



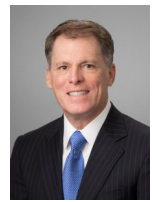
# Weekly E&P Update

February 27, 2024

Vol. 9

## **The Evolving Challenges of CCS Reservoir Engineering**

By Steve Hendrickson  
President of Ralph E. Davis Associates



Last week, I had the pleasure of participating in an enlightening webinar sponsored by the Society of Petroleum Engineers entitled "[Seven Unique Appraisal Challenges Derisking CCS Projects](#)" presented by [Robert Laronga](#). Following the enhancement and clarification of the Section 45Q tax credits for carbon sequestration a few years ago, many projects have entered the design and permitting phase. We're now getting greater insight into the technology and analysis needed to address these projects' unique engineering problems and risks.

The seven challenges Laronga discussed in the webinar were storage efficiency, storage and trapping mechanisms, unproven seal capacity, rock/brine/CO<sub>2</sub> interactions, increasing pressure over time, injectivity over time, and supercritical fluid properties. An eighth challenge, wellbore integrity of legacy wellbores, was omitted due to time constraints.

Many of these topics are familiar to geologists and petroleum engineers who have worked on hydrocarbon development projects; however, the regulatory overprint on CCS projects requires more technical diligence than most have encountered. Laronga stated that CCS projects have the most extensive coring, logging, and laboratory analysis programs he has seen, and they are comparable to what would be needed for a deepwater appraisal well. What is ultimately required for a given project is a function of the project details and the regulator's discretion.

I can only touch on some of the topics covered, but here are a few key takeaways from a reservoir engineer's perspective.

**Multizone Evaluation is Necessary** - This includes not just the saline aquifers, but also the overlying seal and potentially a back-up sealing layer and formations below the storage zones.

**Complex Processes Are at Work** - In many oil and gas developments, hydraulic and mechanical are the primary physical processes of interest. In CCUS, however, we also must contend with chemical and thermal processes.

**Capillary Pressure is Important** - CO<sub>2</sub> is not very effective at displacing brine. This limits how low the residual water saturation can go without excessively high pressures that could fracture the rock. It may also be necessary to measure the capillary pressure attributes of the overlying seal - a step that's not typically done in oil and gas development.

**System Properties Are Dynamic** - It's common in oil and gas to consider changes in pressure and fluid composition over time. Still, the unique interactions between the fluids and rocks in CCUS projects complicates this. These interactions include mutual solubility between the CO<sub>2</sub> and brine, the mineralization of CO<sub>2</sub> (as a carbonate), the acidification of the brine that can react with the rock, and the precipitation of salts from the brine. These processes influence each other and can affect porosity and permeability in complex and offsetting ways.

**Well Testing Becoming Revitalized** - The nature of the wells drilled during the shale revolution resulted in a generation of reservoir engineers who didn't need to apply pressure transient analysis (and other) techniques very often, but these skills will be needed to monitor changes in CO<sub>2</sub> injector's skin and permeability changes over time.

There was much more presented, but to learn more, check out Laronga's SPE journal paper "[Integrated Formation Evaluation for Site-Specific Evaluation, Optimization, and Permitting of Carbon Storage Projects](#)".

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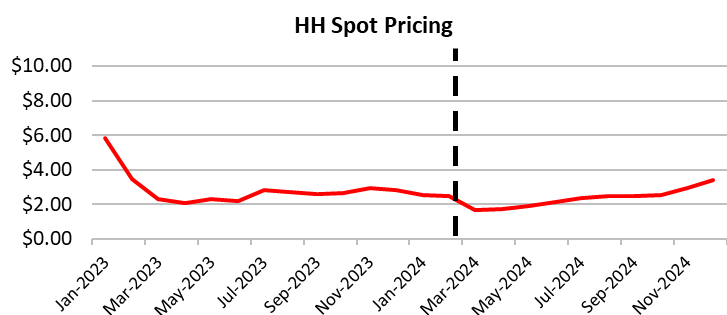
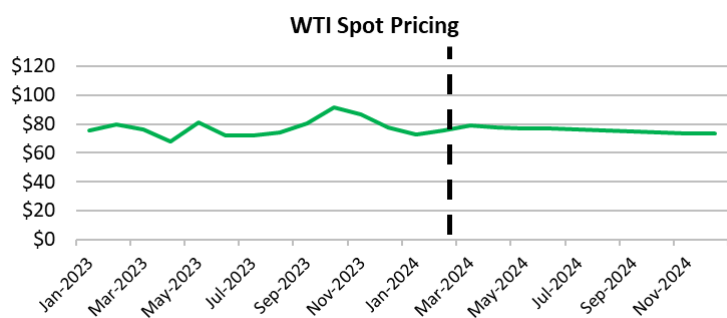
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## NYMEX FUTURE PRICING



## MONDAY'S MARKET CLOSE

### NYMEX WTI CRUDE OIL FUTURES as of February 26, 2024 Close (\$/bbl)

Period	Current	WoW Change	Last Week	1 Yr Ago
2024	\$75.43	(\$1.20)	\$76.63	\$72.16
2025	\$70.69	(\$0.87)	\$71.56	\$68.47
2026	\$67.31	(\$0.76)	\$68.07	\$65.33
2027	\$65.26	(\$0.71)	\$65.97	\$62.58
2028	\$64.22	(\$0.71)	\$64.93	\$60.04

### NYMEX HH NATURAL GAS FUTURES as of February 26, 2024 Close (\$/MMBtu)

Period	Current	WoW Change	Last Week	1 Yr Ago
2024	\$2.36	\$0.14	\$2.22	\$3.62
2025	\$3.41	\$0.13	\$3.28	\$3.84
2026	\$3.75	\$0.12	\$3.63	\$3.97
2027	\$3.77	\$0.06	\$3.71	\$4.01
2028	\$3.71	\$0.03	\$3.68	\$4.06

## INDUSTRY METRICS—QUICK SNAPSHOT

	Current	Last Week	WoW Change	%Change
Crude Oil Near-Month Price (\$/bbl)	\$77.62	\$78.98	(\$1.36)	(1.7%)
Natural Gas Near-Month Price (\$/MMBtu)	\$1.63	\$1.53	\$0.10	6%
Weekly Upstream-Deal Transaction Value (\$MM)	\$4,045.00	\$26,000.00	(\$21,955.00)	(84%)
Weekly Number of Upstream-Deal Transactions	4	2	2	100%
Current Total US Rig Count	626	621	5	0.8%
US Field Crude Oil Production (MMbbl/day)	13.3	13.3	0	-
US Field Dry Natural Gas Production (Bcf/day)	109.5	109.9	(0.4)	(0.4%)
Commercial Crude Oil Stocks-Excluding SPR (MMbbl)	443	439	4	0.8%
Natural Gas Stocks-Working Gas Underground Storage (Bcf)	2,470	2,636	(166)	(6%)
Total Drilled But Uncompleted Wells (DUC-Last Month)	4,386	4,386	0	-

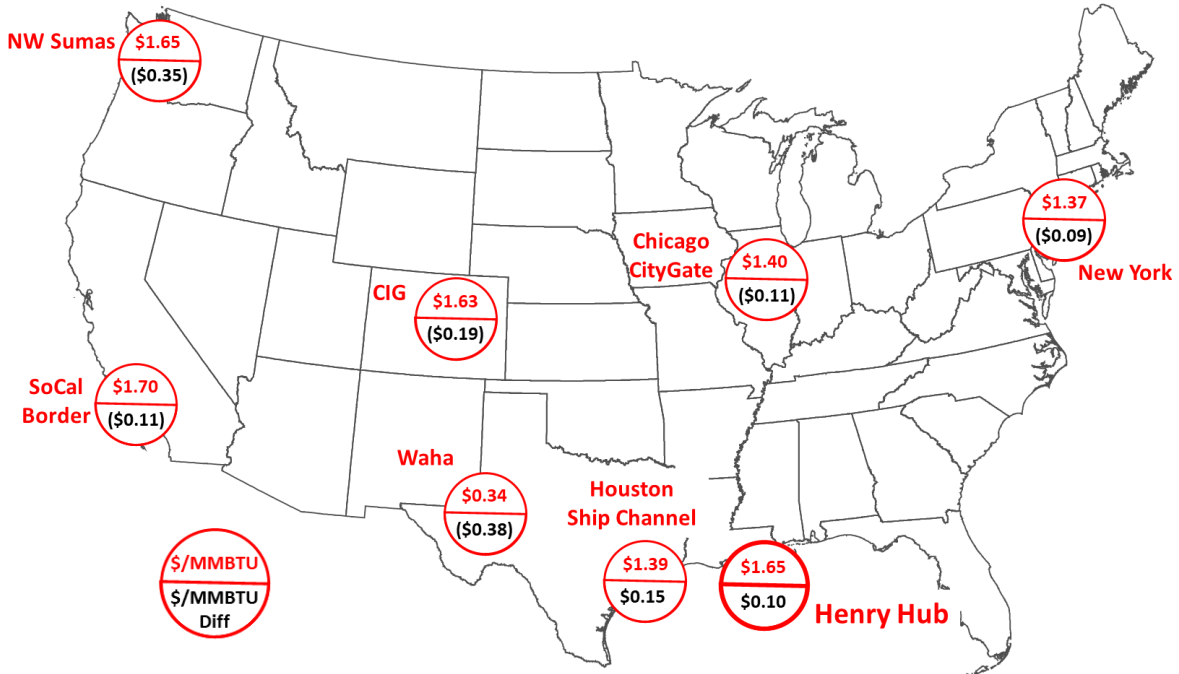
\*Source—Energy Information Administration, United States (EIA)

\*Source—Baker Hughes North America Rotary Rig Count & PLS M&A Database

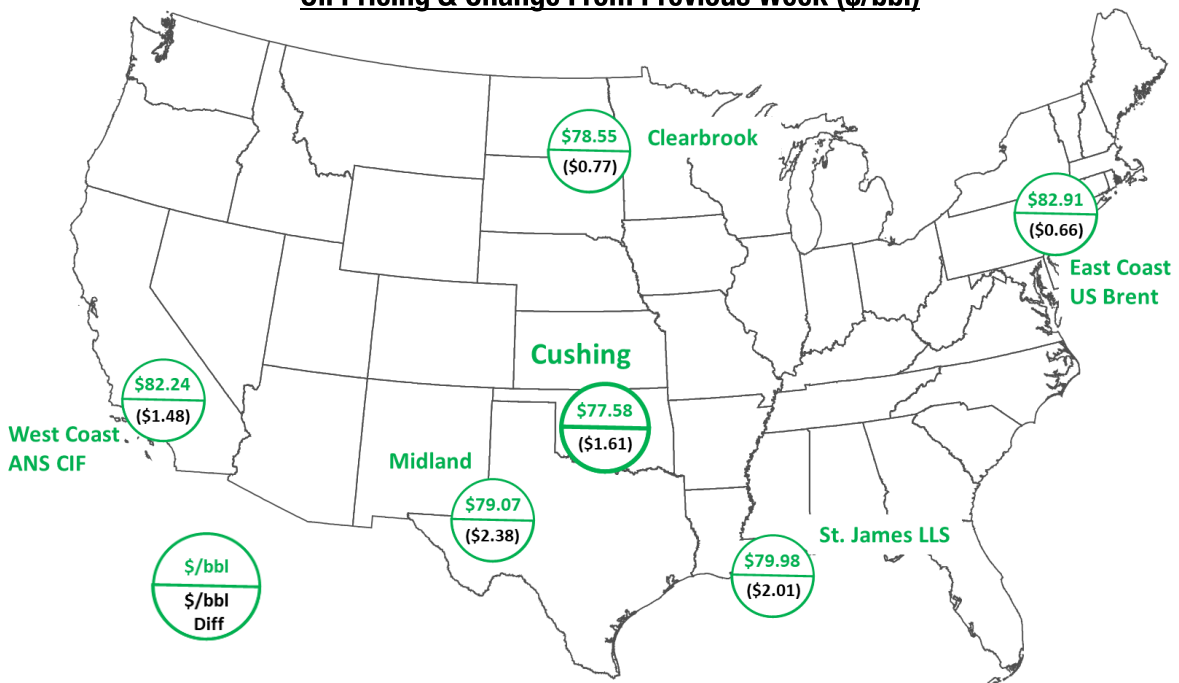


**US COMMODITY PRICES CONTINUED**

**Natural Gas Pricing & Change From Previous Week (\$/MMBtu)**



**Oil Pricing & Change From Previous Week (\$/bbl)**



\*Source—Bloomberg LP



## **SELECTED INDUSTRY HEADLINES**

### **U.S. Oil and Natural Gas Production Hits Record Highs**

Despite a 4.6% reduction in U.S. drilling activity on an average yearly basis, U.S. crude production climbed to an all-time high of 12.93 MMBopd in 2023, an 8.8% increase compared to the 11.88 MMBopd average of 2022.

### **Oil Prices Rise on Uncertainty Over Gaza Ceasefire Hopes**

Oil prices rose on Tuesday as the market focused on uncertainty over a potential Gaza ceasefire and some expectations that producer group OPEC+ will extend voluntary supply cuts in March.

### **Oil Rises on Stronger US Physical Markets and China Demand**

Oil rose as physical markets in the US strengthened and demand from China showed signs of picking up.

### **More Evidence of Declining Production Sees Natural Gas Advance Early (LOGIN CREDENTIALS REQUIRED)**

Continued signs of easing production volumes in updated estimates Tuesday helped lift April natural gas futures in early trading.

### **US Power Grids Seek More Coordination With Natgas Firms to Improve Reliability**

Several U.S. power grid operators published a position paper on Wednesday which identifies issues and outlines suggestions to improve the reliability of gas-electric coordination.

### **Low Gas Prices Reshape Haynesville 2024 Production Outlook**

Sub-\$2 gas prices at the US benchmark Henry Hub are putting operators in the Haynesville Shale under the gun recently, raising questions about the potential for a slowdown in drilling and production there.

### **Tumbling US Natural Gas Prices Prove Unstoppable, Hurting Producers**

For nearly a year, U.S. natural gas producers have slammed the brakes on production as prices fall.

### **Natural Gas Price Drop Could Spell Doom for Producers**

Natural gas prices have continued to fall, with a mild winter and overproduction that has seen producers in the American shale patch attempt to dial down output only to have oil companies producing gas as a byproduct throw a spanner in the plans.

### **Natural Gas Hasn't Been This Cheap in Decades (LOGIN CREDENTIALS REQUIRED)**

The lowest inflation-adjusted prices in at least 34 years have drillers throttling down from record production

### **US Producers Tout LNG Growth Outlook Despite Regulatory Uncertainty**

US gas producers are confident that impacts from the Biden administration's decision to suspend issuance of key LNG export permits for new projects will be limited over the next few years as they ready plans to serve incremental demand growth from projects already under construction.

### **Total CEO: US LNG Shaky, Global Projects Brought Into Spotlight (LOGIN CREDENTIALS REQUIRED)**

U.S. President Joe Biden's decision to pause approvals for new U.S. LNG projects benefits similar projects around the world and casts doubt around U.S. supply, TotalEnergies' Pouyanné told analysts during the company's quarterly webcast.

### **EPA Approves Year-round Sales of Higher Ethanol Blend in 8 Midwest States**

Drivers in eight Midwestern states will be able to fuel up with a higher blend of ethanol throughout the year under a final rule announced Thursday by the Environmental Protection Agency.

### **Louisiana's Carbon Capture Permitting Authority Challenged by Enviro Groups**

Environmental groups have challenged the Biden administration's decision to give primary permitting authority to Louisiana over the state's carbon sequestration wells, which the U.S. government says are key tools to address climate change.





## **SELECTED RECENT TRANSACTIONS**

### **Esperanza, Andros Capital Partners to Acquire ExxonMobil's Interests in Ursa, Princess Fields**

Esperanza Capital Partners and Andros Capital Partners LLC have announced the execution of a definitive purchase agreement to acquire Exxon Mobil Corporation's assets in the Ursa and Princess fields in the Gulf of Mexico.

### **Chord Energy, Canada's Enerplus to Combine Into \$11 Billion Company in North Dakota's Williston Basin**

Chord Energy Corp. and Canada's Enerplus Corp. said late Wednesday they have agreed to merge in an \$11 billion stock and cash deal with an eye toward establishing a "premier" position in North Dakota's Williston shale basin.

### **Benchmark Buys Revolution Resources' Anadarko Assets in \$145 Million Deal**

Benchmark Energy II is acquiring Revolution Resources just over four years after Revolution bought out Jones Energy Inc.'s Midcontinent portfolio.

### **Bayswater Acquires New Oil and Gas Production, Drilling Assets in DJ Basin**

Bayswater Exploration & Production, a Denver-based oil and natural gas development company, recently acquired assets that will continue to expand its operations in the Denver Julesburg Basin in Weld County, Colorado.

### **Diamondback Agrees to \$26 Billion Deal to Buy Endeavor Energy in Growing Permian Push**

Shale producer Diamondback Energy said on Monday it would buy the largest privately held oil and gas producer in the Permian Basin, Endeavor Energy Partners, in a cash-and-stock deal valued at about \$26 billion, including debt.

### **California Resources Corporation to Combine With Aera Energy**

California Resources Corporation announced the signing of a definitive merger agreement to combine with Aera Energy, LLC in an all-stock transaction valued at approximately \$2.1 billion.

### **Vital Energy Closes Deal to Acquire Additional Interests in Permian Basin Assets**

The \$78-million deal gives Vital Energy additional working interests in producing assets associated with the recent asset acquisition from Henry Energy LP, Moriah Henry Partners LLC, and Henry Resources LLC.

### **Silver Hill Energy Partners to Buy Liberty Resources' North Dakota Assets**

Silver Hill Energy Partners said it would acquire Liberty Resources II's interests in oil and gas properties and all of Liberty Midstream Solutions in North Dakota for an undisclosed amount.

### **Permian Resources Unveils Two Bolt-on Acquisitions For \$175 Million**

Permian Resources announced a series of deals consisting of two bolt-on acquisitions, an acreage swap, a sale of non-core assets and additional grassroots acquisitions.

### **W&T Offshore to Increase Oil and Gas Production With \$72 Million U.S. Gulf of Mexico Acquisitions**

W&T Offshore, Inc. has completed the accretive acquisition of six fields in shallow waters of the U.S. Gulf of Mexico.

### **Talos Energy to Acquire QuarterNorth Energy For \$1.29 Billion**

Oil and gas company Talos Energy, said it will acquire privately held QuarterNorth Energy in a \$1.29 billion cash-and-stock deal to bolster its presence in the Gulf of Mexico.

### **Prairie Operating Expands With \$94.5 Million Asset Acquisition**

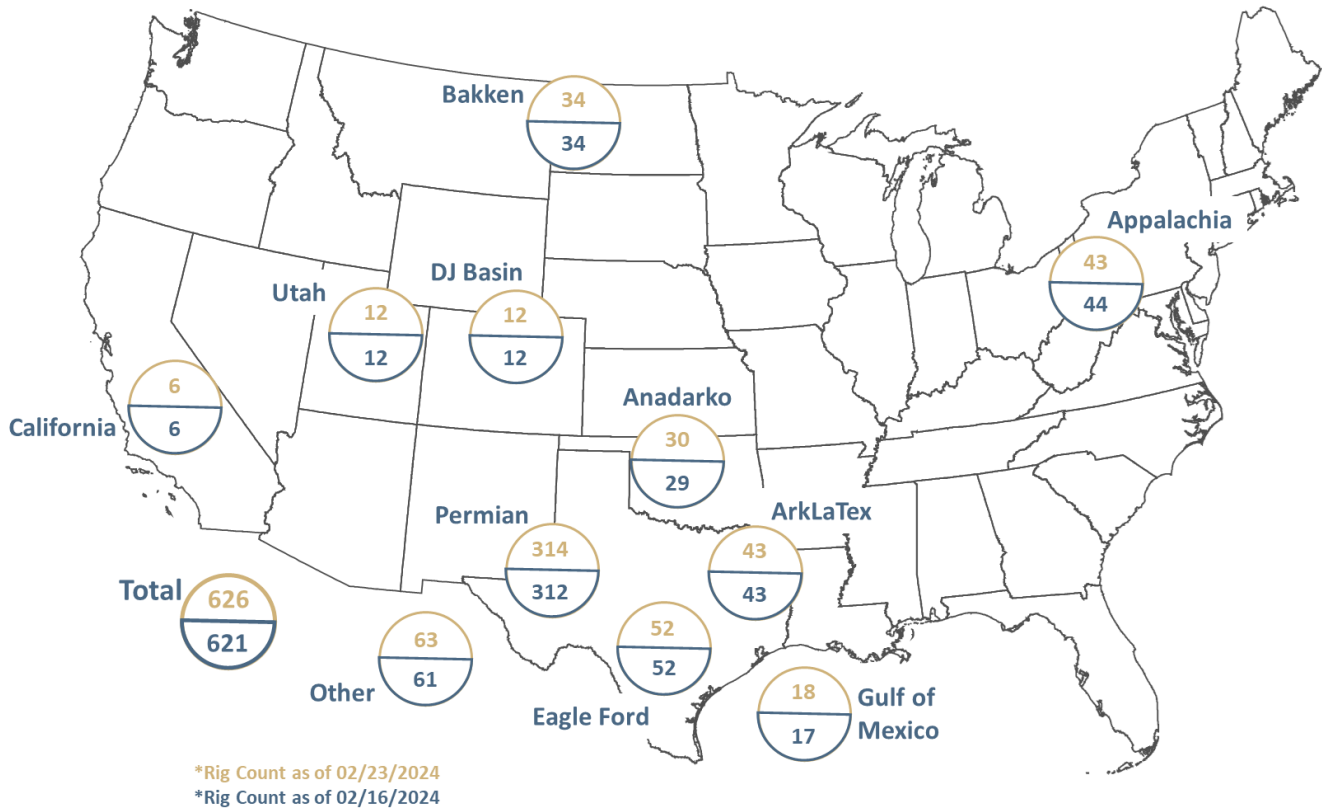
Prairie Operating Co., an oil and gas company, has announced a definitive agreement to acquire the assets of Nickel Road Operating LLC for a total consideration of \$94.5 million.

### **Chesapeake Energy Merges With Southwestern For \$7.4 Billion—Becomes Largest Natural Gas Producer In U.S.**

Chesapeake Energy will merge with Southwestern Energy in an all-stock deal valued at \$7.4 billion, both companies announced Thursday, the latest transaction in the energy industry that would make Chesapeake the largest natural gas producer in the U.S.



## RIG ACTIVITY BY US REGION

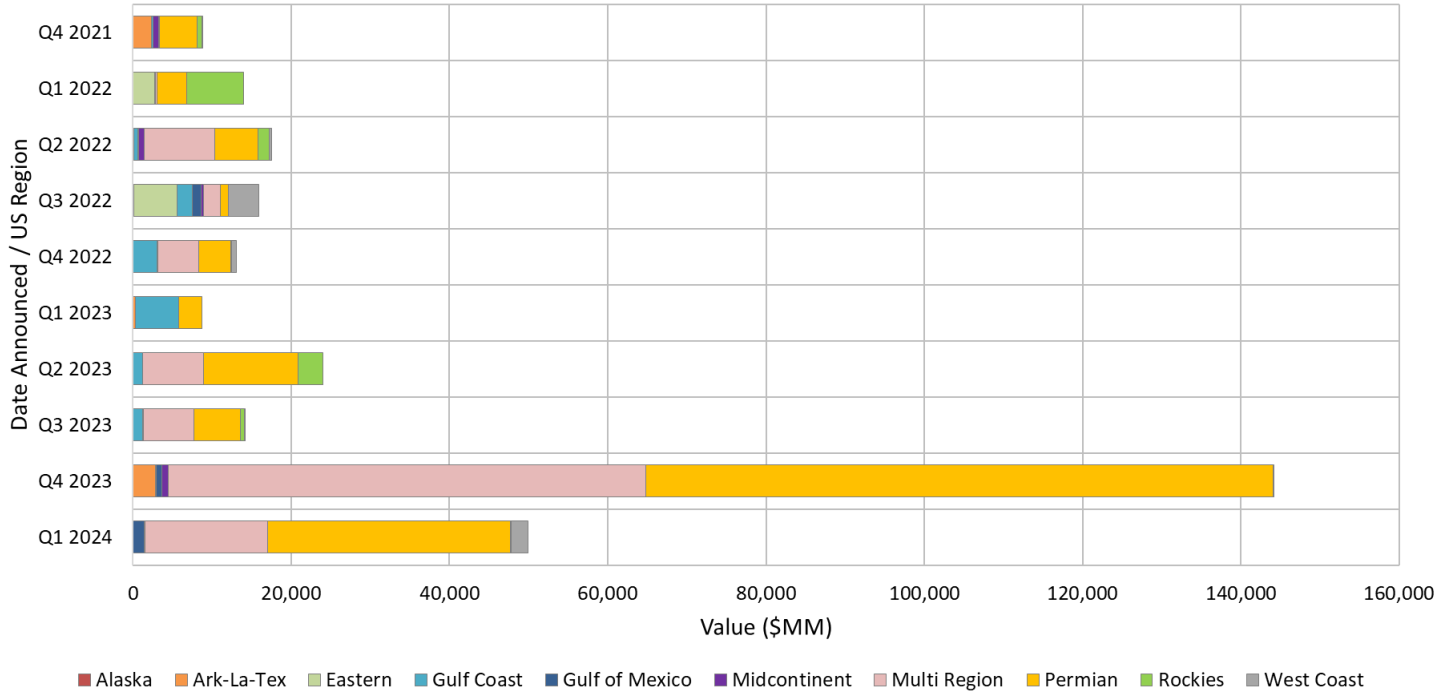


	Week Ending 02/23/2024			Week Ending 02/16/2024		Week Ending 02/24/2023
U.S. Rig Breakouts	Count	+/-	Count	+/-	Count	
Oil	503	6	497	(97)	600	
Gas	120	(1)	121	(31)	151	
Not Specified	3	0	3	1	2	
Directional	50	2	48	6	44	
Horizontal	560	0	560	(133)	693	
Vertical	16	3	13	0	16	
Land (Inc Others)	606	4	602	(128)	734	
Inland Waters	0	0	0	(2)	2	
Offshore	20	1	19	3	17	
<b>US Total</b>	<b>626</b>	<b>5</b>	<b>621</b>	<b>(127)</b>	<b>753</b>	

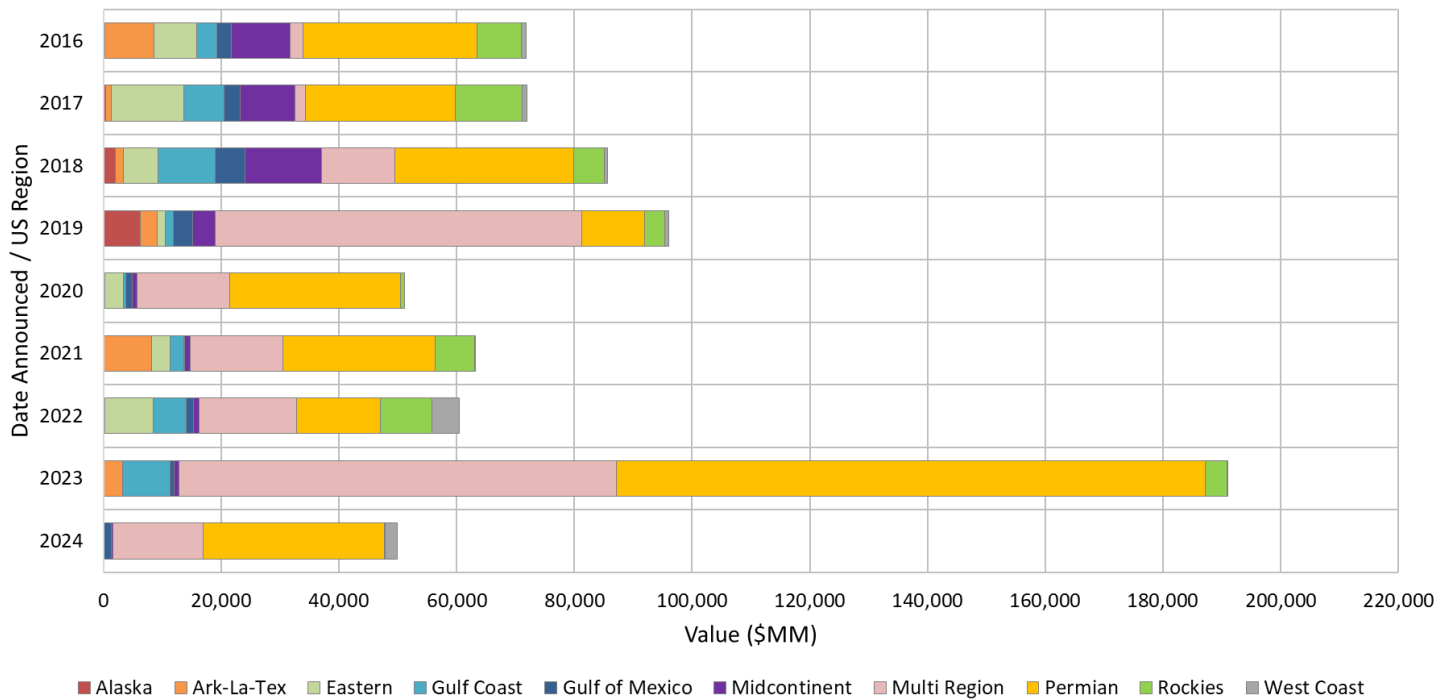
\*Source—Baker Hughes Weekly Rig Counts



## DEAL VALUE BY US REGION (BY QUARTER)



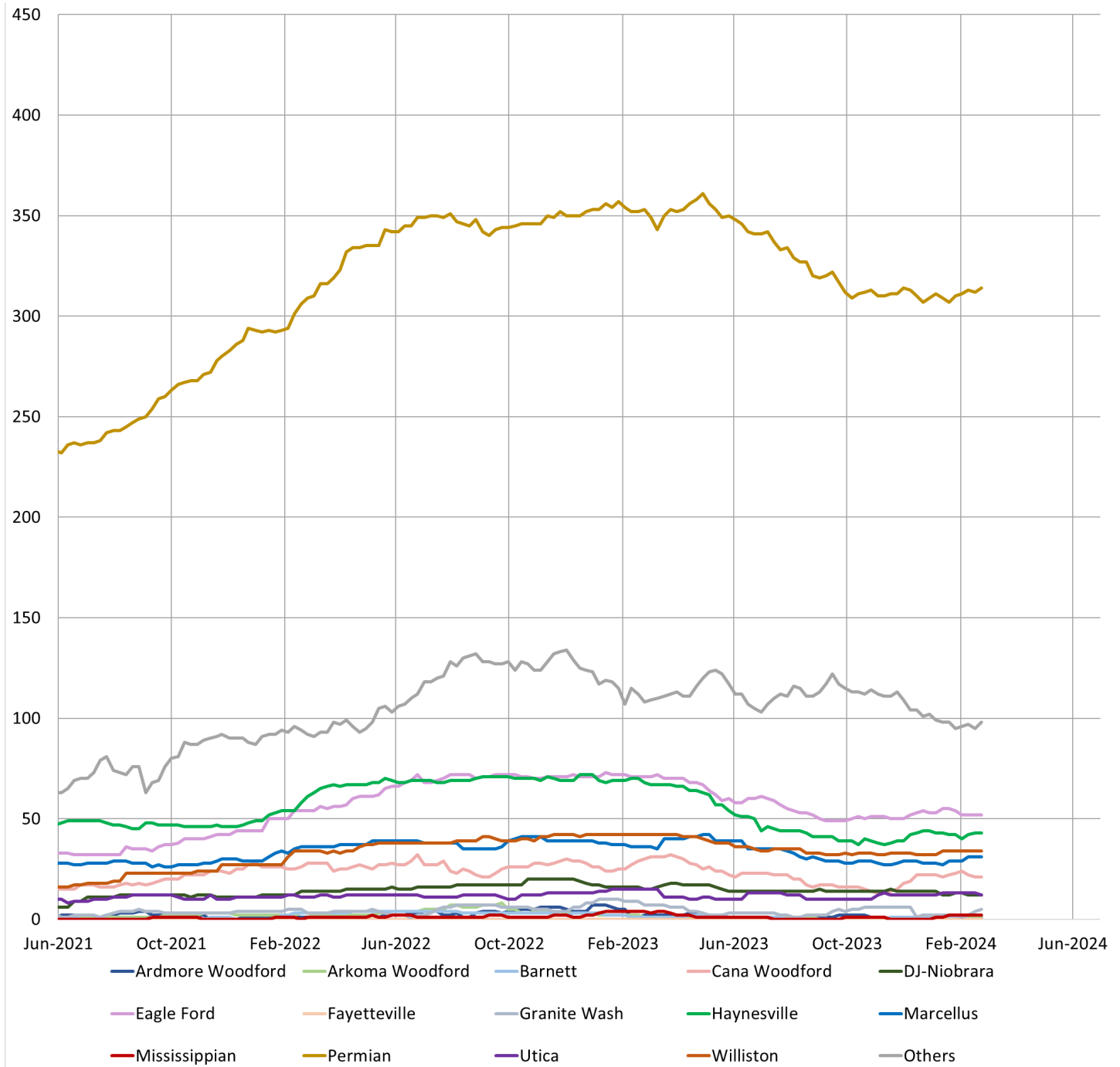
## DEAL VALUE BY US REGION (BY YEAR)



\*Source—PLS M&A Database (Charts exclude terminated deals)



## RIG ACTIVITY BY US REGION

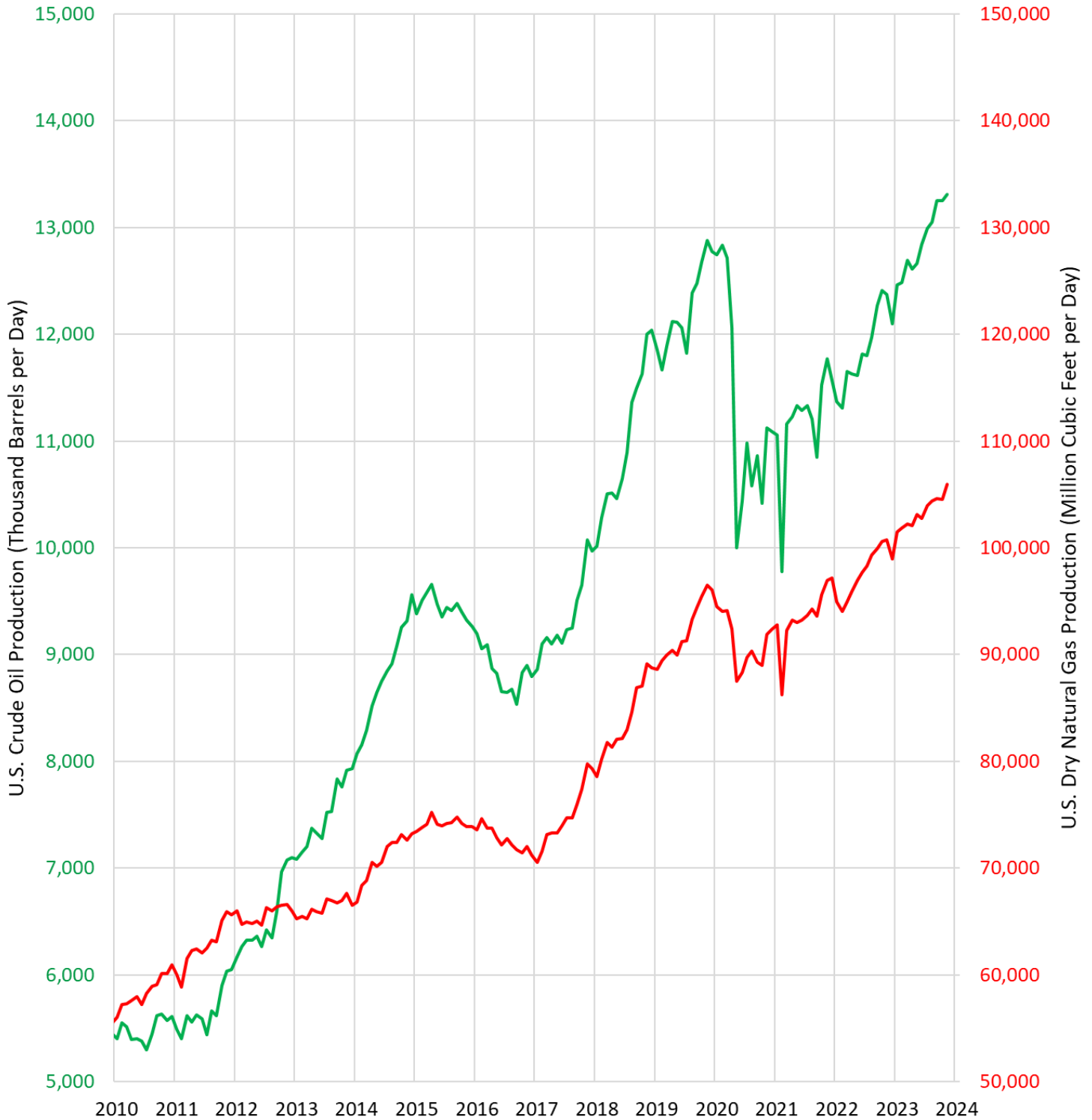


\*Source—Baker Hughes Weekly Rig Counts





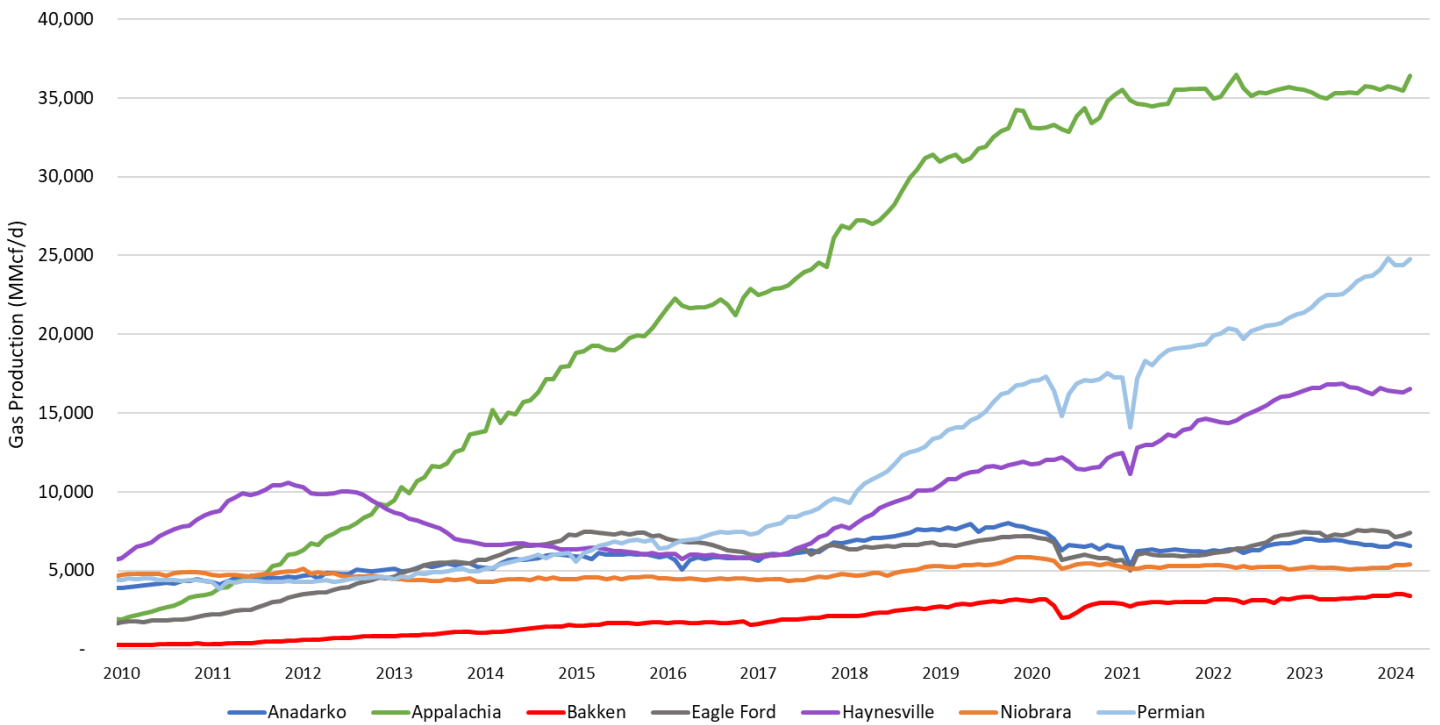
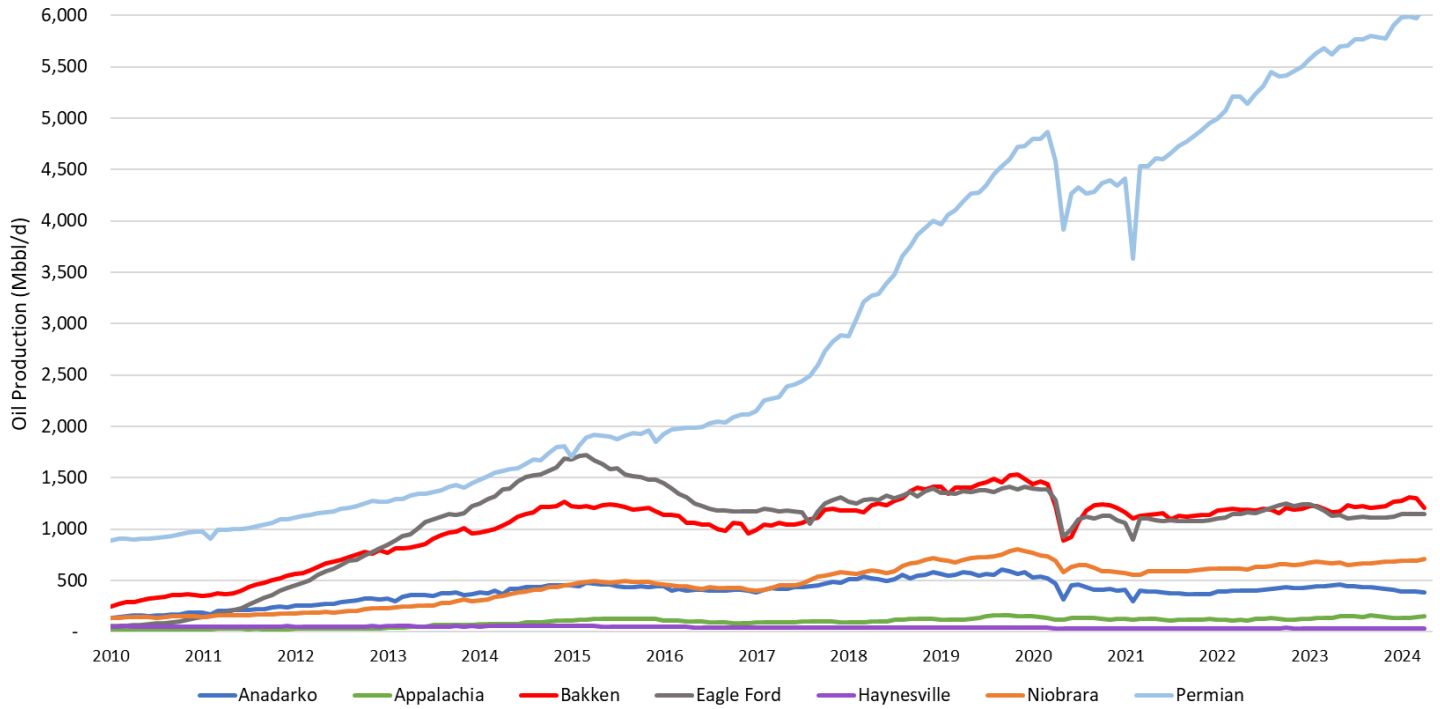
**US DAILY CRUDE (MMbbl) & DRY NATURAL GAS PRODUCTION (MMcf)**



\*Source—Energy Information Administration, United States (EIA)



## HISTORICAL PRODUCTION OF SELECTED US SHALE REGIONS



\*Source—Energy Information Administration, United States (EIA)



## UPCOMING EVENTS

### February 2024

<a href="#">SPE Business Development A&amp;D Symposium</a>	February 28	Houston, TX
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### March 2024

<a href="#">Big Energy! Gala 2024</a>	March 2	Houston, TX
<a href="#">5th Circuit Bankruptcy Bench-Bar Conference</a>	March 6-8	New Orleans, LA
<a href="#">Tulsa Irish Festival</a>	March 8-10	Tulsa, OK
<a href="#">OneGoal Pathways of Promise Luncheon</a>	March 20	Houston, TX
<a href="#">ROCC US Men's Clay Court Championship</a>	March 30 - April 7	Houston, TX

### April 2024

<a href="#">World Oilman's Poker Tournament (WOPT)</a>	April 3-5	Las Vegas, NV
<a href="#">The Leukemia &amp; Lymphoma Society (LLS) Big Climb</a>	April 6	Houston, TX
<a href="#">HBA &amp; HPF Spring Social</a>	April 11	Houston, TX
<a href="#">World Oilman's Mineral &amp; Royalty Conference (MARC)</a>	April 15-16	Houston, TX
<a href="#">Quorum Qnections Conference</a>	April 23-25	Las Vegas, NV
<a href="#">HPF/SPE Fifth Annual Crawfish Boil</a>	April 24	Houston, TX
<a href="#">World Oilman's Tennis Tournament (WOTT)</a>	April 24-27	Houston, TX
<a href="#">ADAM Energy Golf Tournament</a>	April 29	Frisco, TX

\*Denotes an Opportune Sponsored Event



## **ABOUT RALPH E. DAVIS ASSOCIATES**

**Ralph E. Davis Associates LLC (RED)** is an industry-leading petroleum engineering and geosciences firm committed to satisfying the individual needs of clients. We accomplish this by holding ourselves to the highest standards of integrity and professionalism to deliver honest, direct and actionable insights to help clients achieve their strategic objectives. We distinguish ourselves by combining reservoir engineering, geoscience evaluation techniques and advanced data analytics with economic analyses to provide our clients with individual, customized solutions.

Banks, bondholders, private equity firms, financial institutions and law firms around the world trust in RED's diverse services and unrivaled upstream oil and gas expertise to deliver comprehensive solutions that help clients make informed decisions. We add value to every engagement by employing a team approach, leveraging Opportune LLP's experienced bench of experts in transactional due diligence, tax advisory, investment banking, restructuring and valuation.

We offer technical and economic analyses to deliver our clients a complete, independent, accurate and detailed assessment of the value of their assets. We apply a robust set of technical capabilities to assist our clients. Our capabilities include:

- Reservoir engineering and geosciences
- Economic forecasting and reporting
- Data analytics and geospatial analysis

## **KEY CONTACTS**



**Steve Hendrickson** is the President of Ralph E. Davis Associates, an Opportune LLP company. Steve has over 35 years of professional leadership experience in the energy industry with a proven track record of adding value through acquisitions, development and operations. Steve is a licensed professional engineer in the state of Texas, and holds an M.S. in Finance from the University of Houston and a B.S. in Chemical Engineering from The University of Texas at Austin. He recently served as a board member of the Society of Petroleum Evaluation Engineers (SPEE) and is a registered FINRA representative.



**John Beaird** is Vice President of Ralph E. Davis Associates, an Opportune LLP company. John has 39 years of oil and gas management, reservoir engineering, and petroleum economics evaluation experience. Recent relevant experience includes the Permian, Western Gulf, Tx-La-Miss Salt, Mid-Continent, Denver-Julesburg, Wind River, Williston Basin, and Appalachian Basins. John is a registered Petroleum Engineer in the State of Texas and holds a B.S. in Petroleum Engineering from Louisiana Tech University. He is also an active member of the Society of Petroleum Evaluation Engineers (SPEE).



David Edwards is a Petroleum Engineer at Ralph E. Davis Associates, an Opportune LLP company. David has over three years of reserves engineering experience in conventional and unconventional reservoirs. Before RED, David was a Petroleum Engineer at a lower middle market A&D advisory firm where he handled the technical processes for marketed assets. He began his career with an operator in Dallas, where he contributed to its engineering, operations, and A&D teams. David holds an M.B.A. from The University of Texas Permian Basin and a B.S. in Petroleum Engineering from The University of Oklahoma.

