Vox

Could squeezing more oil out of the ground help fight climate change?

The pros and cons of enhanced oil recovery, or EOR.

By David Roberts on October 2, 2019 10:00 am

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To secure a stable climate for future generations, humanity will need to permanently bury gigatons of carbon dioxide (CO2). There is already too much in the atmosphere — 415 parts per million, when scientists say 350 ppm is the upper bound of safety — and we emit **more and more each**

year.

Building a carbon capture and storage (CCS) industry of sufficient size would mean starting immediately, but at least for now, there is little financial incentive to do so. Companies can't make money burying carbon, so they mostly don't.

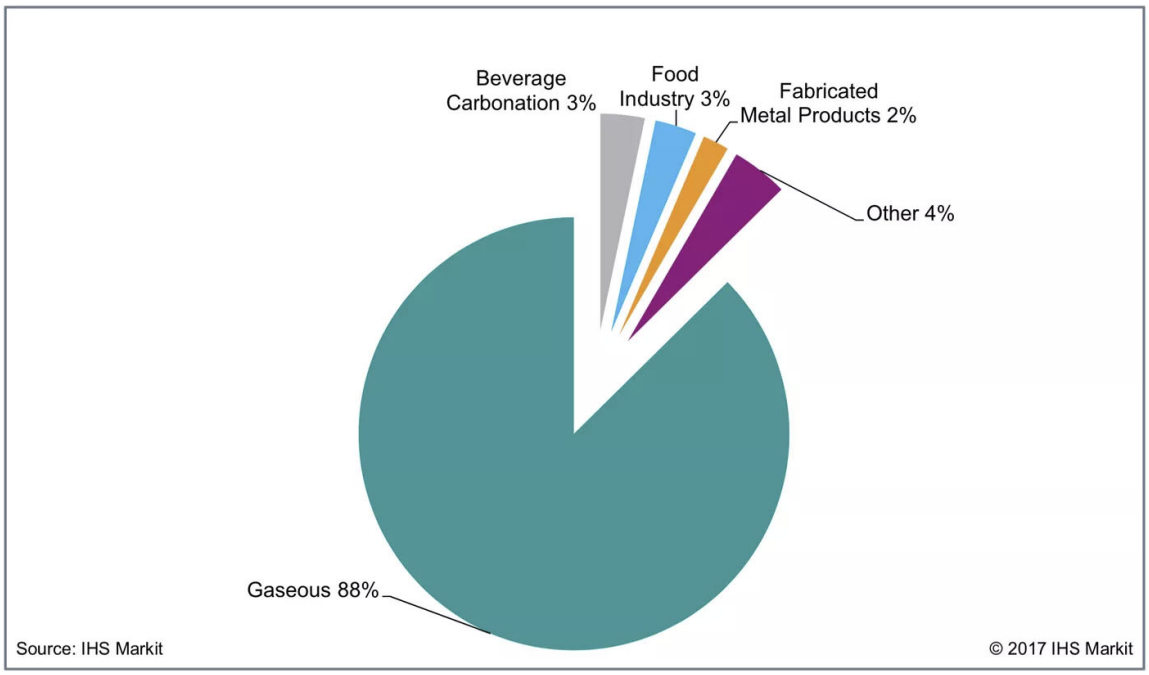
One way to scale up the carbon-capture side of the industry would be to boost demand for captured CO2, which can be used as an input or feedstock in various other industrial processes. Capturing CO2 (either from industrial waste streams or from the ambient air) and using it in industry is known as carbon capture and utilization (CCU).

The idea is that CCU can be used as an "on-ramp" for eventual CCS, pushing down the costs of carbon capture and laying down some of the foundational infrastructure, like pipelines, needed for eventual CCS at scale.

This is the second in what will be a four-part series of posts on CCU. The **first** is a brief introduction to the need for CCS and the various types of CCU that might help get it going. It will give you a lay of the land. In the third post, I will cover some of the more intriguing and promising uses of CO2, such as in concrete, fuels, and plastics.

In this post, however, I want to focus on what is currently the largest industrial use of CO2: enhanced oil recovery (EOR), whereby pressurized CO2 is injected into existing oil and gas reservoirs to squeeze more hydrocarbons out. Today, EOR is the only industrial use of CO2 that has reached appreciable scale.

As this graphic from market research firm **IHS Markit** shows, 88 percent of global CO2 use is "gaseous," meaning direct use of CO2 to boost fossil fuel recovery (in the US, it's about 75 percent):



IHS Markit

And EOR holds another distinction: It is also the only current carbon sequestration industry of any scale. It uses a lot of CO2 and leaves a lot of it permanently buried. If there's any on-ramp for CCS around, this is it.

EOR is an easy call for the oil and gas industry. More oil, more revenue; it's all upside. But for those of us interested in slowing and reversing the growth of global carbon emissions as quickly as possible, it is much more complicated. Vexing, even.

There is a strong argument for EOR as a way to reduce the carbon intensity of oil and sequester substantial amounts of carbon. But there is also a

compelling case against it, namely that there should be less oil and gas production, not more.

Almost everyone I've spoken to about EOR feels at least a little conflicted about it. Is subsidizing oil production really the only way to get large-scale carbon sequestration started? Are we really going to let oil and gas companies influence the scale and speed of climate policy?

Let's try to suss this out. First, we'll review the case for, then the case against.

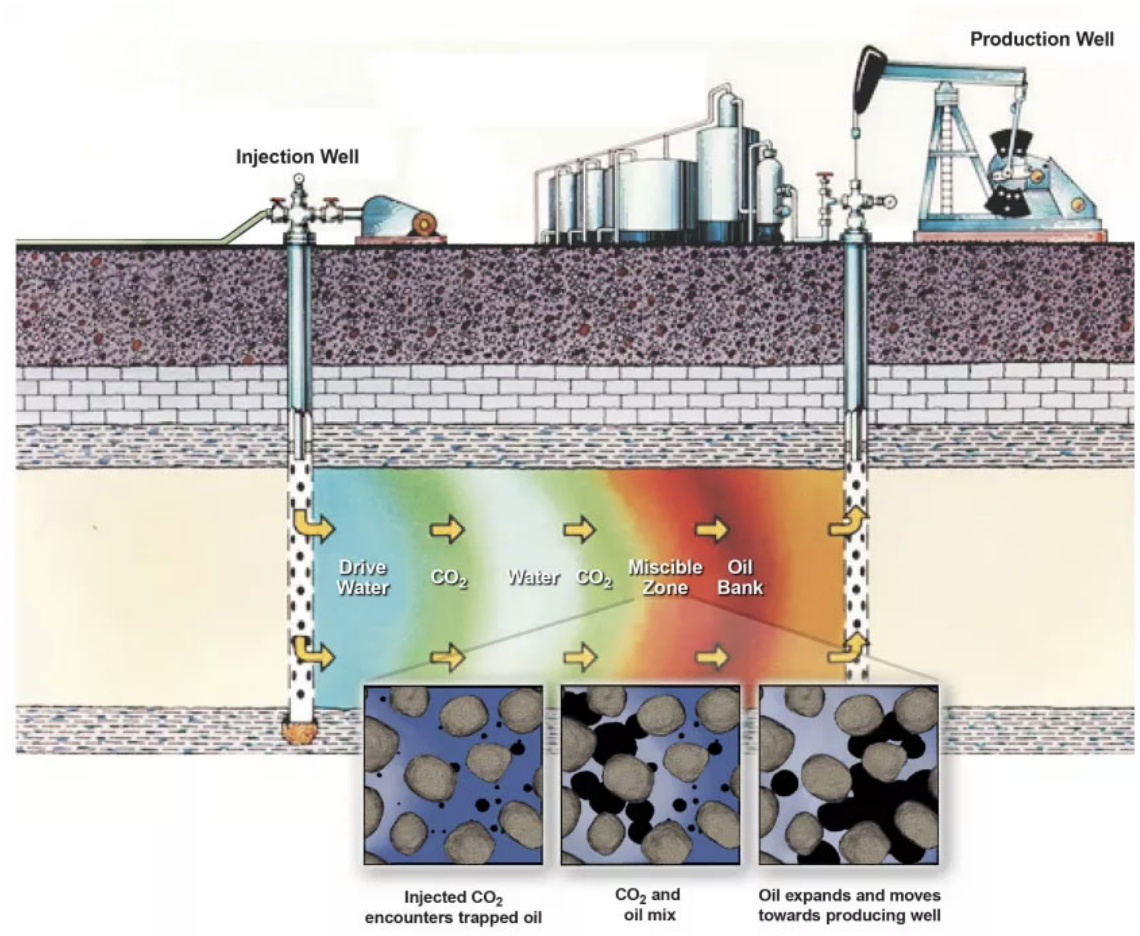
The climate case for EOR

New industry groups like the **Energy Advance Center** (BP, Chevron, Southern Company) and coalitions like the **Carbon Capture Coalition** (trade groups, oil and gas companies, and a few nonprofits) are springing up, making the argument that digging more oil and gas out of the ground

can help fight climate change. It might seem counterintuitive, but in theory, at least, it is possible.

Let's review the basics of EOR. When oil companies dig wells, there are three phases of production. During primary production, the natural pressure built up within underground reservoirs pushes oil to the surface; about **10 percent of the oil** in the reservoir is recovered this way. During secondary production, a fluid, usually water or gas, is pumped through the reservoir to flush loose more oil; that can recover anywhere from 20 to 40 percent of the oil.

Tertiary production is anything done after that, including injecting any fluid not originally found in the reservoir. The most common form of tertiary production is EOR, whereby high-pressure CO2, sometimes alternated with pulses of water, is injected into wells to bond with the oil and carry more of it to the surface. EOR can recover up to 60 percent of the oil in a reservoir.



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(Technically, EOR can involve injecting a **variety of substances**, but for the purposes of this post, I'm going to use it to mean EOR using CO2.)

EOR has been around in the US since the early 1970s. The world's most active EOR region is the Permian Basin, in western Texas and southeastern New Mexico. Of the 450,000 barrels per day produced by EOR in the US, 350,000 come from the Permian. Thousands of miles of pipeline and infrastructure have been built for the purpose.

A note here: EOR is different from hydraulic fracturing, or "fracking," the much-better-known practice of pumping high-pressure fluids underground to release more oil and gas. In a nutshell, fracking forces open new fissures in the rock, while EOR "scrubs" existing channels.

(For the best technical rundown of EOR and its CO2 mitigating potential, see **this new paper in *Frontiers in Climate***, by Vanessa Núñez-López and Emily Moskal of the Jackson School of Geosciences and the University of Texas at Austin respectively, henceforth "the *Frontiers* paper." For a shorter and more accessible treatment, see **this brief** by researcher Deepika Nagabhushan for the Clean Air Task Force.)

Most of the CO2 used in EOR stays underground

When CO2 is injected underground for EOR, most of it, around 90 to 95 percent, stays there, trapped in the geologic formation where the oil was once trapped. If the CO2 comes from the right source and enough is buried, it could amount to substantial carbon sequestration. But those are important caveats.

First, less than 15 percent of the CO2 used in today's US EOR operations (as of 2010) is pulled from "anthropogenic" sources like natural gas processing and hydrocarbon conversions. Over 85 percent comes from "terrestrial" sources, a few big natural CO2 reservoirs under the Earth's surface. It was already sequestered; it has to be dug up. The best EOR can hope to do is re-bury it, a decidedly carbon-intensive practice over the full lifecycle.

(No appreciable amount of EOR CO2 yet comes from direct air capture, though there's a **big DAC demonstration plant running** in the Permian.)

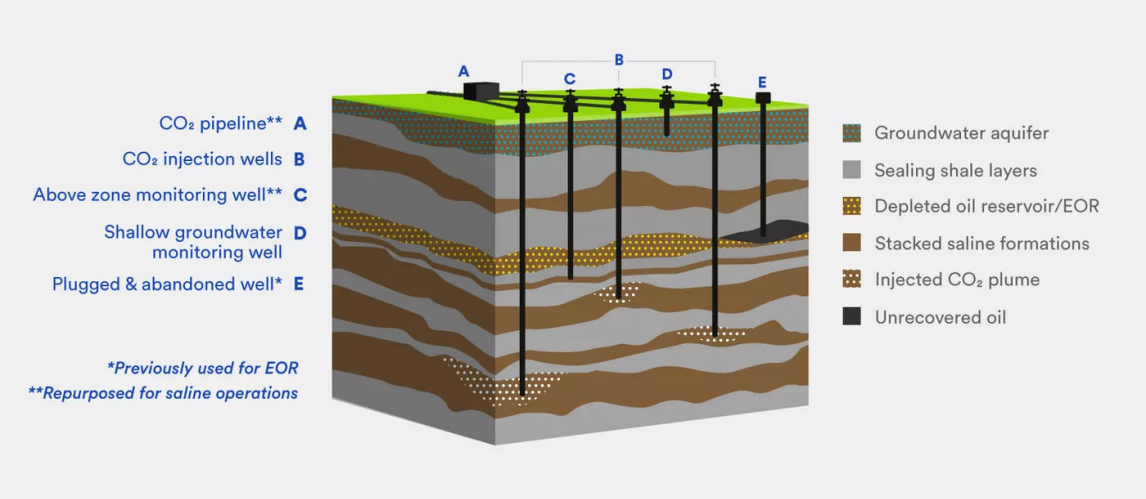
Second, absent government policy, EOR operators view CO2 entirely as a cost. They want to minimize how much they buy, how much they use, and how much remains sequestered.

EOR advocates in the climate community say that both these conditions can be changed through smart regulations and incentives. They say EOR companies can be guided by policy to a) prefer captured CO2 over terrestrial CO2, and b) use and bury as much CO2 as possible.

In an ideal world, all EOR operations would draw exclusively on anthropogenic CO2, and they would all sequester the maximum amount possible. That might make them carbon negative on a lifecycle basis. Even short of that, they could lower the lifecycle emissions of the oil and gas produced.

As long as oil and gas are being used, advocates say, it's better to have

lower-carbon versions. In other words, counter-intuitively, digging up more oil and gas could help make progress on climate change. This vision has a number of things to recommend it.



CATF

EOR is an attractive on-ramp for CCS

First, the big problem with CCS is that, in the absence of a fairly stiff price on carbon, there's no incentive to do it, which means it's hard to get private capital to invest in it. EOR is the only form of large-scale, permanent carbon sequestration that currently makes a profit. Under the right policy regime, the profit-making motive could be harnessed in service of burying carbon. In the process, EOR could help scale up CCS and drive costs down.

Second, while most of the saline aquifers (porous, brine-filled rocks deep underground) that are being discussed for large-scale CCS have not yet been explored in any detail, the reservoirs from which EOR draws are much better understood. There are more historical records, they have been subject to more testing and monitoring, and their ability to securely store their contents over long periods of time has been demonstrated by the fact that they trapped hydrocarbons for millions of years. They are promising locations with which to get started on CCS in the near term.

Third, oil companies have the equipment, experience, and capital to manage a huge industry like CCS. They know exactly the price point at which burying CO2 would become more profitable than digging up oil and will switch from the one to the other when that price point is reached. They

already have much of the infrastructure in place. It's just up to policymakers to help make capture CO2 cheap.

Ultimately, the ability to effectively use EOR to reduce carbon depends on a standardized method of measuring the full lifecycle emissions of the EOR process. Such a standard is now sorely lacking. There are basic disagreements over how and what to measure. There's no way to fairly credit EOR's carbon reductions until they can be quantified.

Whether EOR actually is, or can be, carbon-negative is the subject of much dispute

As the *Frontiers* paper shows, many different lifecycle analyses (LCAs) have been done on EOR, but they tend to draw the boundaries of the analysis in different places, which makes them difficult to compare. Some conclude EOR operations are a net CO2 contributor; some that they are net carbon negative. It is confusing.

Frontiers in Climate

One of the authors of the *Frontiers* paper, Nuñez-López, has done a ***dynamic* LCA** on EOR projects, which measures the CO2 released over time as oil production diminishes. It found that EOR projects are net carbon-negative early on — anywhere from six to 18 years — and then go carbon positive as oil production declines.

Regulators could use that information to encourage maximizing mitigation potential; Operator decisions can make a big difference in how much CO2 is ultimately captured. Industry analysts think that, with advanced EOR techniques and boosted storage, the amount of CO2 injected per barrel of oil could rise from 0.40 to 0.60 tons.

Here, the Clean Air Task Force (CATF) draws on an International Energy Agency (IEA) lifecycle analysis showing that, taking into account the effect of additional oil supply on the global market, a barrel of EOR oil represents 37 percent less CO2 than conventional oil. (The CO2 in the modeling is captured at coal and natural gas plants.)

CATF

Keep in mind, though, that this kind of analysis depends on quantifying exactly how much new EOR oil will displace other, dirtier forms of oil — versus simply adding to the amount of oil consumed. Those kinds of predictions are notoriously dodgy; no one truly knows how much boosted oil supply from EOR might simply increase the world's oil addiction.

Until LCA becomes more standardized and reliable, policy crediting EOR for CO2 reductions involves a fair amount of hope and faith.

In the US, the main policy support for EOR is the 45Q tax credit

As the *Frontiers* paper shows, the legal and regulatory regime governing EOR is kind of a mess, mostly adapted from an oil and gas regulatory regime designed to drive more domestic production.

In the US, the primary policy support for CCS is the **45Q federal tax credit**, which was expanded and reformed in the Bipartisan Budget Act of 2018. (Tax incentives for the oil and gas industry are what pass for bipartisan climate policy in the US Congress.)

45Q now offers:

- $35/ton for CO2 sequestered by EOR
- $35/ton for other beneficial uses of CO2 (e.g., synthetic fuels or plastics — my next article will be on this)
- $50/ton for CO2 sequestered outside of EOR.

(All these credits phase in over a 10-year period from 2017 to 2026.)

As **this modeling** from CATF shows, 45Q "leads to significant deployment of CCS, capturing and storing approximately 49 million metric tonnes of CO2 annually in 2030," without displacing any renewable energy. That would get the US about two-thirds of the way to the reductions needed by 2030 in the electricity sector.

Even the amount of CCS expected to be induced by 45Q is nowhere close to what IEA says will be required in a 2-degree scenario. However, EOR advocates say, it's a start.

EOR is potentially big enough in scale to absorb most of the carbon captured at industrial facilities for the next several decades. And with the political and policy landscape so uncertain, the *Frontiers* paper concludes, "CO2-EOR is the main conduit through which companies planning to or already employing CCS find value in the face of political uncertainty."

That, in brief, is the climate case for EOR.

The climate case against EOR

The case against EOR is more piecemeal. Many environmental groups **oppose it** because of its **potential effects on groundwater**. Many environmental justice groups **oppose it** because they believe, with good reason, that the polluting facilities kept alive by carbon capture will be located in their communities.

But the core of the climate case against EOR is simple: Climate change is an emergency. We need to bury lots of carbon, but it is crazy to let the oil and gas industry set the pace and the terms. EOR under certain rarified circumstances may be carbon negative, but you know what's always carbon negative? Burying CO2 without digging up a bunch of oil to burn.

Sooner or later, we're going to have more carbon to bury than EOR can handle anyway. We're going to have to figure out how to bury it in saline aquifers. From a climate perspective, it makes sense to figure that out, and start doing it, as soon as possible.

Rather than slowly luring private capital into the enterprise by subsidizing oil and gas production — putting one foot on the accelerator and one on the brake — we should just cough up the public money necessary to do CCS at scale, just like we did with public sewer systems to dispose of a different kind of waste.

After all, empowering oil and gas companies with new sources of oil and revenue is not without cost, in political economy terms.

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Oil and gas companies are, after all, bad actors. For decades upon decades, they've been lying about climate change, fighting furiously against any regulation that would force them to internalize the costs of their pollution, and lobbying against clean energy policies at the federal and state level, especially through their trade associations and dark money groups. They are still doing all of those things today.

Yes, they sell a product we need, for which there is demand. But that's just the point: They are corporations driven by the profit motive to sell as much of their product as possible. Humanity's long-term interests dictate using as little of their product as possible. The struggle against climate change is, in part, going to be a struggle against oil and gas companies. Sure, in theory, over time, they could evolve into pure carbon sequestration companies or renewable energy companies or pipeline services companies. But in this reality, now, they are multi-billion-dollar hydrocarbon companies.

Anyone who ignores that basic political economy, who believes oil and gas companies will be good-faith partners in a climate-emergency effort, is

indulging in a kind of willful naivete that is entirely too common in the carbon wonk community.

EOR represents an enormous new source of production and revenue for oil companies

Today, EOR using CO2 is only responsible for about 5 percent of US crude oil production, but it is key to the industry's plans for expansion (note: expansion, not phase out).

There is an enormous pot of gold at the end of the EOR rainbow. Market consultants Advanced Resources International **estimates** the total amount of additional oil accessible by EOR in the US is 284 billion barrels. (As of 2018, the US consumes about 7.5 billion barrels a year.) It says that 80 billion barrels of that are recoverable with "next generation EOR" technologies already in use.

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One of the primary US EOR companies, Denbury Resources has **told investors** that CO2-EOR can unlock between 10 and 23 billion barrels of oil

in Texas alone.

Newer research on "residual oil zones" has shown enough promise that researchers claim it could unlock 800 billion, even a *trillion* new barrels to recovery, just in the Permian Basin.

And that's just in conventional oil wells. Though it doesn't come up much in EOR discussions, the "**next frontier**" for the oil industry is to use CO2 to boost unconventional shale oil and gas. (The Department of Energy's **$40 million investment in EOR** included one unconventional oil project in the Bakken.)

"If the industry can perfect CO2 injection into shale formations and tight oil," John Noël, a researcher at Greenpeace, told me, "it could unlock an almost endless amount of oil under the right conditions."

That is an enormous incentive to pursue EOR. But here's the thing: The single biggest expense in EOR operations is CO2. At times in recent history, EOR's expansion was constrained by the supply of CO2. There's reason to believe that CO2 from natural reservoirs can't possibly keep up with EOR demand in coming years.

The oil and gas industry badly needs more and cheaper CO2 in order to expand EOR operations.

Now, it has realized that it can reframe its use of CO2 in EOR as an effort to fight climate change. It's is a win-win for oil and gas companies: They get to pose as climate champions, harvesting the good PR, while taxpayers subsidize a key industrial input that's driving their expansion. Meanwhile, they are forming groups like Advance Energy Center to lobby for the weakest possible rules and oversight.

Most EOR operations are dirty and oil and gas groups are lobbying against regulation

Let's remember that today, the vast majority of EOR operations are not using anthropogenic CO2. They are using terrestrial CO2. That kind of EOR is, from a climate perspective, garbage — if anything, worse than conventional oil production.

And oil and gas companies are already using their influence to **game the rules that exist**. Currently, the IRS is updating its guidance on how to implement 45Q requirements. Oil and gas companies, under cover of

Energy Advance Center, submitted comments to the IRS arguing that the agency should get rid of the strict verification rules for EOR sequestration (Subpart RR under the EPA's GHG Reporting Rule, for fans) that were implemented with the expanded 45Q credits. That would mean EOR projects could claim credits based on the amount of CO2 received on site, with no obligation to demonstrate or verify actual storage.

On a political level, this is what it means to let oil and gas companies into the climate effort. "It's in their DNA to cut corners, deregulate, gaslight, and streamline," Noël told me. "I am confident there are a dozen other areas where the industry is taking advantage of access to regulators and their well resourced expertise in order normalize O&G development in ways the progressive community doesn't even see yet."

Fossil fuel protests in Brussels. | Photo credit should read EMMANUEL DUNAND/AFP/Getty Images

The climate case for EOR is ultimately an argument that a path forward amenable to oil and gas companies is the only path possible. Give them regulatory certainty and enough subsidies, and they will eventually build the CCS needed while unlocking billions of barrels of oil along the way.

The climate case against EOR would urge us to think bigger.

Thinking bigger about EOR and CCS

If climate change is an emergency, policymakers ought to treat it that way. It cannot be enough to slowly induce oil and gas companies to shift to more carbon-friendly practices, taking care not to unduly startle them. They must be jolted.

At the very least, 45Q should be strengthened, the monitoring and verification standards protected, and the subsidy for geologic storage increased. But here are a few policy ideas, listed in order of increasing ambition, that might get the decarbonization job done faster.

1. Rather than simply subsidizing the EOR operations that choose to switch to captured CO2, all EOR operations could be required to do so. And they could be required to maximize (and verify) permanent geologic sequestration. Those requirements could be accompanied, in the beginning, by a subsidy, to avoid any alarming jumps in oil or gasoline prices, but over time, subsidies could fade out and they could simply become regulatory requirements. The social license of EOR operations should be contingent on their burying captured carbon, and they should shoulder those costs.
2. A national low-carbon fuel standard (LCFS), like the one in California, could be put in place and steadily ratcheted down, requiring all oil and gas companies, not just those doing EOR, to offset more and more of the carbon content of their products, until eventually they were burying (or funding the burial of) an amount of carbon equal to the amount their

fuels produced. (The LCFS would also apply to imported oil.) This would also amount to a fundamental change in the social license of oil and gas operations. You want to dig up oil and gas; you have to pay to bury carbon.

3. Oil and gas companies could be nationalized and set, by policy, on a path that would steadily phase out production of hydrocarbons and steadily scale up carbon sequestration. Eventually, they would become large, publicly owned sequestration companies. There's simply no reason to have private, profit-making entities standing as middlemen between the public and the solution to an existential crisis, slowing things down and skimming off the rewards.

I don't know that I necessarily endorse any of these ideas unreservedly — I'd need to do a lot more thinking and talking to people to wrap my head around them — but I list them to make a point: The EOR conversation among wonks and policymakers is woefully narrow. It is built around the presumption that oil and gas companies must be kept happy and that political disturbance must be minimized.

Treating climate change as an emergency means embracing the fact that political disturbance is inevitable and so is a struggle with the political power of the oil and gas industry. It may be that EOR can play a constructive role in a comprehensive decarbonization plan, helping to reduce the carbon content of the oil we can't avoid using. But its use and limitations should be shaped by the public interest, not by the interests of oil and gas investors.

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