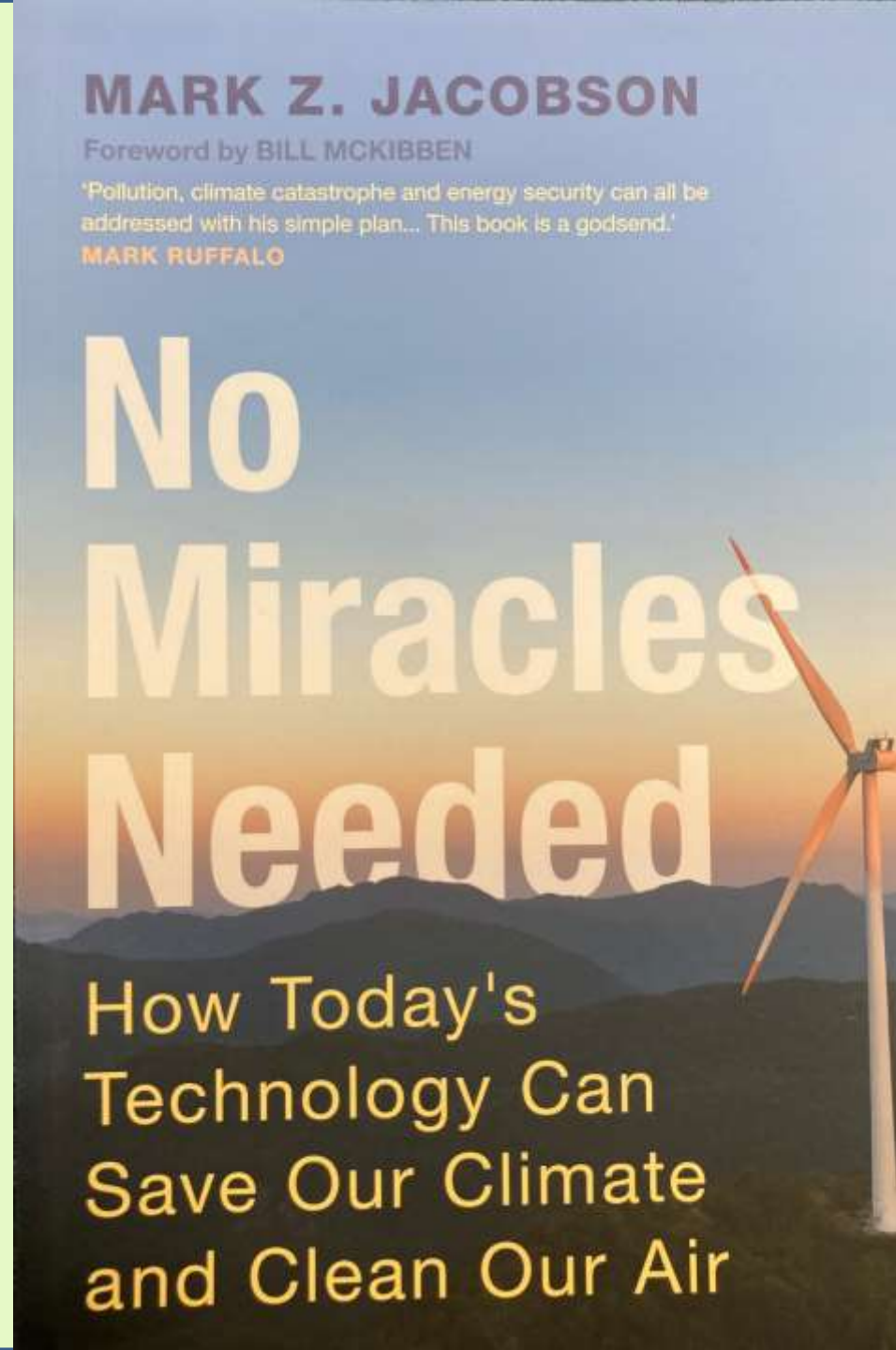
Foreword by BILL MCKIBBEN

'Pollution, climate catastrophe and energy security can all be addressed with his simple plan... This book is a godsend.'

MARK RUFFALO

# No Miracles Needed

How Today's  
Technology Can  
Save Our Climate  
and Clean Our Air



For really up to date information, these are my “go-to” people.  
They give readers the straight facts about CCUS.

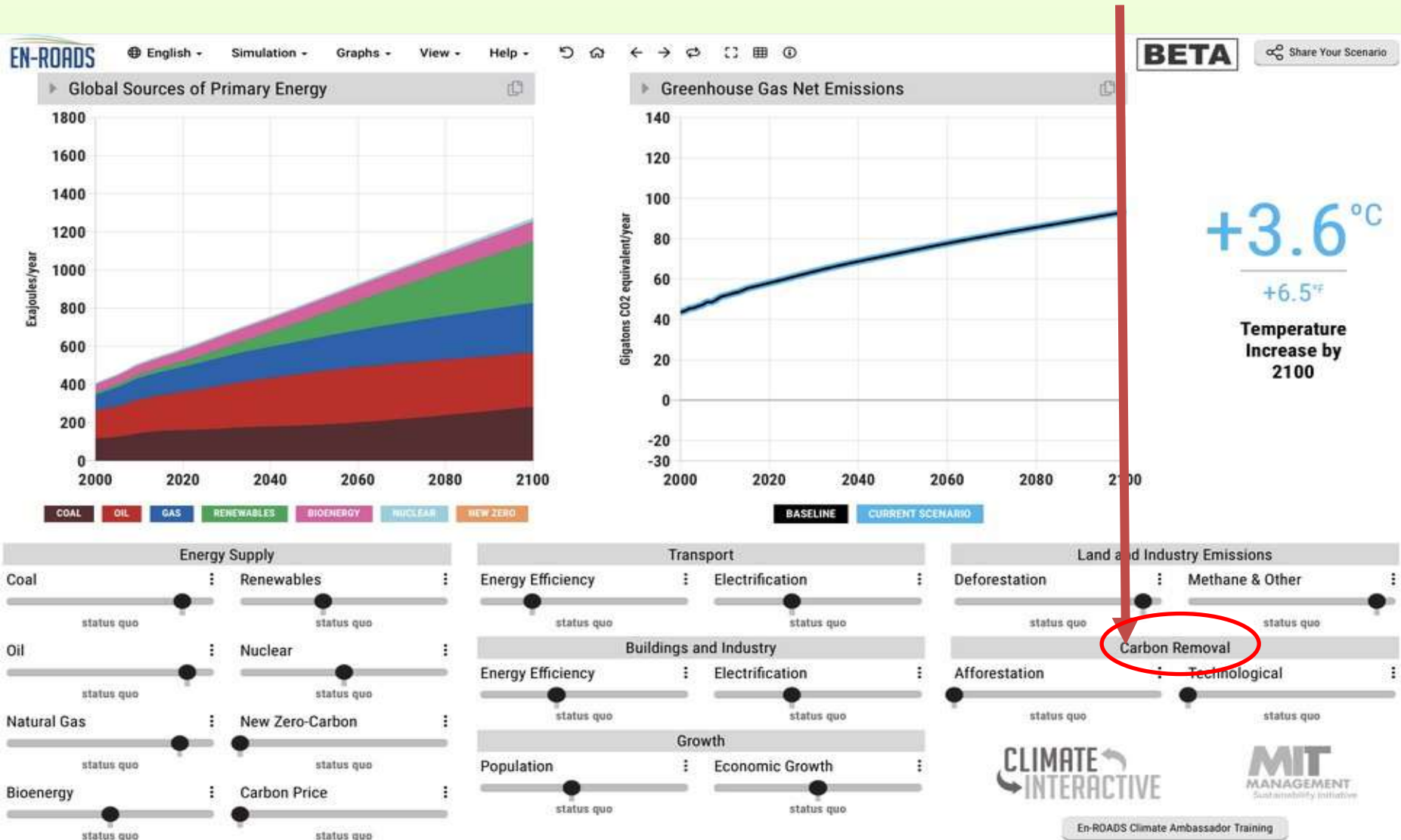


**Institute for Energy Economics  
and Financial Analysis**

“Globally, the collective capacity of all operational CCUS plants is estimated to be 38.5 million metric tons.

These facilities are addressing less than one-thousandth of global emissions annually, which now exceeds 50 billion tons.”

Test your favorite methods to tackle the climate crisis on EN-ROADS. For example, see what “Carbon Removal” does to move the needle.



## What is the price range for carbon capture in \$/ton?

It varies, but with few exceptions, the \$/ton needed to capture carbon is very high.

The approaches vary, but the cost typically ranges from between \$100 to \$1,000/ton.

For example, the DOE's DAC "CarbonShot" program aims to drop today's price of north of \$1,000 to \$100/ton by 2032.



## What is the price range for carbon capture in \$/ton?

The high price is due to inherent thermodynamic inefficiencies, primarily caused by **parasitic power costs**.

Except for its use in enhanced oil recovery and carbonated drinks, and a few other uses, CO<sub>2</sub> is a waste product, with little market value.

But it is a profit center for the oil companies and others, especially if 'business-friendly' politicians make it so, which is exactly what they have done.



# How expensive is CCUS?



- In 2021, the Wyoming legislature, in an attempt to ‘save coal,’ passed a law that the state’s utilities need to install CCS at existing coal-fired plants.
- Wyoming utilities recently presented a reality check regarding the consequences of that action in their filing of data at the Wyoming Public Service Commission.



# How expensive is CCS?



- “According to Black Hills’ ongoing analysis, adding carbon capture to the Wygen II and Neil Simpson II coal plants, would increase rates for its customers in Wyoming by about 15%, or a range of **\$22.75 to \$25.34 per month for the average residential customer** and \$40.71 to \$103.97 per month for commercial customers.”

Source: WYOfile
- “It would also **reduce electrical generation output at the plants by more than 30%**, exposing ratepayers to additional costs for replacement power.”

That’s one way to stimulate the sagging Wyoming coal market.  
Force coal-fired generating stations to burn more coal.

Source: WYOfile

# Here's the simple arithmetic

1ppm of atmospheric CO<sub>2</sub> weighs ~8 billion tons

Use a deliberately selected low-ball, highly aspirational assumed average carbon capture cost of \$100/ton.....

Multiply \$100/ton times 8 billion tons.

It would cost **\$800 billion to reduce the CO<sub>2</sub> level by 1ppm.**

Year in, and year out.

**\$800 billion** to reduce  
**1ppm of CO<sub>2</sub> in the atmosphere**

420ppm

-1ppm

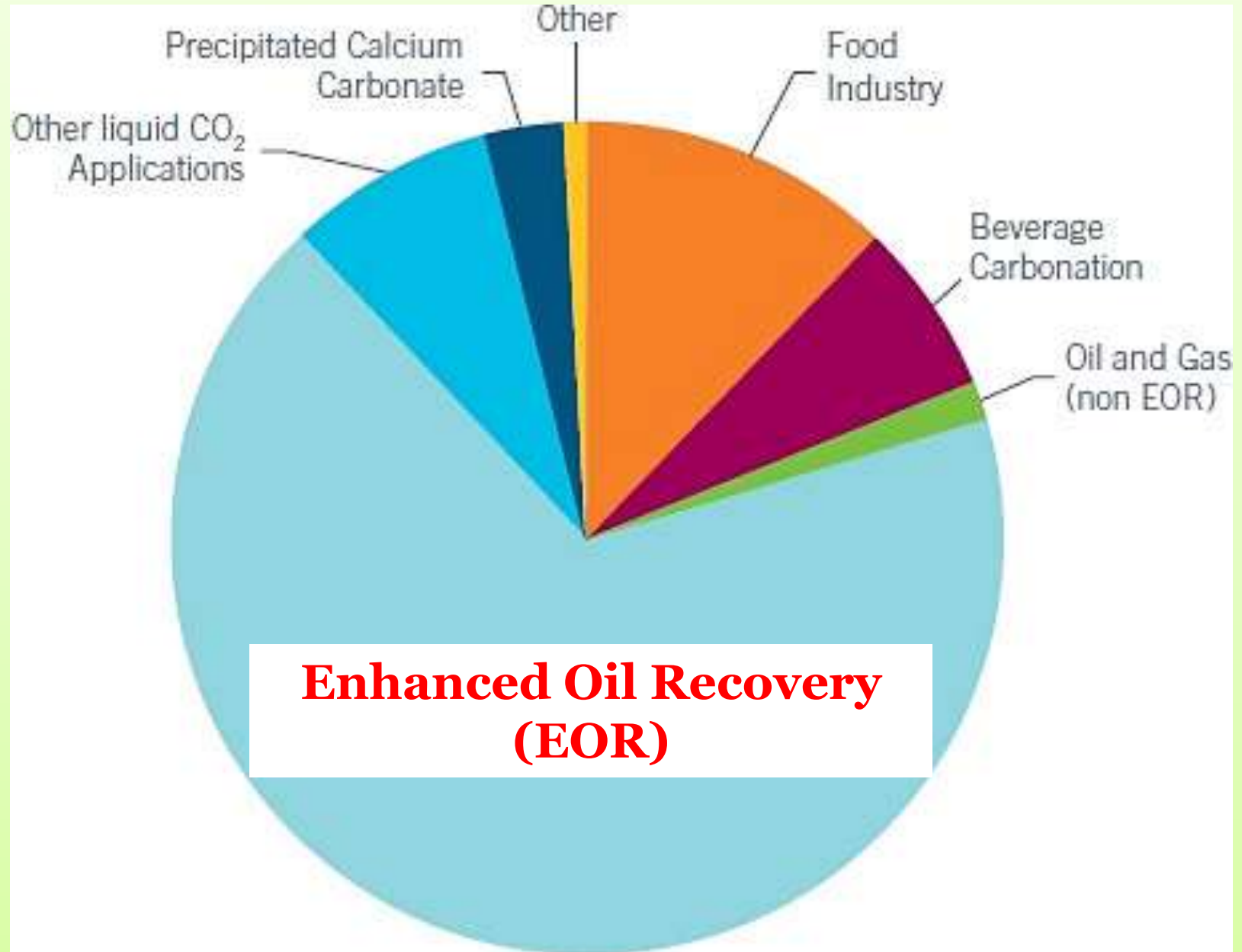
419ppm

*And this math ignores the 2.5ppm annual growth of CO<sub>2</sub>.*

Consider priorities and distractions.

Consider price and scale.

After capture, **pipe** the CO<sub>2</sub> to the markets



After capturing the carbon,  
the CO<sub>2</sub> is **pressurized** and **pip**ed  
to the oil fields to recover more oil, *to  
burn and send even more CO<sub>2</sub> to the  
atmosphere.*

Or the CO<sub>2</sub> can be **pip**ed to saline  
basins for supposedly long-term  
geologic sequestration.



U.S. Department  
of Transportation  
**Pipeline and  
Hazardous Materials  
Safety Administration**

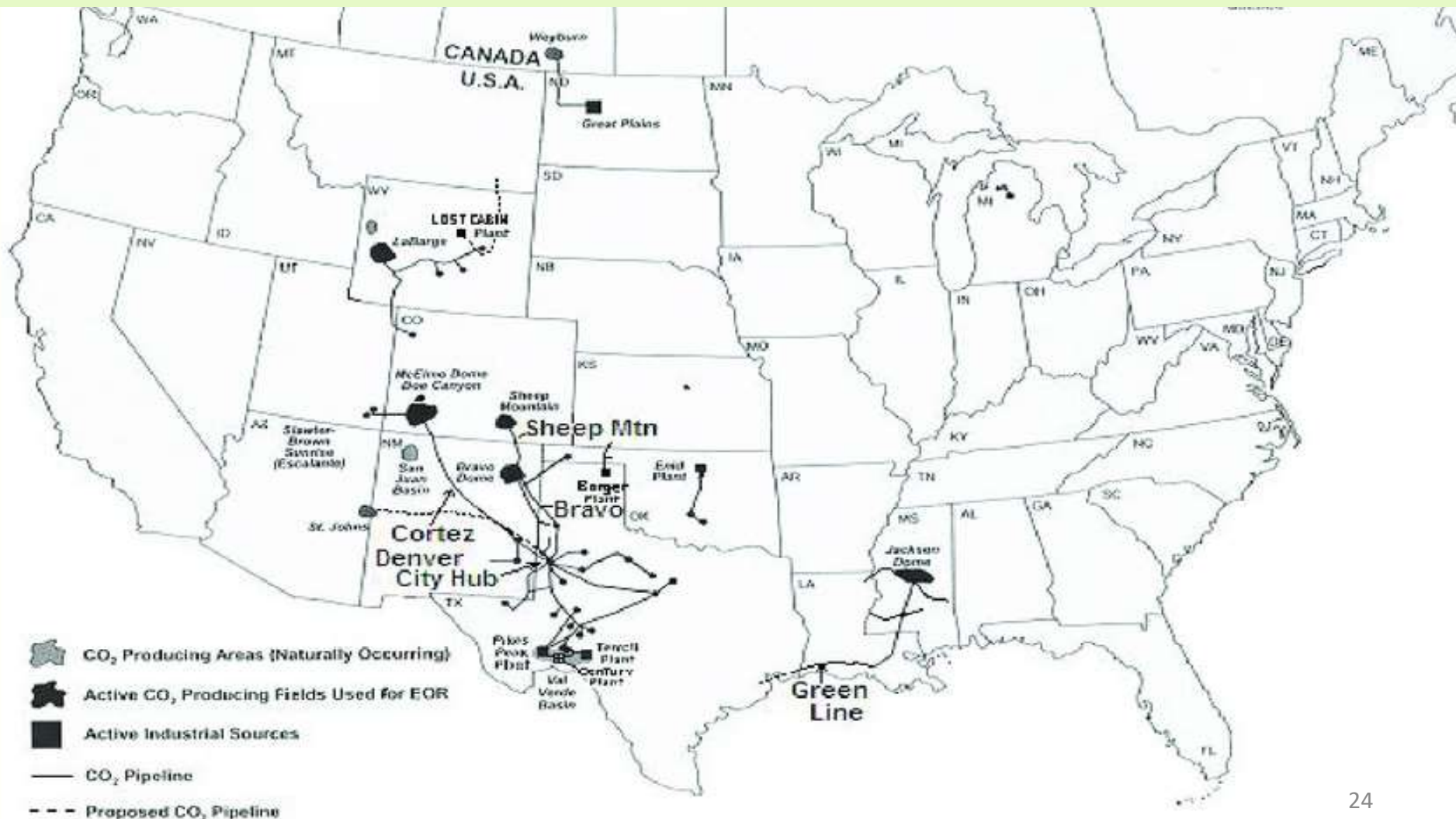
## CO<sub>2</sub> pipelines are regulated by

- The PHMSA's regulations have large gaps on CO<sub>2</sub> pipelines, including having no regulations if the CO<sub>2</sub> is transported as a liquid or a gas, only as a supercritical fluid.
- Water, notoriously difficult to eliminate from CO<sub>2</sub> pipelines, allows the formation of carbonic acid in the pipeline which has a ferocious appetite for carbon steel.
- The current CO<sub>2</sub> pipeline regulations do not sufficiently address any of these risks.

# Co<sub>2</sub> Pipeline Safety

- CO<sub>2</sub> is an asphyxiant that is heavier than air, and it can travel large distances at lethal concentrations from the pipeline after a rupture.
- CO<sub>2</sub> pipelines are susceptible to ductile fractures, which can, like a zipper, open up and run down a significant length of the pipe, they can release immense amounts of CO<sub>2</sub>, hurl large sections of pipe, expel pipe shrapnel, and generate enormous craters.

The US has about 5,000 miles of CO<sub>2</sub> pipelines in operation.  
Approximately 90% of these pipelines move CO<sub>2</sub> from geologic formations to the oil patch for **EOR**.  
Approximate historical cost to pay for the CO<sub>2</sub> = \$35/ton.



There are **192 ethanol plants in the US**.  
They have a high concentration of CO<sub>2</sub> in their  
emission stream.

**Ethanol is a much easier target for carbon capture**  
than coal, gas, and – of course – thin air.

This is why the ethanol is the first industry out of  
the chute to make a major push for CCUS –  
especially now that Congress offered so much more  
cash from the Treasury in the 45Q subsidy  
(*discussed in a minute*).

# Heartland Greenway CO<sub>2</sub> Pipeline

Navigator CO<sub>2</sub> Ventures is proposing a pipeline that would capture 15 million metric tons of liquefied carbon dioxide annually from Midwest ethanol and fertilizer plants, transport it in liquidized form across five states and store it underground in Illinois.



## The struggle in the Midwest over states' exercising eminent domain for CO<sub>2</sub> pipelines

“The Colorado Constitution authorizes eminent domain, defined as the taking of private property for public use, provided that just compensation is paid to the property owner.

If carbon sequestration is deemed to be in the public interest (typically through a legislative declaration), the state could exercise eminent domain for pore space for storage areas.

It is currently unclear whether current gas pipeline statutes authorize pipeline companies to exercise eminent domain for pipelines carrying CO<sub>2</sub>.”

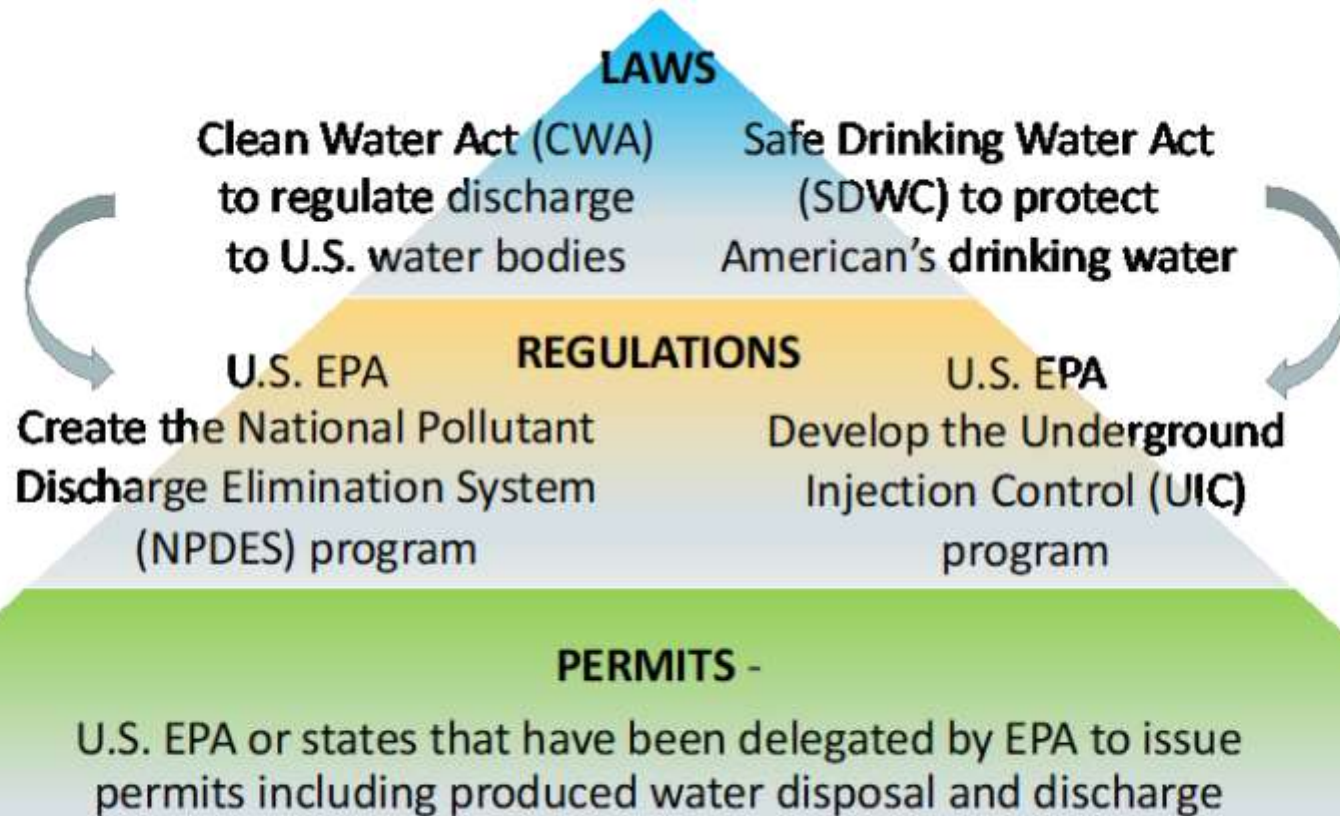
## March 14, 2023

### Des Moines Register poll

The poll shows that **a strong majority of Iowans oppose eminent domain for the pipelines**, regardless of their political party, gender, age, religion, income or where they live.

- 72% of Republicans oppose using eminent domain for pipeline construction
- 82% of Democrats and 79% of independents
- 76% of men and 80% of women
- 78% of respondents younger than 45 along with those 45 and older; and
- 80% of rural residents and 76% of urban residents.

# Injection Laws, Regulations, Permits



# EPA Classification of Injection Wells

- Class I - Industrial and Municipal Waste Disposal Wells
- Class II - Oil and Gas Related Injection Wells –  
*This includes enhanced oil recovery*
- Class III - Injection Wells for Solution Mining
- Class IV - Shallow Hazardous and Radioactive Injection Wells
- Class V - Wells for Injection of Non-Hazardous Fluid into or Above Underground Sources of Drinking Water
- **Class VI Wells - Used for Geologic Sequestration of CO<sub>2</sub> -**  
*These wells are not used for enhanced oil recovery.*

# EPA requirements for Class VI wells

1. Comprehensive monitoring requirements that address all aspects of well integrity, CO<sub>2</sub> injection and storage, and ground water quality during the injection operation and the post-injection site care period.
2. Financial responsibility requirements assuring the availability of funds for the life of a GS project (including post-injection site care and emergency response).
3. Reporting and recordkeeping requirements that provide project-specific information to continually evaluate Class VI operations and confirm USDW protection.

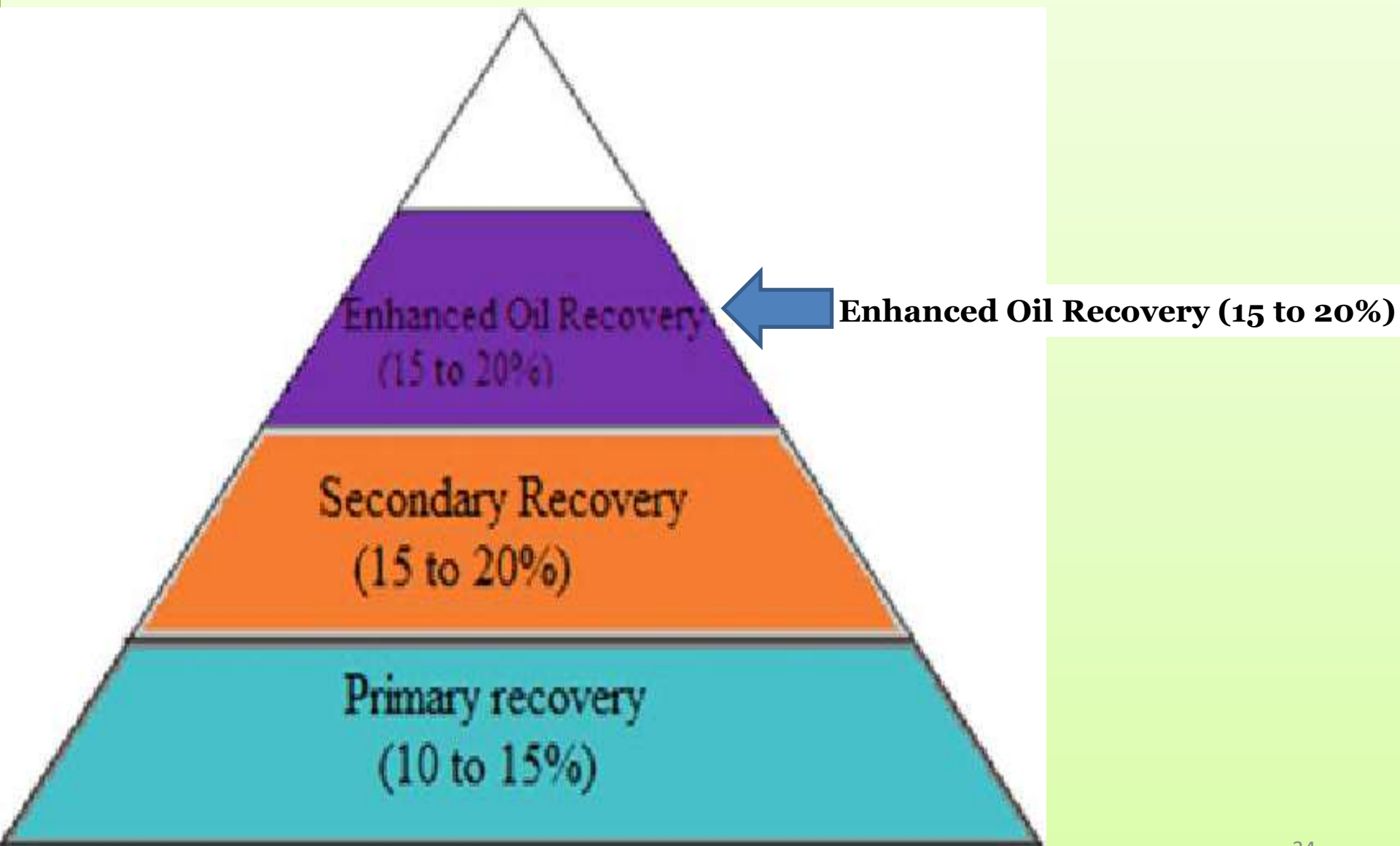
# EPA requirements for Class VI wells

4. Extensive site characterization requirements.
5. Injection well construction requirements for materials that are compatible with and can withstand contact with CO<sub>2</sub> over the life of a geologic sequestration project.
6. Injection well operation requirements.

There are over 750,000  
Class I through V wells in the US.

There are **only 2 Class VI wells** for the injection of CO<sub>2</sub> into geologic formations for long-term storage or geologic sequestration.

# Use CO<sub>2</sub> for enhanced oil recovery to get the oil out that was left behind



## EOR

“In the US, primary recovery, then water flooding have recovered about one-third of the 624 billion barrel oil endowment. That has left behind 414 billion barrels of oil.

Much of this “left behind oil,” equal to 284 billion barrels, is technically favorable for CO<sub>2</sub>-EOR and is widely distributed across the U.S.”

Source: Enhanced Oil Recovery Institute

Multiply 284 billion barrels times \$100/barrel.  
CO<sub>2</sub> used for EOR could yield **\$28.4 trillion** in additional revenue for the oil industry.

The trick is to get the taxpayers to pay for as much of the cost of CO<sub>2</sub> as possible.

# To concentrate on EOR

EOR is the “holy grail” for the oil industry- to extend their production, and income, by decades.

They can continue to pay for CO<sub>2</sub> from geologic formations, or they can get paid to use captured carbon.

**EOR is a key to understand the CCUS dynamic at play.**

# To concentrate on EOR

If the oil industry wants to get paid to use mechanically captured carbon for EOR, that will entail the need for special CO<sub>2</sub> pipelines, but not Class VI wells.

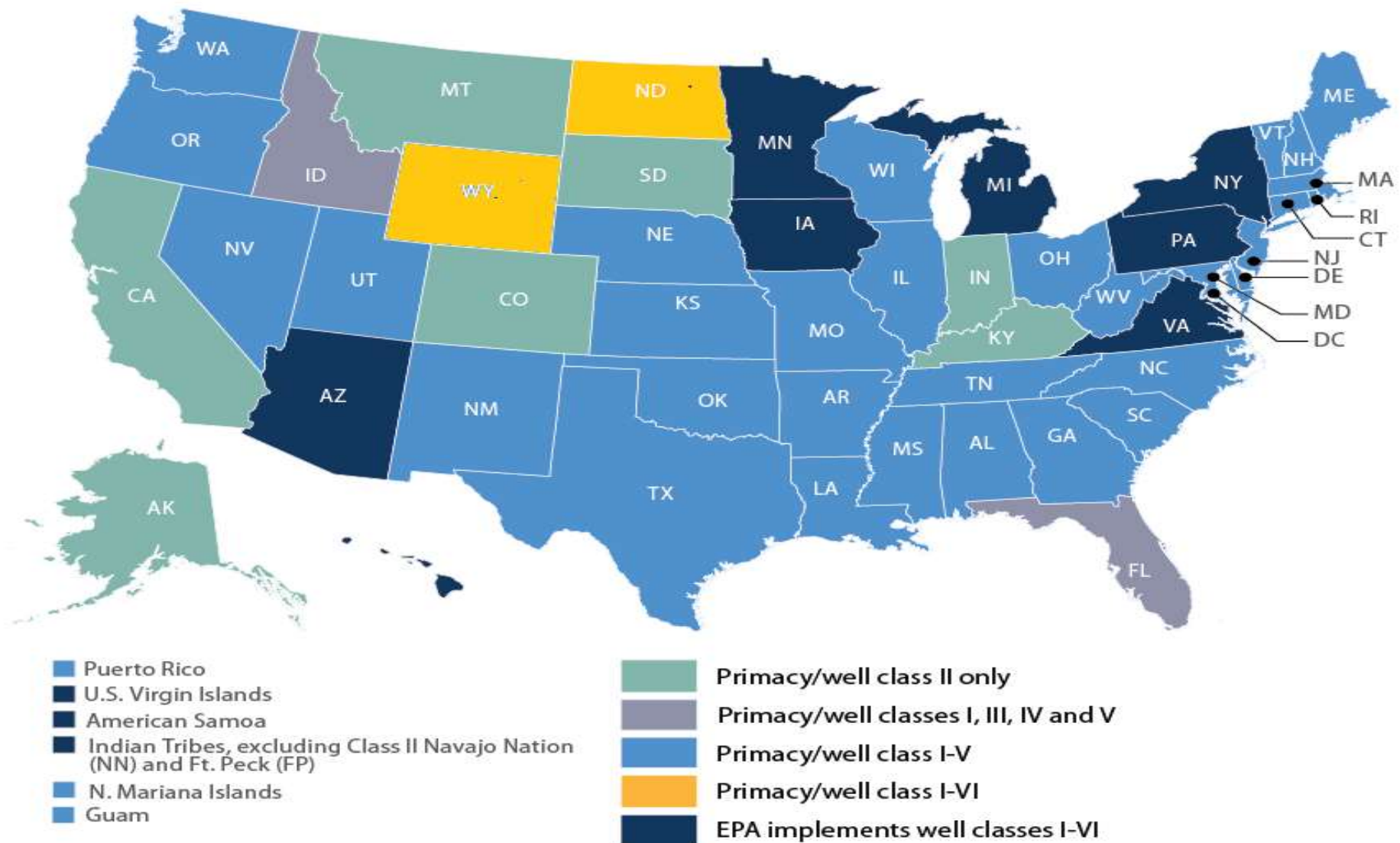
If they want to get in to a second business-geologic sequestration injection, they must obtain permits for Class VI wells from the EPA as a condition of tapping in to 45Q federal money.

# To concentrate on EOR

Industry far prefers to obtain Class VI permits from states, presuming that local promotional politics will get wells permitted **faster** than waiting 'forever' to get Class VI permits from the EPA.

But first, states must apply for, and be granted, primacy by the EPA. It typically takes 2 years of preparation before the EPA will approve an application. There is a push for state primacy in Colorado. Where is the push coming from?

# Injection Well Primacy Map



## Class VI wells

For CO<sub>2</sub> sequestration

45Q payment:

Point source -\$85/ton

DAC - \$180/ton

CO<sub>2</sub> goes down.

Not expected to  
come back up.

## Class II wells

For Oil Production  
and Enhanced  
Oil Recovery

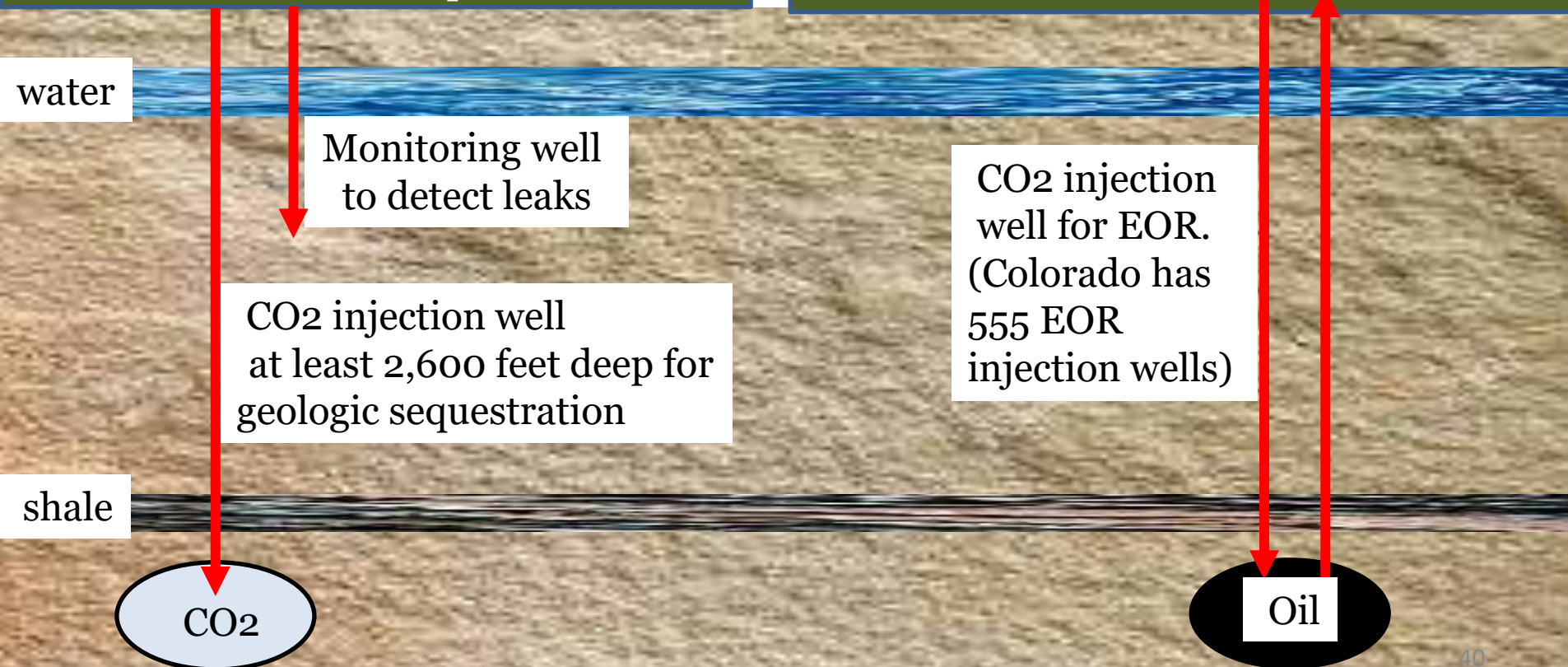
45Q payment:

Point source - \$60/ton

DAC - \$130/ton

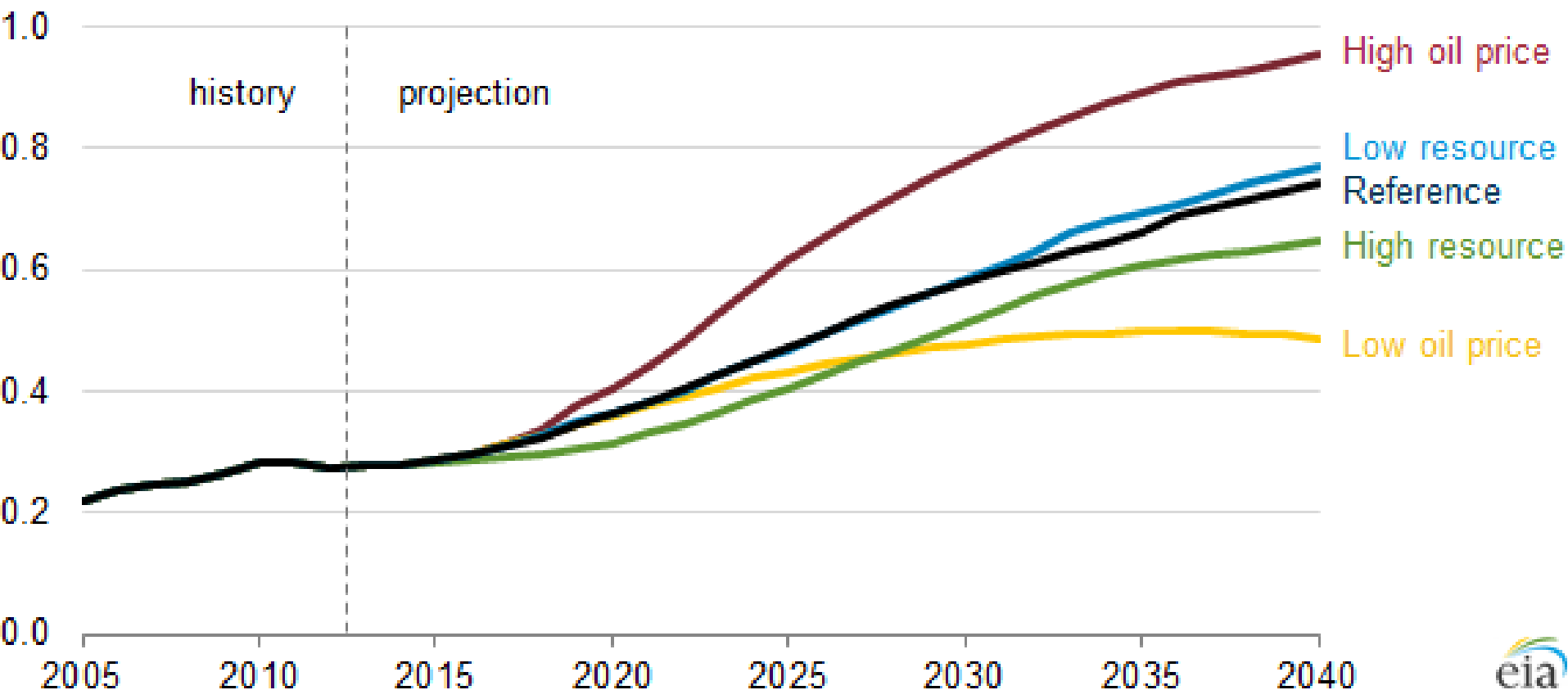
CO<sub>2</sub> goes down.

CO<sub>2</sub> comes right back up.

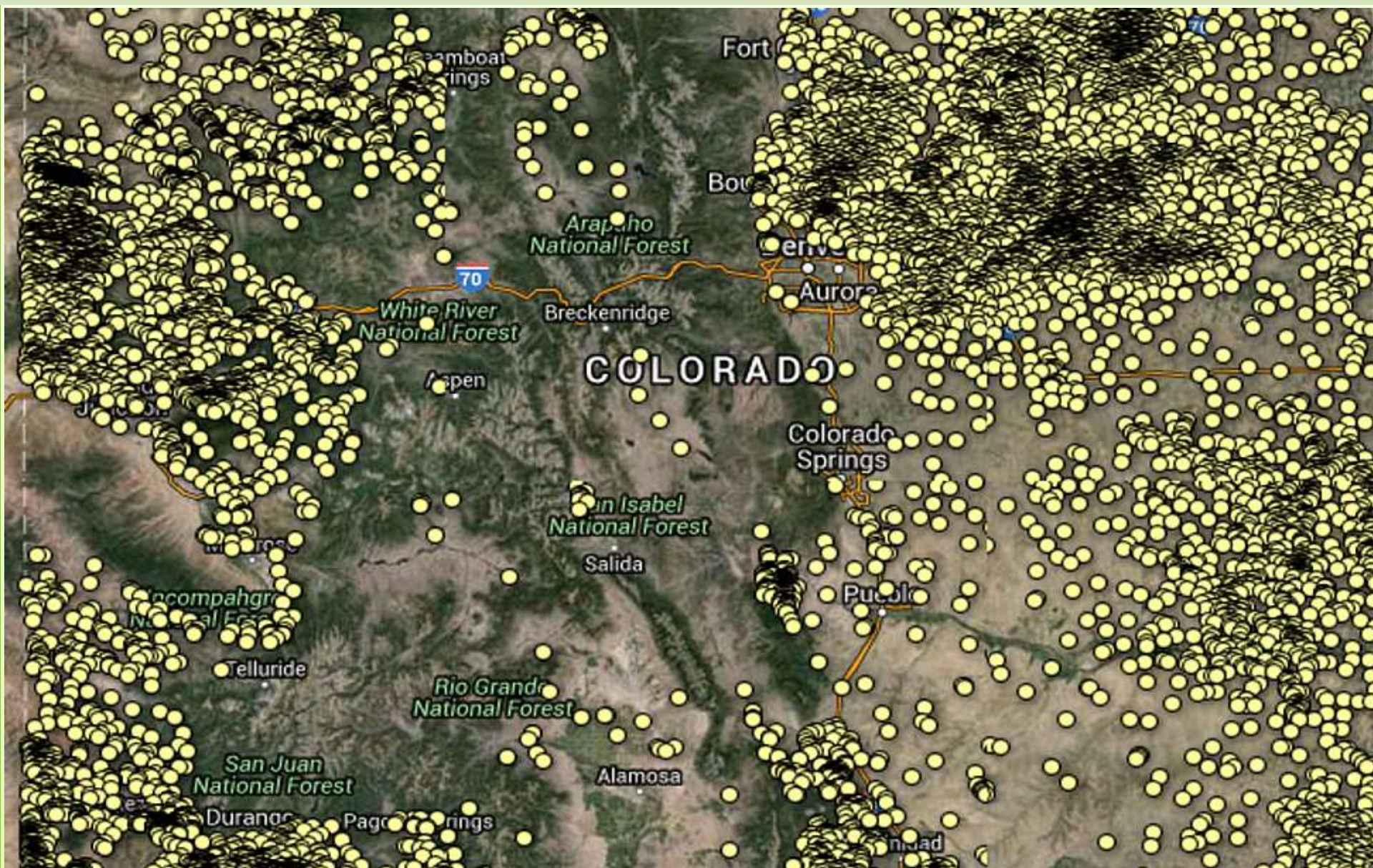


# The more CO<sub>2</sub> injected, the more oil will be produced. It's that simple.

Crude oil produced from carbon dioxide injection in AEO2014, by case (2005-40)  
million barrels per day



Colorado has enough on its plate before starting to promote CCUS.  
Here are the state's abandoned oil and gas wells.



Source: Colorado Oil and Gas Conservation Commission

# Oil lobbying and horse-trading politics ended in a massive CCUS subsidy



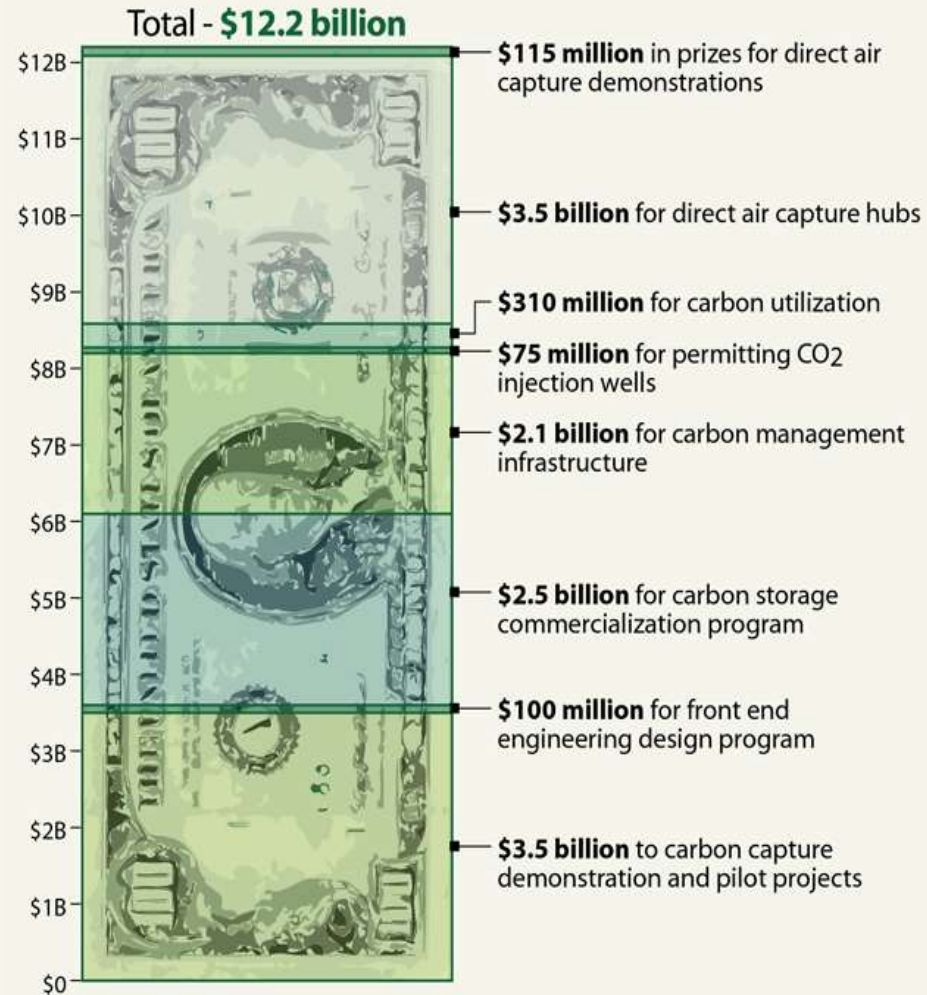
**The 2021 Bipartisan Infrastructure Law** allocated \$12.2B for CCUS.

That includes

- \$3.5B for 4 regional DAC hubs
- \$3.5B for transport and storage of carbon
- money to build a massive pipeline network to carry captured CO<sub>2</sub>
- \$75M to help EPA with permitting Class VI injection wells.

## Big Money for Carbon Capture and Removal

The Infrastructure Investment and Jobs Act of 2021 appropriated more than \$12 billion to carbon capture and removal, representing the single largest investment ever in the technologies.



NOTE: Figures are rounded.

# Carbon capture tax credit Inflation Reduction Act (\$/tonne)

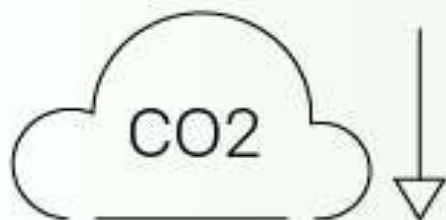
Before IRA

Inflation Reduction Act

POINT SOURCE

DIRECT AIR CAPTURE

## UNDERGROUND STORAGE



\$50

\$85 | \$180

## UTILIZATION



\$30

\$60 | \$130

## UTILIZATION IN ENHANCED OIL RECOVERY



\$30

\$60 | \$130

As of July 28, 2022.

Sources: Clean Air Task Force; S&P Global Commodity Insights

# **The 45Q tax subsidy has been used for EOR for many years**

The Treasury Inspector General for Tax Administration found that from 2009-2019, the oil and gas industry improperly claimed almost \$900 million in 45Q credits, accounting for 87% of the total 45Q credits claimed.



A 2021 GAO report says that the DOE spent over \$1 billion since 2009 to build 11 CCUS projects. Only 3 were built, and they don't work.

The report was ignored by Congress when they made CCUS a big part of the IRA.

<https://www.gao.gov/assets/720/718229.pdf>



Uh. Oh.

The GAO reported the 45Q scam.  
Congress' response? Ignore and double down.





TAXPAYERS *for*  
COMMON SENSE

- “The U.S. Treasury Department in 2021 put the price tag for 45Q at \$20.1 billion from FY2021-FY2031. But that changed last year when the Treasury Department's 45Q 10-year cost estimate jumped to **\$30.6B**.
- What we have found is that American taxpayers are being forced to foot the bill for a flawed climate solution in the form of a tax credit that is subsidizing the very industries responsible for climate change.”

# Two CCUS-related bills are pending in the Colorado legislature.

**SB23-016** - Concerning Measures to Promote Reductions in Greenhouse Gas Emissions in Colorado

**HB23-1210** - Concerning carbon management, and, in connection therewith, ensuring that carbon management projects are eligible for grants under the industrial and manufacturing operations clean air grant program and providing for the creation of a carbon management roadmap.

We can discuss these bills during the question and answer period.

# Conclusions

Citizens of Colorado, particularly those who have been working so hard to address the climate crisis, should now grasp the extent of the CCUS hype – from capture, to pipelines, to wells, to the Treasury Department.

Now is the time to present the facts to the Colorado energy and environment public policy sphere.

It is unlikely that they have been provided sufficient early knowledge about the realities of CCUS.

By and large, Colorado has intelligent public servants.

Help decision-makers see through the CCUS folly **early on** to avoid wasting financial, regulatory, and promotional efforts that might otherwise fly under the radar.

Thank you

Questions and answers

The slide deck is available at  
[moreywolfson@aol.com](mailto:moreywolfson@aol.com)