



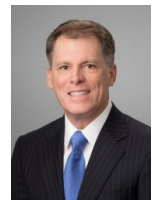
Weekly E&P Update

April 4, 2023

Vol. 13

Underground Hydrogen Storage Challenges - Part 2

By Steve Hendrickson
President of Ralph E. Davis Associates



In last week's newsletter, we gave a brief overview of the challenges associated with underground hydrogen storage (UHS). Coincidentally, this week the [Society of Petroleum Engineers](#) (SPE) published the April online edition of the [Journal of Petroleum Technology](#) (JPT), which contains two excellent articles by [Trent Jacobs](#) on the subject. This gave me a good opportunity to continue our discussion of the topic.

Jacobs' [first article](#) (SPE membership required to view) addresses uncertainties in the viability of UHS and describes the most important technical obstacles facing researchers and project developers. There's a good summary of these issues, particularly concerning depleted gas fields, that expands on the points I raised last week. Jacobs mentions there "are plenty of hurdles for sure, but none are deemed deal breakers." That may be the case, but after reading the article, the hurdles do add up, and it seems we are a long way from resolving many of them.

The second article goes into greater depth about [using salt caverns for hydrogen storage](#), highlighting some factors that make this approach much more attractive than storage in saline aquifers or depleted fields. A key one is the absence of porous reservoir rock in the cavern storage system. The presence of reservoir rock creates several technical and economic challenges, including reactions of minerals with hydrogen, potential microbial activity, increased need for a gas cushion between the hydrogen and brine layers, uncertain storage seal effectiveness, lower rates of withdrawal, and likely greater amounts of working gas that are permanently lost. And while depleted reservoirs and saline aquifers have never been used for UHS, there are already working cases of salt cavern storage. The biggest downside to salt cavern storage is that the underground salt accumulations are concentrated on the Gulf Coast, far from most renewable energy sources.

My take from these two articles is that depleted reservoirs and saline aquifers are unlikely to be widely adopted for UHS, but some isolated cases may be viable. These will require extensive engineering and design work specific to the local conditions and a lengthy pilot period. As a result, I believe they're unlikely to be relevant for many years. Salt cavern storage, however, avoids many of the problems of the other two, we have years of experience with them, and they can be permitted and constructed much faster. My guess is they'll become the more relevant approach over the next several years.

Table Of Contents

[This Week in Oil & Gas](#)

[US Commodity Prices](#)

[Industry Headlines](#)

[Recent Transactions](#)

[Rig Activity by US Region](#)

[Deal Value by US Region](#)

[Total US Rig Count by US Region](#)

[US Daily Crude & Dry Natural Gas Production](#)

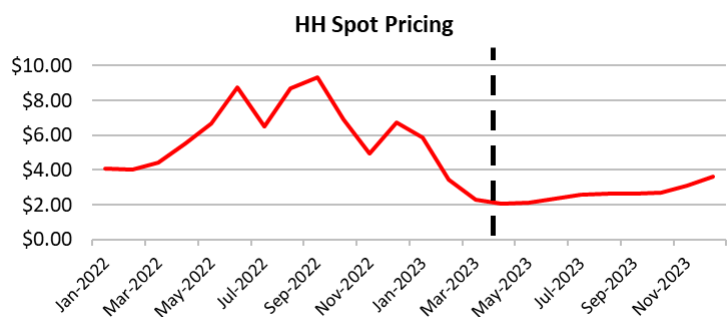
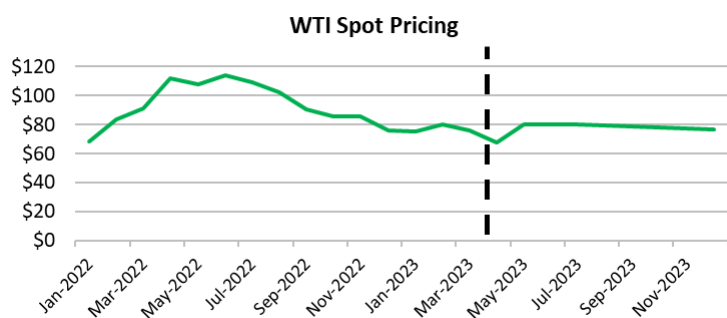
[Historical Production of US Shale Regions](#)

[Upcoming Events](#)

[About Us/Key Contacts](#)



NYMEX FUTURE PRICING



MONDAY'S MARKET CLOSE

NYMEX WTI CRUDE OIL FUTURES as of April 03, 2023 Close (\$/bbl)

Period	Current	WoW Change	Last Week	1 Yr Ago
2023	\$79.05	\$6.73	\$72.32	\$86.77
2024	\$73.49	\$4.07	\$69.42	\$80.88
2025	\$68.52	\$2.04	\$66.48	\$76.45
2026	\$64.76	\$0.68	\$64.08	\$73.08
2027	\$61.69	(\$0.19)	\$61.88	\$70.95

NYMEX HH NATURAL GAS FUTURES as of April 03, 2023 Close (\$/MMBtu)

Period	Current	WoW Change	Last Week	1 Yr Ago
2023	\$2.71	(\$0.04)	\$2.75	\$4.53
2024	\$3.54	(\$0.08)	\$3.62	\$3.82
2025	\$4.19	(\$0.04)	\$4.23	\$3.81
2026	\$4.25	(\$0.04)	\$4.29	\$3.89
2027	\$4.23	(\$0.04)	\$4.27	\$3.97

INDUSTRY METRICS—QUICK SNAPSHOT

	Current	Last Week	WoW Change	%Change
Crude Oil Near-Month Price (\$/bbl)	\$72.98	\$69.51	\$1.25	5%
Natural Gas Near-Month Price (\$/MMBtu)	\$2.18	\$2.15	\$0.03	1%
Weekly Upstream-Deal Transaction Value (\$MM)	\$0.00	\$0.16	(\$0.16)	(100%)
Weekly Number of Upstream-Deal Transactions	1	2	(1)	(50%)
Current Total US Rig Count	755	758	(3)	(0.4%)
US Field Crude Oil Production (MMbbl/day)	12.2	12.3	(0.1)	(0.8%)
US Field Dry Natural Gas Production (Bcf/day)	104.9	105.7	(0.8)	(0.8%)
Commercial Crude Oil Stocks-Excluding SPR (MMbbl)	474	481	(7)	(2%)
Natural Gas Stocks-Working Gas Underground Storage (Bcf)	1,853	1,900	(47)	(4%)
Total Drilled But Uncompleted Wells (DUC-Last Month)	4,773	4,773	0	-

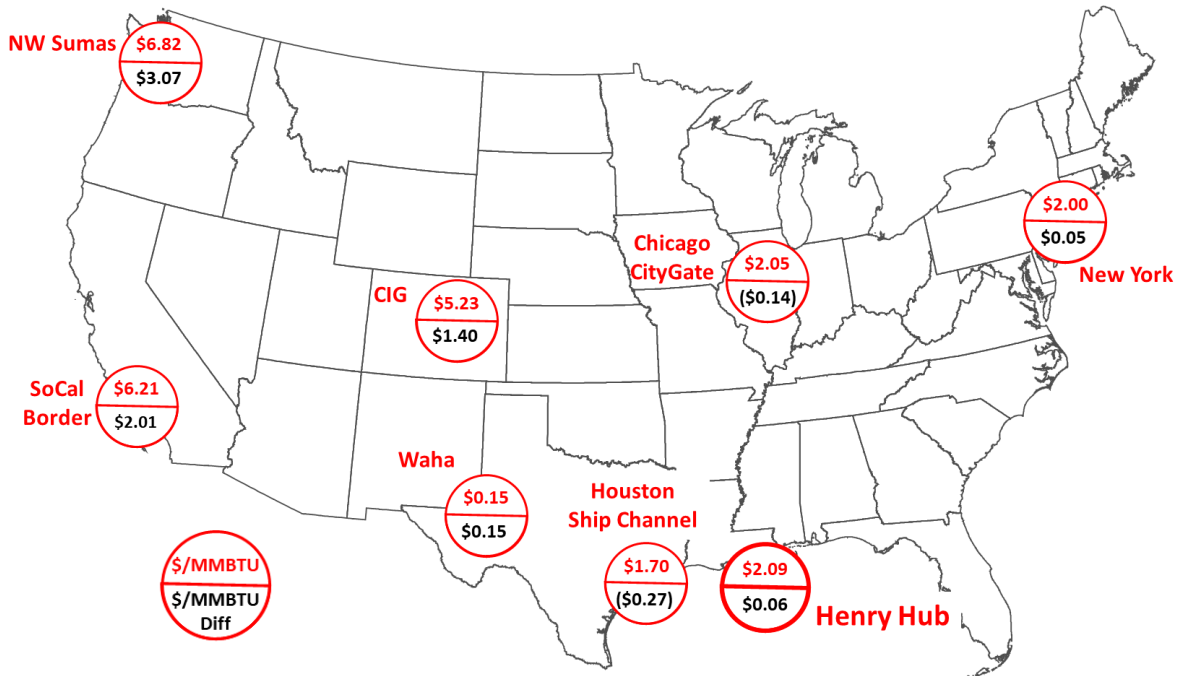
*Source—Energy Information Administration, United States (EIA)

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

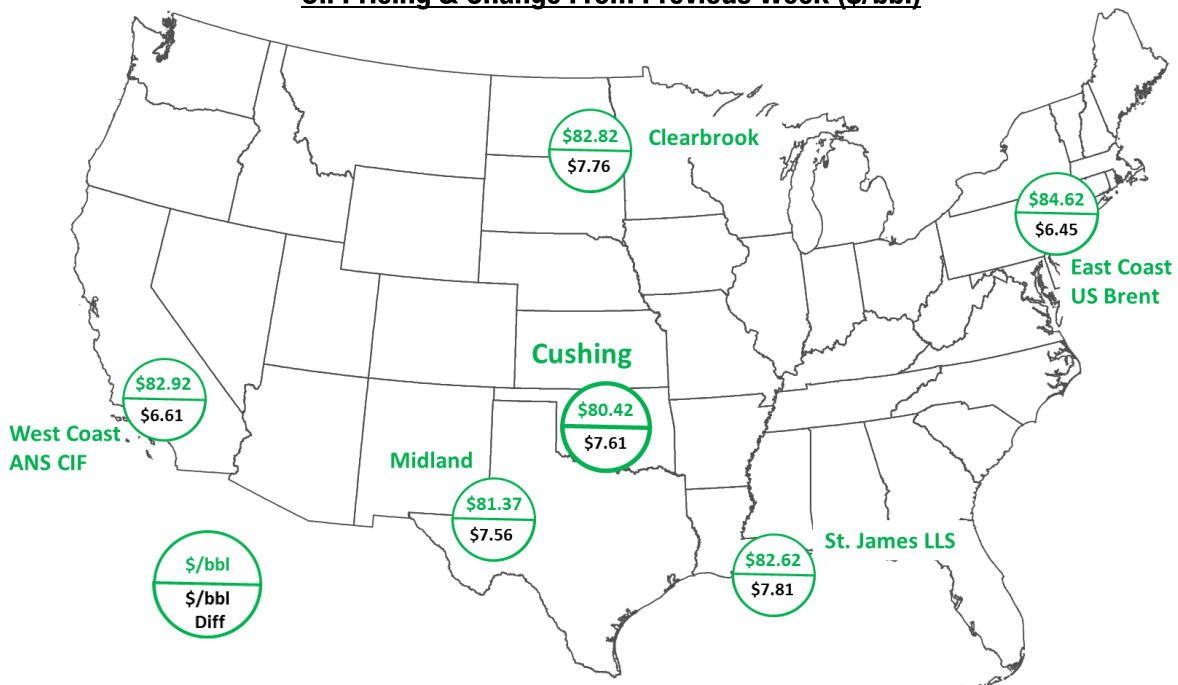


US COMMODITY PRICES CONTINUED

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



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



*Source—Bloomberg LP



SELECTED INDUSTRY HEADLINES

Oil Prices Soar After OPEC+ Announces Production Cuts

Oil rallied the most in more than a year after OPEC+ unexpectedly announced output cuts that threaten to tighten the market and deliver a fresh inflationary jolt to the world economy.

5 Things To Know About Saudi Arabia's Stunning Decision To Cut Oil Production

Saudi Arabia and a handful of other countries stunned the world recently by announcing significant cuts in their oil production – totaling more than a million barrels of oil per day – starting in May.

US Has Replaced Russia As Europe's Top Crude Oil Supplier

The United States is now the biggest supplier of crude oil to the European Union. In December, 18% of the bloc's crude imports came from America, EU data office Eurostat said recently.

What Fast-Growing Oil Demand In Asia Means For The Rest Of The World

China has become a staple in analysts' oil and gas price forecasts, but it's not just Asia's largest economy, other larger and smaller economies in Asia could replace China as the single most important driver of global oil demand.

Will EVs Really Crush All Oil And Gas Demand

There's been no shortage of blue-sky forecasts from EV enthusiasts who have predicted an apocalypse for the oil industry, but how real are these forecasts is what some experts are asking.

U.S. Production Of Petroleum And Other Liquids To Be Driven By International Demand

Strong continuing international demand for petroleum and other liquids will sustain U.S. production above 2022 levels through 2050, according to most of the cases we examined in the Annual Energy Outlook 2023 by the U.S. Energy Information Administration.

Reservoir Simulations Use AI to Change with the Times (LOGIN CREDENTIALS REQUIRED)

Artificial intelligence and new simulation technologies are automating the modeling process for oil and gas, carbon capture and storage and geothermals.

Japan Considers Funding Hydrogen Plan With \$113 Billion Investment

Japan will consider setting aside 15 trillion yen (\$113 billion) in public and private-sector funds over the next 15 years to create hydrogen and ammonia supply chain to help clean up its energy sector.

West Texas Intermediate To Join Global Crude Oil Benchmark (LOGIN CREDENTIALS REQUIRED)

Midland crude oil will join the global Brent benchmark, potentially boosting exports from Houston due to its abundance of storage facilities, export terminals, refineries and its proximity to the mighty Permian Basin.

The Year Crude Oil Markets Embraced Something New

The creation of the WTI Crude Oil futures contract 40 years ago was a leap of faith that not everyone believed it would succeed, let alone become the key global benchmark that it is today.



SELECTED RECENT TRANSACTIONS

Wedgemount Resources To Acquire Additional Texas Permian Basin Oil And Gas Assets

Wedgemount Resources Corp., is pleased to announce that it has entered into a Purchase and Sale Agreement for the acquisition of additional oil and gas assets located in the prolific Permian Basin of west central Texas.

Principal Solar To Acquire Minerva-Rockdale Leases, Wells, And Assets

Principal Solar, Inc. recently announced that it has executed a Letter of Intent to purchase a controlling working interest in the leases and oil & gas wells along with all of the assets associated with the Minerva-Rockdale Oil Field from Winchester Oil & Gas LLC.

Carrier Energy Partners II Sells Eagle Ford Assets

Carrier Energy Partners II, LLC has closed on the sale of its oil and gas assets in the Eagle Ford Shale in South Texas for total cash consideration of \$145 million.

CPP Investments Partners With IKAV To Acquire Aera Energy

Canada Pension Plan Investment Board (CPP Investments) will partner with international asset management group IKAV to acquire California energy producer Aera Energy LLC.

Riley Permian Announces New Mexico Yeso Trend Acquisition

Riley Exploration Permian, Inc. recently announced that it has entered into a definitive purchase agreement to acquire oil and gas assets from Pecos Oil & Gas, LLC, an affiliate of Cibolo Energy Partners LLC, for cash consideration of \$330 million.

Baytex To Acquire Eagle Ford Operator Ranger Oil, Accelerates Shareholder Returns And Introduces A Dividend With Enhanced Free Cash Flow

Baytex Energy Corp. recently announced that it has entered into a definitive agreement to acquire Ranger Oil Corporation, a pure play Eagle Ford company.

Diamondback Energy, Inc. Announces Fourth Quarter And Full Year 2022 Financial And Operating Results; Increases Base Dividend

Diamondback Energy, Inc. recently announced financial and operating results for the fourth quarter and full year ended December 31, 2022, which includes entering into definitive agreements to divest certain Midland and Delaware Basin assets in Texas.

Chesapeake Energy Corporation Announces Sale Of Second Eagle Ford Package For \$1.4 Billion

Chesapeake Energy Corporation recently announced that it has executed an agreement to sell a portion of its remaining Eagle Ford asset to INEOS Energy for \$1.4 billion.

Verde Bio Holdings, Inc. Announces Acquisition Of Haynesville Shale Mineral And Royalty Interest

Verde Bio Holdings, Inc. recently announced that it has entered into an agreement to acquire revenue producing mineral and royalty interests in the prolific Haynesville Shale of Northern Louisiana, held by a private seller for a purchase price of \$425,000 in cash.

Foothills Exploration Acquires Certain Leases and Wells In Oklahoma

Foothills Exploration recently announced that it had managed to complete the acquisition of some wells and leases in Comanche County in Oklahoma.

Vital Energy Announces Midland Basin Acquisition

Vital Energy, Inc. recently announced the signing of a definitive purchase and sale agreement to acquire the assets of Driftwood Energy Operating, LLC, inclusive of all leasehold interests and hedges, in exchange for 1,578,948 shares of Vital common stock and \$127.6 million of cash.

Surge Energy America Announces Recent Acreage Acquisitions And Finalization Of Houston Corporate Office Move

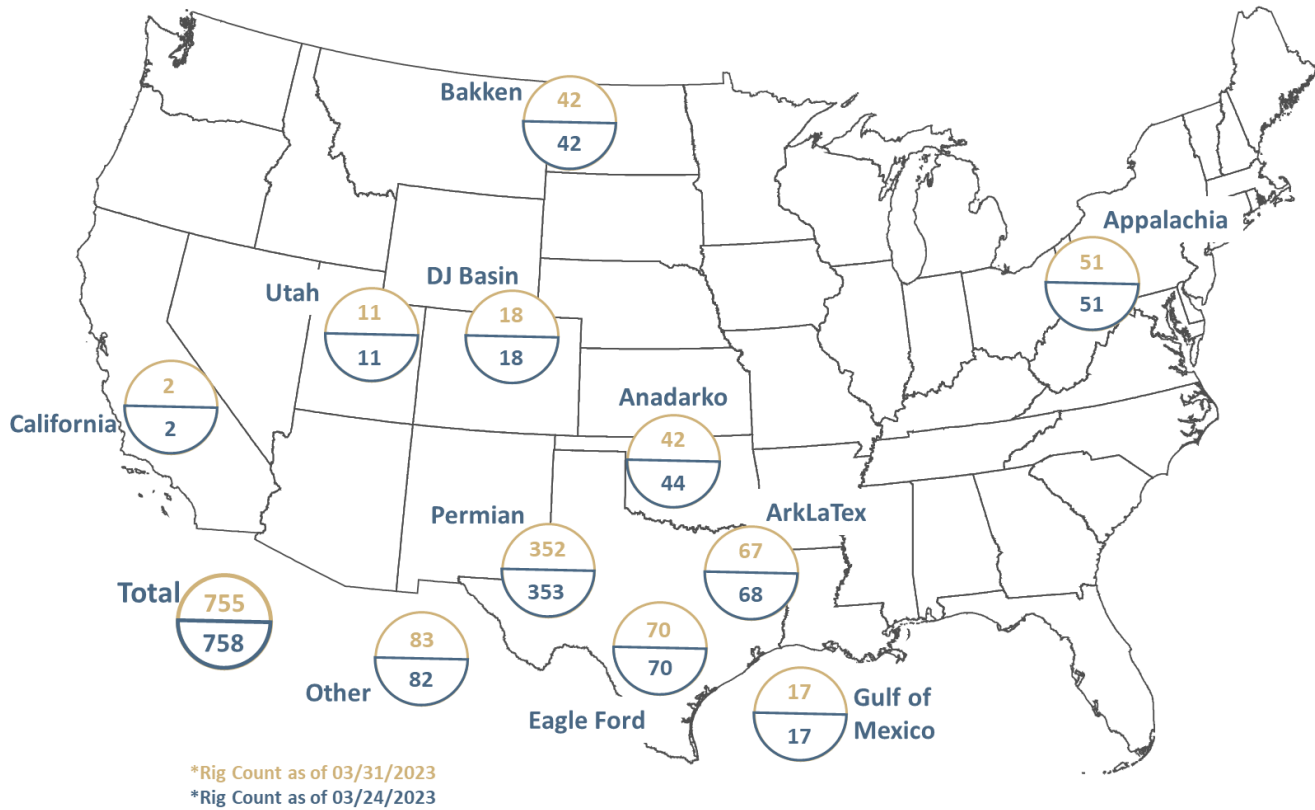
Surge Energy US Holdings Company recently announced it has recently added incremental acreage to the Company's portfolio. Additionally, earlier this month the company finalized the previously announced move of its corporate office.

Alliance Resource Partners, L.P. Announces \$72.3 Million Mineral Acquisition

Alliance Resource Partners, L.P. recently announced a \$72.3 million acquisition of oil & gas mineral interests in the Permian Basin from JC Resources LP.



RIG ACTIVITY BY US REGION

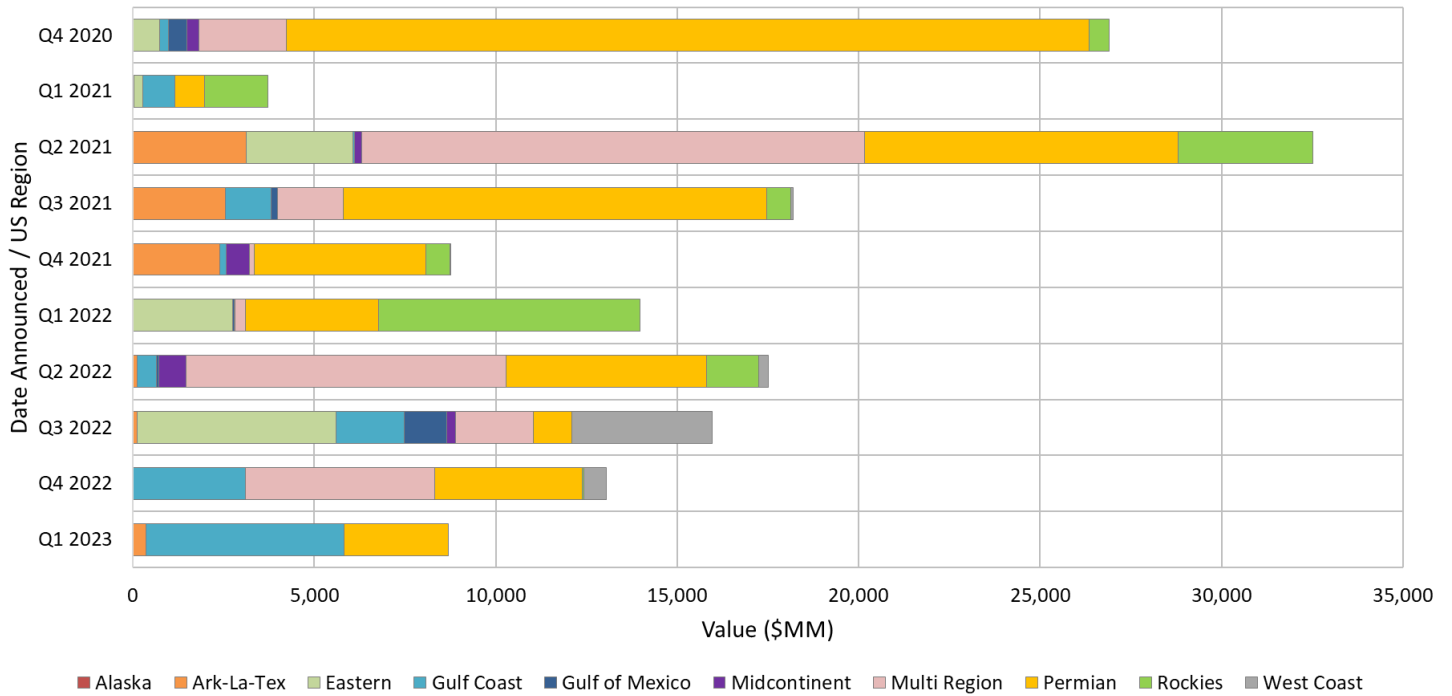


	Week Ending 03/31/2023			Week Ending 03/24/2023		Week Ending 04/01/2022
U.S. Rig Breakouts	Count	+/-	Count	+/-	Count	
Oil	592	(1)	593	59	533	
Gas	160	(2)	162	22	138	
Not Specified	3	0	3	1	2	
Directional	51	1	50	16	35	
Horizontal	691	(1)	692	78	613	
Vertical	13	(3)	16	(12)	25	
Land (Inc Others)	736	(3)	739	79	657	
Inland Waters	1	0	1	(1)	2	
Offshore	18	0	18	4	14	
US Total	755	(3)	758	82	673	

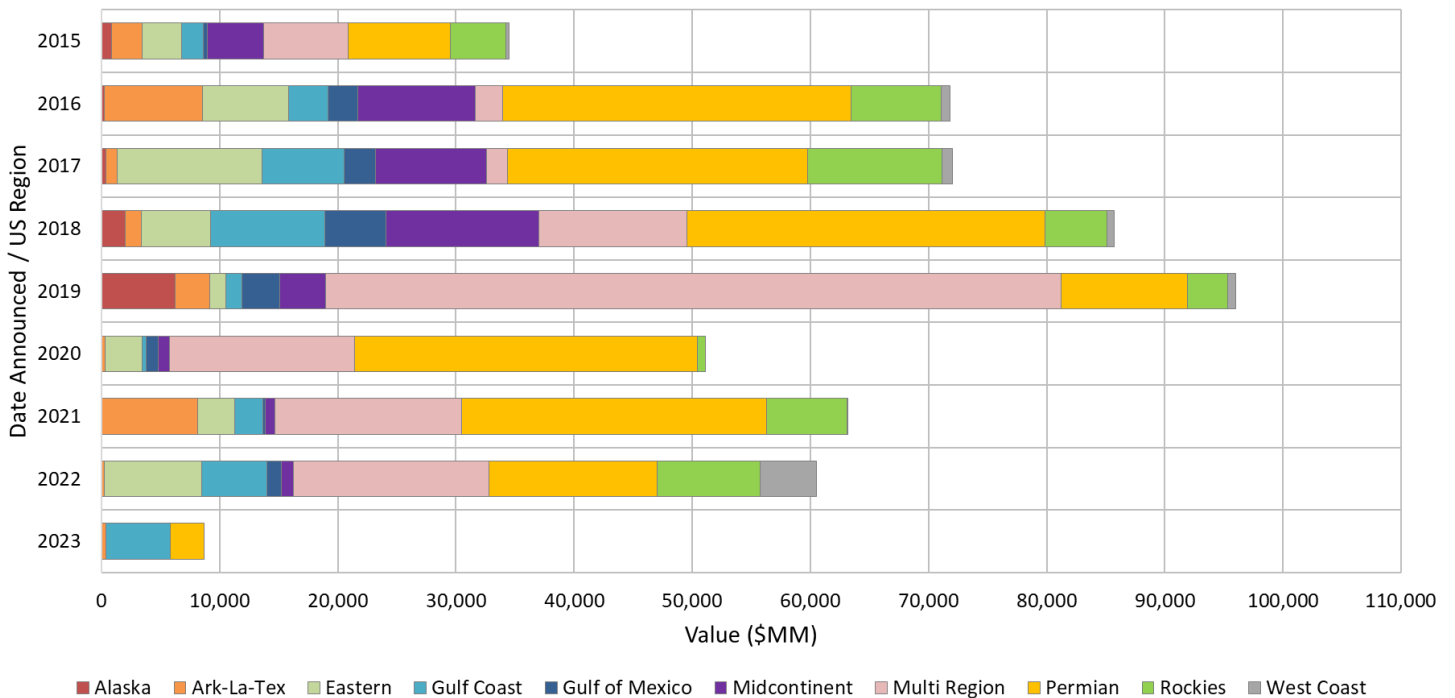
*Source—Baker Hughes Weekly Rig Counts



DEAL VALUE BY US REGION (BY QUARTER)



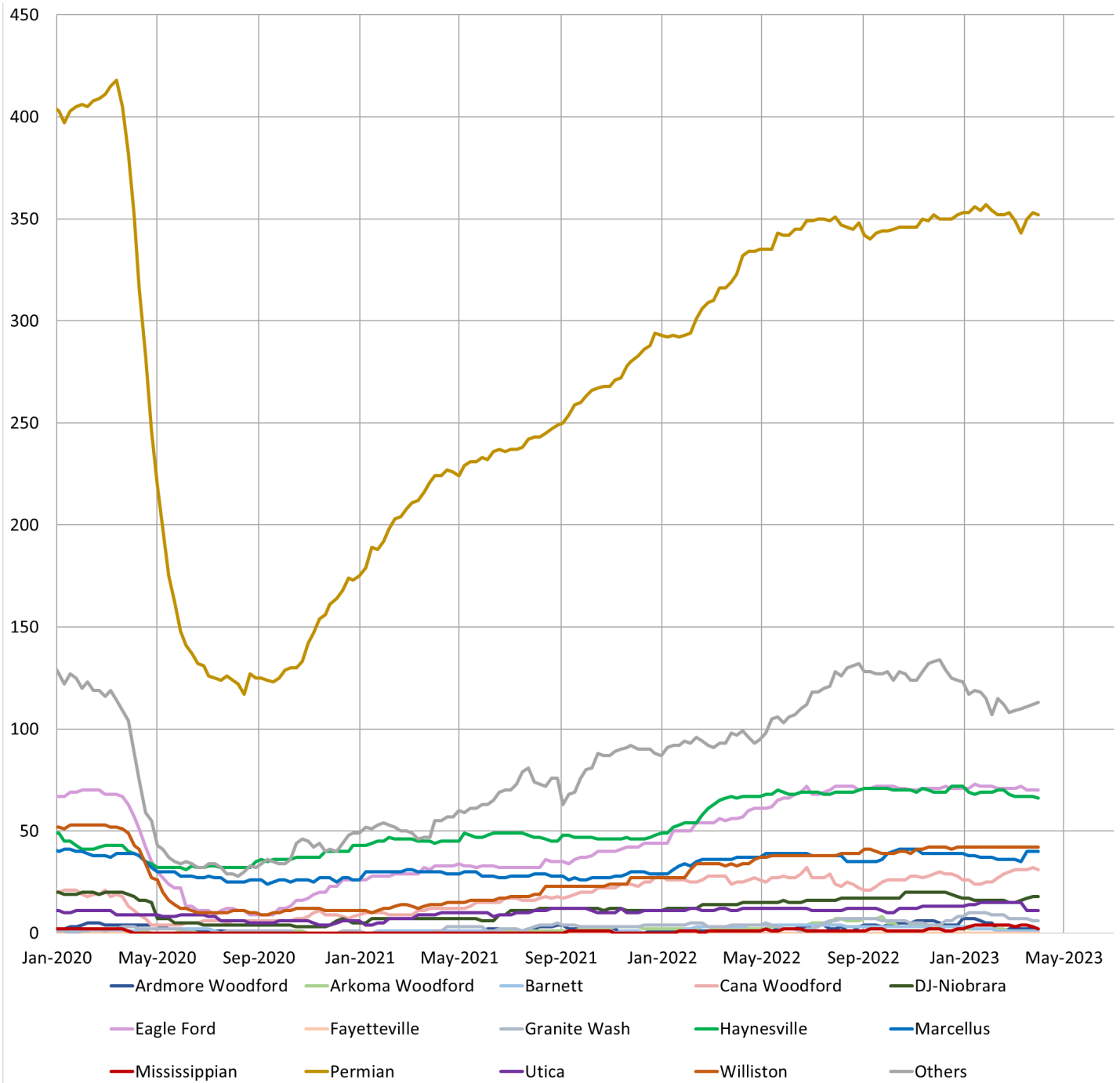
DEAL VALUE BY US REGION (BY YEAR)



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



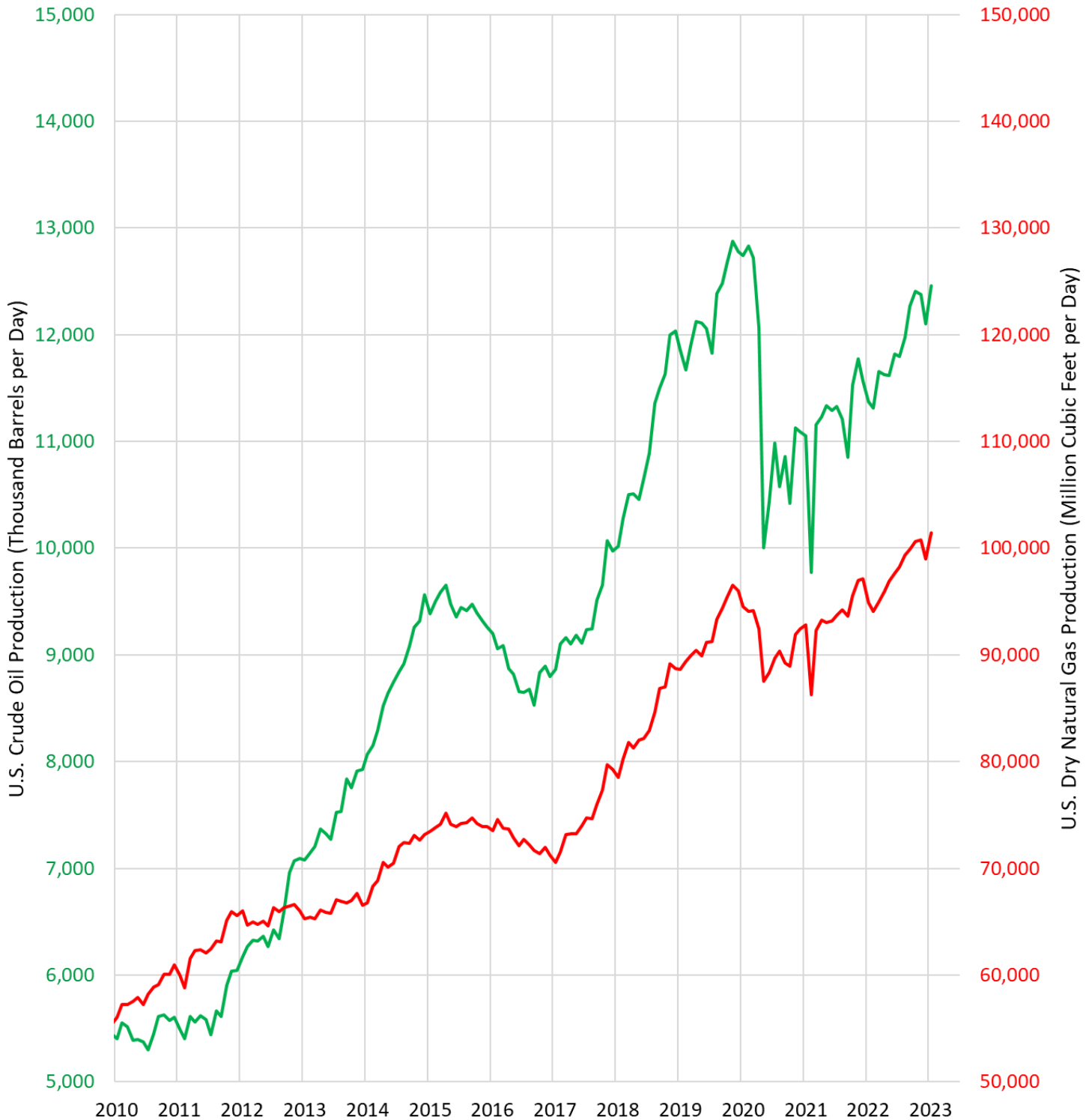
RIG ACTIVITY BY US REGION



*Source—Baker Hughes Weekly Rig Counts



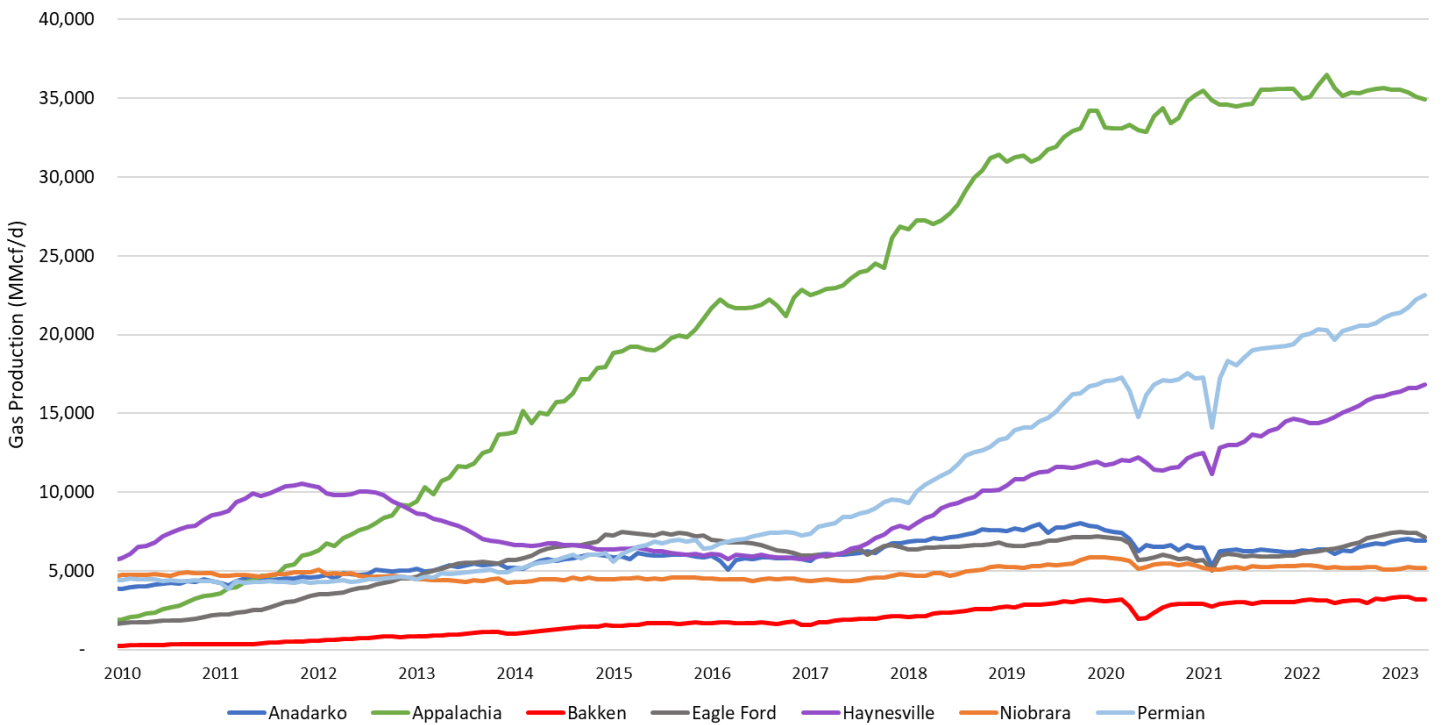
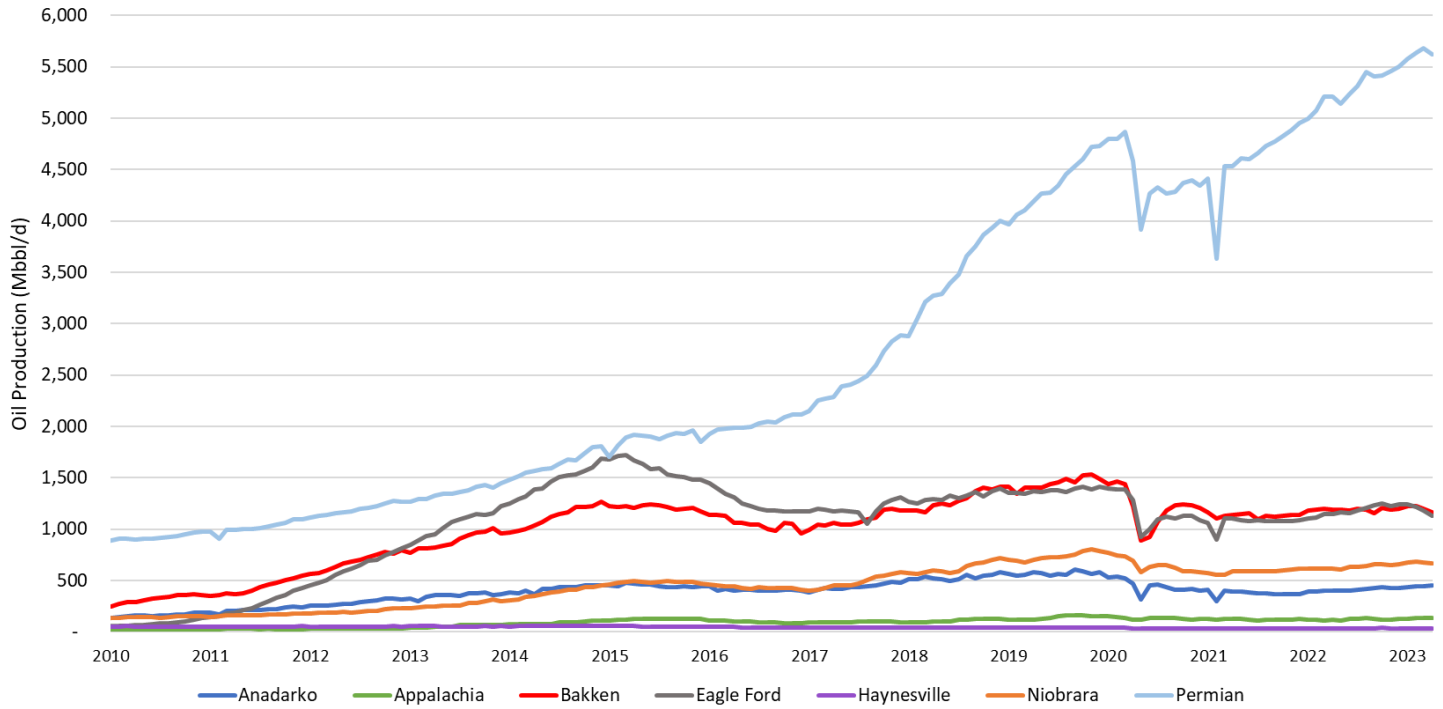
US DAILY CRUDE (MMbbl) & DRY NATURAL GAS PRODUCTION (MMcf)



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



HISTORICAL PRODUCTION OF SELECTED US SHALE REGIONS



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



UPCOMING EVENTS

April 2023

<u>US Men's Clay Court Championship 2023</u>	April 1-9	Houston, TX
<u>World Oilman's Minerals & Royalty Conference (MARC)</u>	April 10-11	Houston, TX
<u>HBA & HPF Spring Social</u>	April 13	Houston, TX
<u>Small Steps Wine Classic</u>	April 19	Houston, TX
<u>2023 World Oilman's Poker Tournament</u>	April 26-28	Las Vegas, NV
<u>World Oilman's Tennis Tournament (WOTT)</u>	April 26-29	Houston, TX
<u>Houston Producers Forum/SPE Fourth Annual Crawfish Boil</u>	April 27	Houston, TX

May 2023

<u>Offshore Technology Conference 2023</u>	May 1-4	Houston, TX
<u>Energy Valuation Conference</u>	May 11	Houston, TX
<u>North American Petroleum Accounting Conference</u>	May 18-19	Dallas, TX
<u>DUG Permian Basin & Eagle Ford Conference & Exhibition</u>	May 22-24	Fort Worth, TX

June 2023

<u>Society Of Petroleum Evaluation Engineers (SPEE) Annual Meeting</u>	June 17-20	Newport, RI
--	------------	-------------

July 2023

<u>Banff Energy Summit</u>	July 12-14	Banff, Alberta, Canada
--	------------	------------------------

*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).



Yvonne Trujillo is a Senior Petroleum Engineer at Ralph E. Davis Associates, an Opportune LLP company. Yvonne has over 25 years experience in the oil and gas industry with extensive expertise in reserves engineering, SEC and PRMS/SPE reporting and economics and asset evaluation in conventional and unconventional reservoirs in the U.S. Lower 48. Yvonne earned a B.S. in Mechanical Engineering at Simon Bolivar University in Caracas, Venezuela and an M.S. in Petroleum Engineering at the University of Houston.



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.

