How Oil and Gas Companies are Pivoting Toward Climate Change

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By

Ian Palmer

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For Mary Ann and Kim—for your enthusiastic support during the tough life challenges we all endured while this book was being written. Your resilience has been an inspiration to me.

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FOREWORD

This book, *How Oil and Gas Companies Are Pivoting toward Climate Change*, was an enjoyable read. It is written using clear and understandable prose with topics well researched and explained.

The topics presented show how the largest Western-world oil and gas companies are dealing with the realities of fossil fuel–induced global warming and their resulting climate changes while still maintaining profitability.

The book draws the distinction between US and European major oil companies, where US companies have strategies of maintaining and sometimes actually increasing production with plans to compensate for CO_2 emissions using CCS [carbon capture and storage] or DAC [direct air capture], and to reform methane to hydrogen fuel. In contrast, European majors are actually planning to replace some of their oil and gas production with wind, solar, and geothermal.

The book gives a very nice overview of how LNG [liquefied natural gas] is like liquid gold and has been ramped up to aid Europe and Asia. The description of how Occidental Petroleum, Chevron, and ExxonMobil + Pioneer are operating in the Permian basin shows that US oil and gas production will be alive and well for at least the next twenty-five years.

As to CO_2 abatement and storage, the book shows how oil and gas companies are cooperating with governments in working to achieve net-zero CO_2 emissions by 2050. However, this will not be easy.

With regard to renewable energy, the book gives a very pertinent example of Australia as a success story in transition to renewable energies. It explains how solar, wind, and batteries are replacing coal, oil, and gas but stresses how the world's transition has a long way to go, especially in the US.

As for possible legal problems during this transition to renewables, the book gives the case of a California lawsuit versus big oil. The story shows how difficult it will be to hold big oil (e.g., ExxonMobil) responsible for climate change, even though they predicted very accurately the rise of

global temperatures from 1980 up to 2020 when fossil fuel production was included.

The book states that global warming is not the same as climate change and that such damaging elements of climate change (the "killer quad" of droughts, floods, hurricanes, and wildfires) have not been shown to change significantly in the last forty to fifty years. The book says this is consistent with a lack of "climate signals" in the IPCC AR6 [Sixth Assessment Report] (ca. 2023).

The book also says, "If extreme weather events haven't shown any worsening over the past forty to fifty years, when global temperature rose by almost 1°C, there should be less urgency about temperatures rising another 0.3°C to 1.5°C, which the Paris Agreement wanted to prevent by 2050."

I like the way the book ended with a chapter citing other forms of energy that could be developed such as liquid biofuels, fission, fusion, and geothermal. Also, the table from Bill Gates showing additional technologies adapted to reduce GHG [greenhouse gas] is instructive.

In conclusion, the book gives a wealth of topical insight and information that readers can gain to help them understand the climate and geopolitical issues of today's world. The book will help anyone who wants to be informed about climate change and the energy transition but does not have the time or inclination to wade through massive documents on the subject produced by the IPCC, the IEA, BP, etc.

John Cameron

John R. Cameron, with a PhD in ChE from the University of Michigan, has worked over 38 years in the upstream oil and gas industry as an engineer doing research and consulting for major and independent oil companies, service companies and universities.

PREFACE

The hard facts are as follows. The US Energy Information Administration (EIA) has forecast US oil production to reach almost thirteen million barrels per day in 2024 and natural gas to rise to 105 billion cubic feet per day—both new records.

Global greenhouse gas emissions hit a (projected) record high in 2023 of 37.6 Gt of CO_2 equivalent from fossil fuels and industry (Statista 2023a).

In 2023, the world spent a record $1.7 trillion on clean energy, according to Bloomberg, which surpassed the $1.1 trillion spent on fossil fuels. Surprisingly, solar and electric cars in China dominated the difference.

The oil and gas industry employs twelve million workers across the world and supplies over half of the global energy consumed. But the industry's investment in clean energy amounts to just 1% of the worldwide investment. Capital spending on clean energy by oil and gas has been only 2.5% of the industry's total capital expenditures. It would need to be 50% by the year 2030 to reach the goals of the Paris Agreement of 2015.

What should the oil and gas industry do? Start to phase out oil and gas? Or scale up technologies like carbon capture and storage or hydrogen to compensate for business-as-usual oil and gas drilling?

With the unique perspective of a solar space scientist turned oilfield engineer, the book takes an honest look at the fast-changing energy transition.

- How far are global leaders pivoting toward climate change? BP? Occidental? ExxonMobil?
- ExxonMobil confirmed global warming forty years ago. Did they really try to deceive people about climate change?
- Are CCS and hydrogen fuel all they are cracked up to be?
- Batteries are surging, and are displacing gasoline (oil) in cars and trucks and also coal and natural gas in power plants.
- Extreme weather events have not worsened with time over the past forty years, when global temperature has gone up by almost 1°C. So, is the oil and gas industry not responsible for these killer extreme events?

- Is climate change urgency as dire as alarmists are saying? If it's not, will LNG export restrictions be lifted?
- Can oil and gas companies reach net-zero carbon emissions by 2050 without new technology?

While the oil and gas industry confronts challenging choices in regard to climate change, this book also reaches down to a personal level. The book is a handy reference to what is going on both inside and outside the oil and gas business that will undoubtedly impact people working in the business. It is good to keep an eye on the weather!

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Special thanks to Chris Helman, editor, who took a chance and gave me the opportunity to write for Forbes.com. I am indebted to Forbes.com for the many opportunities to contribute.

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John Cameron and Bob Moore perused an early version of the manuscript and provided comments, and John kindly provided the foreword to this book.

INTRODUCTORY NOTE

The oil and gas industry is wrestling with an energy transition that is linked to climate change. These concepts are very complicated, especially when government is linking up with industry. This book describes how oil and gas companies are adapting their thinking and making changes in their operations as they pivot toward climate change. While not a comprehensive study, many different facets of the transition are addressed in this book, and these lead to learnings that will help define the way forward for the oil and gas industry.

LIST OF ABBREVIATIONS

AR6	Sixth Assessment Report
AREH	Australian Renewable Energy Hub
Bcfd	billion cubic feet per day
bcm	billion cubic meters
boepd	barrels of oil equivalent per day
CapEx	capital expenditures
CCS	carbon capture and storage
CH_4	methane
CO_2	carbon dioxide
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAC	direct air capture
DOE	Department of Energy
EDF	Environmental Defense Fund
EIA	Energy Information Administration
EJ	exajoules
EOR	enhanced oil recovery
EPA	Environmental Protection Agency
G-7	Group of Seven
GDP	gross domestic product
GHG	greenhouse gas
Gt/yr	gigatons per year
GW	gigwatt
GWh	gigawatt hours
HERO	Hydrogen Energy Release Optimiser
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRA	Inflation Reduction Act
LNG	liquefied natural gas
MMboepd	millions of barrels of oil equivalent per day
MMbpd	million barrels per day

MMbtu	million British thermal units
MW	megawatt
MWh	megawatt hours
NGLs	natural gas liquids
NOAA	National Oceanic and Atmospheric Administration
NSW	New South Wales
OPEC	Organization of the Petroleum Exporting Countries
Oxy	Occidental Petroleum Corporation
ppm	parts per million
PV	photovoltaic
RCSPs	regional carbon sequestration partnerships
RNG	renewable natural gas
SMR	small modular reactor
Tcf	trillion cubic feet
tpy	metric tons per year
TW	terrawatts
UAE	United Arab Emirates
UIC	Underground Injection Control
UN	United Nations

CHAPTER 1

PUT YOUR MONEY ON THE PERMIAN: THE PHAR LAP OF OIL AND GAS BASINS

The Permian basin is one of the world's premier oil and gas basins. It has been projected that Permian crude oil will grow steadily from about 6 MMbpd in mid-2023 to possibly 8 MMbpd by 2030. Meanwhile, total US production may reach 13.3 MMbpd by 2050.

Phar Lap was a champion racehorse bred in New Zealand and raced in Australia. He won thirty-seven races from fifty-one starts, including the 1930 Melbourne Cup, and was an inspiration to people in the early years of the Great Depression. He died from lead poisoning in the US, but the cause was controversial. His heart was 50% heavier than the average for racehorses, and it was given to the National Museum in Australia. Phar Lap and Secretariat have been called the two greatest racehorses in the world.

The Permian basin is a bit like Phar Lap. It is winning everywhere and is the center of attention for the US and the rest of the world. In 2023, ExxonMobil, for example, bought Pioneer Natural Resources for a huge price, and the merged company will have the largest oil and gas production in the Permian basin—about 11% of the total basin production. All this adds up to a gargantuan company with enormous influence over oil and gas but also over climate change.

The Permian Races Ahead of Pandemic Lows

In early 2022, the Permian basin in West Texas and Southeast New Mexico produced 5 million barrels per day (MMbpd) of crude oil, which was almost half of the total US supply of crude oil (Palmer 2022a; Mathews 2023a). It was projected at the time that the US had seventy-six billion barrels of

untapped reserves, and most of this lay under the Permian (Gaswirth et al. 2018).

The peak of crude oil production in the Permian before the 2020 pandemic was 4.9 MMbpd. But production in the Permian rose to a record 6.0 MMbpd by end of 2023. The Permian is still running hard.

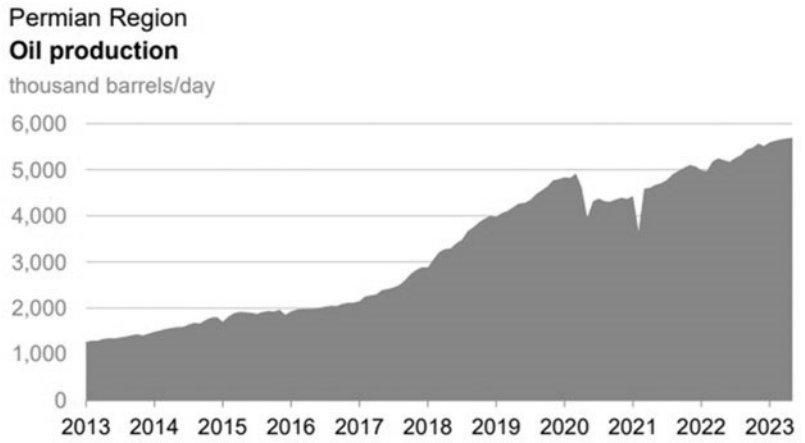

Fig. 1-1. Crude oil production from Permian basin (Mathews 2023a).

Other shale-type producers are increasing too. The Bakken in North Dakota and Montana reached 1.2 MMbpd in 2023 but remained a good bit lower than its peak of 1.54 MMbpd, recorded in November 2019. In early 2023, the Eagle Ford in Texas rose to nearly 1.2 MMbpd but also lay well below its pre-pandemic peak of 1.40 MMbpd (EIA 2024a).

Natural gas production in the US has been surging even more. Associated gas in the Permian rose from 17.4 billion cubic feet per day (Bcfd) pre-pandemic to about 22.5 Bcfd in May 2023—a surge of 29%. Total production in the US was about 100 Bcfd, to which the Permian contributed a remarkable 23%.

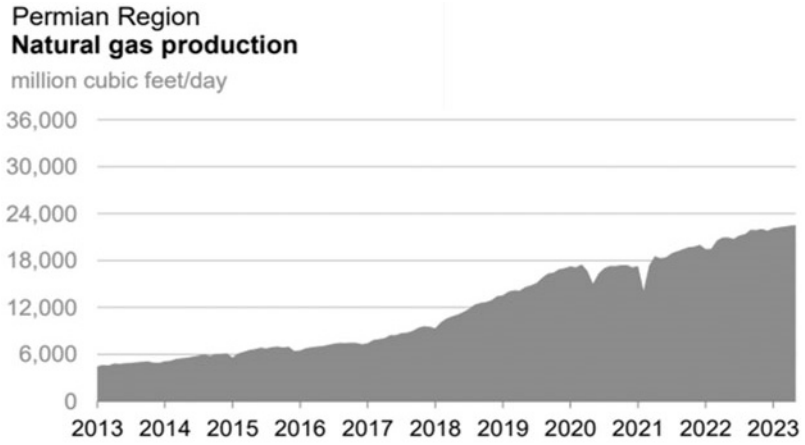

Fig. 1-2. Natural gas production from Permian basin (Mathews 2023a).

In the Haynesville Shale, which straddles the border between Louisiana and Texas, natural gas production rose from 12.0 Bcfd pre-pandemic to 16.8 Bcfd in May 2023. This was a surge of 40%. The largest gas play in the US, the Appalachian—which includes the Marcellus Shale—actually fell from 36 Bcfd pre-pandemic to 35.3 Bcfd in May 2023.

What are the Keys of Success in the Permian?

In late 2018 the United States Geological Survey completed an assessment of the entire Delaware basin, a subset of the Permian existing in both Southeast New Mexico and Far West Texas (Gaswirth et al. 2018). They came up with over forty-six billion barrels of technically recoverable continuous oil resources, plus 281 trillion cubic feet (Tcf) of natural gas and twenty billion barrels of natural gas liquids (NGLs). NGLs are liquid compounds more complex than methane (the major component of natural gas), such as ethane and pentane.

What to remember: The Permian is a catchword for wealth and energy security for the US. But what will happen to it during the energy transition?

The immense quantities of oil and gas in the Delaware basin make up the largest deposit of oil and gas ever documented by the United States Geological Survey in the US. Quite simply, it's the nation's dominant energy play, with some of the largest recoverable reserves in the world.

The technical key is a few horizontal wells drilled per pad in stacked pay zones, each horizontal about two miles long and fracked up to forty separate times along its length. Monster wells making more than 10,000 barrels of oil equivalent per day (boepd) have been reported (Palmer 2020a).

Permian Will Peak at 8 MMbpd in 2030

The betting on the Permian future is positive. Five watchdog heavyweights forecast crude oil production rising steadily through 2028 before peaking in the range of 7.3–8.0 MMbpd around 2030 (Crowley, Wethe, and Ferman 2023). The watchdog companies are the Energy Information Administration (EIA), Wood Mackenzie, Rystad, Enverus, and S&P Global.

According to a Bloomberg survey, oil production will expand by 40% through 2030 (Crowley, Wethe, and Ferman 2023). After plateauing for a few years, a slow decline will set in in 2035, which promises oil will be a consistent supplier of energy consumption for decades.

The Permian will offset production declines from other shale basins in the US. Federal forecasts suggest total US oil production stabilizing in the range of 12.3–13.3 MMbpd through 2050.

US oil production in 2022 was 11.9 MMbpd, about 12% of global production (99.8 MMbpd), and looks like a stayer and a good bet to last the distance until 2050. The US produces more oil than Saudi Arabia (No. 2) and Russia (No. 3). In the first half of 2023, US oil exports reached a record of 4 MMbpd—not bad for a country that was prohibited from exporting oil until 2015.

The Permian Feeds LNG Futures

As of mid-2023, the Permian and Haynesville have increased their natural gas production by 4–5 Bcfd since the pandemic of 2020. This is a surge of 29% for the Permian and 40% for Haynesville.

It's not a coincidence that both these resources lie close to the liquefied natural gas (LNG) export terminals spread along the Gulf of Mexico. LNG has a very bright future (Palmer 2023a).

Since the war in Ukraine, investments in LNG have moved quickly from uncertainty due to supply-chain delays and climate-fearing stranded assets to a position of "Let's get the funding and permitting done as soon as possible" (Palmer 2023b). US contractors in 2023 have been arm-wrestling over long-term exports with Europe, China, and Southeast Asia countries like Japan and South Korea.

Takeaways

The peak of crude oil production in the Permian before the pandemic was 4.9 MMbpd. But production in the Permian rose to 6.0 MMbpd by the end of 2023. Five watchdog heavyweights forecast crude oil production in the Permian rising steadily through 2028 before peaking in the range of 7.3–8.0 MMbpd around 2030.

US oil production in 2022 was 11.9 MMbpd, about 12% of global production, and looks like a good bet to last the distance until 2050. Federal forecasts suggest total US oil production will stabilize in the range of 12.3–13.3 MMbpd through 2050.

Associated gas in the Permian has risen from pre-pandemic 17.4 Bcfd and reached 22.5 Bcfd in May 2023—a surge of 29%. The golden age for LNG has a strong connection with the Permian. US contractors are currently arm-wrestling over long-term LNG exports with Europe, China, and Southeast Asia countries like Japan and South Korea.

The Permian basin is the capstone of US oil and gas basins, with its production about half and gas production about a quarter of total US production.

CHAPTER 2

VICKI HOLLUB AND JOE BIDEN: UNLIKELY TIES BETWEEN ENERGY SECURITY AND ENERGY TRANSITION

This chapter looks at two important influencers in the field of energy and finds they have common interests that are surprising.

Vicki Hollub is CEO of Occidental Petroleum Corporation. She was the first woman CEO of a large US oil and gas company. Joe Biden is president of the United States.

Previously, a short answer to the question "What do Vicki Hollub and Joe Biden have in common?" would have been "Not much," even though Hollub did have a past connection with Washington politics: she was an advisor to the US Department of Energy during the Trump administration.

Joe Biden came into office in 2020 with plans to stall further expansion of oil and gas, on the belief that renewable energies were the future and oil and gas would fade away. Biden canceled the Keystone XL expansion on his first day in office. Biden paused the leasing of future oil and gas wells on federal land soon after that.

Conversely, Occidental (Oxy) purchased Anadarko in 2019 for a pricey $55 billion, beating out Chevron in the process. Hollub's commitment to the future of oil and gas was obvious.

Hollub would have been aware that the oil and gas industry adds $1.8 trillion to the US economy each year (7.6% of gross domestic product) and supports nearly eleven million jobs (5.4% of total employment) (Jacobs 2023a).

Unexpected Changes

But in the past two years things have changed in unexpected ways.

First came COVID-19 in 2020, and the price of oil collapsed, actually dropping to zero for a short time. It must have been a scary time for Oxy so soon after their Anadarko purchase. But the rebound after COVID-19 was strong for the general economy and for the oil and gas industry in particular.

Then came the Russian invasion of Ukraine in February of 2022. Russia cut gas supplies to Europe, and gas prices hit the roof. Oil prices zoomed up in concert as economic sanctions hit Russia, some countries stopped buying their crude oil, and an oil price cap was instigated by the EU that reduced Russia's sales of crude oil.

Oil sales by Russia were at 23% of the total Russian budget in mid-2023, down from 30%–35% of the Russian budget before the start of the war in Ukraine (Meredith 2023).

But crude prices remained high, averaging $100 per barrel in 2022. As a result, oil and gas companies made record profits in 2022—and the profits were twice as much as the previous record year of 2018 (King 2023).

In the years since 2000, Europe had stepped away from oil and gas and coal while supporting renewables. But renewables could not fill the gap caused by the Russian cuts.

Energy Security

From this European experience, what became clear to Vicki Hollub and Joe Biden was that, first, energy security was critically important to a country or a group of countries with close economic ties, such as the EU.

Second, the US could assist Europe by providing oil and gas, especially LNG, to replace lost Russian supplies. In the twenty-first century, Europe walked away from their own oil and gas industry, preferring instead to rely on oil and gas from Russia. In contrast, Hollub said:

> "In terms of energy independence, hydraulic fracturing has helped the United States maintain a position of power in the world," she said, adding that the major shale plays developed with fracturing account for around 8 [MMbpd] out of the total of 11.6 [MMbpd] of crude that the US produces today. (Jacobs 2022)

The US became self-sufficient in oil and gas production in 2020 for the first time in seventy years, and this can be attributed to the shale and fracturing revolution that began around 2003 (Palmer 2023a). This has enabled the US to open up its exports of LNG to help Europe meet its energy

needs after the invasion of Ukraine. The US is now close to being the largest exporter of LNG in the world.

Hollub spoke further of the geopolitical advantages the oil and gas industry has given the US:

> "I know how [our policymakers] use or leverage" US energy independence in tandem with its defense capabilities, she said. "When you put the two of those together, there's no country in the world that can really challenge us very much" (Jacobs 2022).

These statements by Vicki Hollub could have been made by President Biden, because they refer to integral parts of US national security and its assistance to the EU while the Russian invasion continues.

The Energy Transition

Self-sufficient energy and energy security are not the only things that Vicki Hollub and Joe Biden have in common. They both have a commitment to energy transition by lowering or removing or offsetting greenhouse gas (GHG) emissions—on the way to the Paris 2015 goal of net-zero emissions by 2050.

Oxy's emissions come in three types: Scope 1, 2, and 3. Scope 1 and 2 fall under the responsibility of Oxy, but Scope 3 are emissions by consumers—companies or people who burn the oil and gas or refined products sold by Oxy.

Oxy has pledged to offset Scope 3 emissions, which is radical for an oil and gas company because Scope 3 can be 95% of total emissions related to the company (Jacobs 2022; Palmer 2022b). It's not only the largest source of emissions; it's also the most difficult to control or reduce.

Whoever adopts the blame for Scope 3 emissions—producer or consumer—it's a dominant part of the 73% of global emissions that comes from burning fossil fuels such as oil or gas or coal. Understanding Scope 3, then, is essential to move beyond measuring emissions during production to understanding the total impact of doing business.

For Oxy, the willingness to include Scope 3 emissions makes the company an outlier. The strategy is to use their expertise in carbon capture and storage (CCS), which is a powerful way to offset emissions, for themselves or even for other companies. Basically, Oxy hopes to bury enough CO_2 to compensate the CO_2 that will be released by burning their

oil-gasoline in cars and by burning their natural gas in electrical power plants.

Oxy's Carbon Capture Plans

Like President Biden, Vicki Hollub believes in climate change and Oxy's need to do something ambitious about it: "As we started to learn more about climate change and climate mitigation, we realized this plan needed to happen, and would happen, to help the world" (Jacobs 2022).

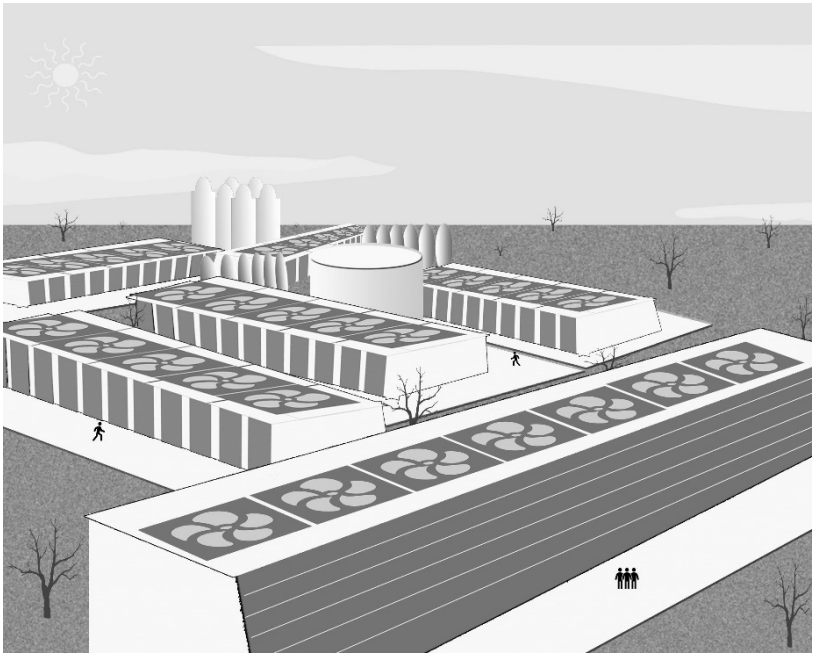

Fig. 2-1. A rendering of Oxy's first Direct Air Capture—Stratos. (Illustration by Gillian Felix.)

Oxy has big plans for direct air capture (DAC), a new technology that uses a wall of fans to blow air over chemicals that suck CO_2, the main GHG, out of the airstream (Palmer 2022c).

The first scaled project, called Stratos, should come online in 2025 in West Texas. A $1.3 billion project, this will separate out CO_2 at the rate of 500,000 metric tons per year (tpy). Other facilities are planned to separate

1,000,000 tpy. This is only 0.016% of total US emissions, but Oxy's goal of one hundred such plants would remove 1.6% of US emissions.

The world's largest investment manager, BlackRock, will invest $550 million in Stratos (Valle 2023). ADNOC (Abu Dhabi National Oil Company) will fund a DAC study with Oxy in United Arab Emirates for a 1,000,000 tpy facility.

Oxy envisions a franchise type of business model, where they charge a licensing fee and the plant is managed by partners. Oxy foresees one thousand such plants across the world will be needed by 2050. If the potential is one thousand such plants, this would equate to removing about 2% of current global emissions. The numbers show how difficult it will be to reach net-zero emissions by 2050.

DAC will be a significant part of carbon capture, but not a dominating part, according to the International Energy Agency (IEA). Carbon will be captured from many sectors of the energy economy (in order), including natural gas, coal, DAC, biomass, and hard-to abate areas. By 2050, IEA predict natural gas at the top, DAC in the middle, and hard-to abate areas, at the bottom, totaling 6.6 Gt per year (IEA n.d.).

Carbon removal credits will play a big part in all this. It's hard to believe, but Oxy has already sold CO_2 removal credits to the Houston Texans football team to offset their emissions from air travel for three seasons. Other companies who have pre-purchased such credits include Amazon, Airbus, and Shopify. The market for carbon removal credits may eventually surge to hundreds of billions of dollars (L. 2023).

Hollub pointed out that a competitor called Climeworks, in Iceland, is capturing only 4,000 tpy, and the method is difficult to scale up to much greater volumes.

CERAWeek

Another thing in common between Hollub and Biden: tax breaks are a big incentive in the congressional Inflation Reduction Act (IRA) for investments in DAC and CCS projects.

In March 2023, John Kerry spoke at CERAWeek to a room packed with oil and gas CEOs. Kerry is the president's climate czar. Kerry and the president sent a message: "We need to not be polarized here. We need to collaborate" (Worland 2023).

The subject was the IRA bill. The bill funds wind and solar renewables but also (1) provides tax incentives for CCS, (2) subsidizes hydrogen, and (3) supports biofuel production. The promise of billions of dollars changes the math for the oil and gas industry, because the industry already has know-how and skills to build these enterprises to scale, and now they have ten years of IRA carrots to take to the bank.

What to remember: Energy security and the energy transition need to grow together.

The industry is seeing the opportunities and flocked to sessions at CERAWeek to hear about the Fed's initiatives. After decades of supporting environmental progress and recent opposition to improving oil and gas enterprises, the federal government is wanting to include oil and gas in its climate change program. "If they want to play clean, we welcome them to the party," said John Podesta, the Biden advisor who is leading IRA implementation (Worland 2023). It seems like Vicki Hollub would shake Joe Biden's hand and say with a smile, "Count us in."

And a bunch of oil and gas people would have liked to shake Biden's hand when the president announced that Conoco-Phillips could drill wells in the Willow project in the National Petroleum Reserve-Alaska (Newman 2023).

Biden is learning that the transition to green energies is a *both*/*and* proposition. The US needs continued access to oil and gas while developing renewable energies that will gradually replace them. But at the same time oil and gas needs to offset leftover carbon emissions to satisfy net-zero emissions by 2050.

Federal forecasts suggest total US oil production will stabilize in the range of 12.3–13.3 MMbpd through 2050. But it's not clear whether switching from gasoline to electric vehicles, which will have a dramatic effect on oil production, has been included in this prediction (Palmer 2021a).

For the past two years, Vicki Hollub has been saying that Oxy is becoming a carbon-management business. What they perceive as a major business opportunity is starting to take shape.

Takeaways

Though surprising, Vicki Hollub and President Biden have a lot in common right now: the price of oil, energy security, the energy transition, carbon capture and storage (CCS), and direct air capture (DAC). And, last but not least, attractive contract monies and tax credits newly minted by the US government to develop endeavors that reduce GHG emissions.