RESERVOIR SOLUTIONS

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Ryder Scott geothermal audit in oil and gas reserves software is newest wrinkle

Ryder Scott broke ground late last year, setting a company-first on a geothermal energy audit of reserves for a potential acquisition by client Cyrq Energy Inc.

The audit focused on production performance and was relatively similar to an oil and gas reserves audit of PDP (proved developed producing) reserves, said **Steve Gardner**, who performed the work. He is a managing senior vice president at the Denver office of Ryder Scott.

Early in a project, the most common approach to estimate geothermal reserves is the volumetric method. Later, when the evaluator has more historical data and wells, numerical modeling is frequently used.

Ryder Scott conducts thermal modeling with the CMG STARS simulator. Cyrq had built a reservoir simulation model, but wanted Ryder Scott to attempt using decline-curve analysis (DCA) for the audit, which is a very trusted technique for oil and gas producing wells.

In DCA or simulation, evaluators use historical performance trends to forecast future production. Evaluators start with an inventory of available data to decide on a forecasting method. Cyrq provided data on steam and water mass, total mass production, enthalpy, and wellhead pressures and temperatures.

Outside the box

To facilitate the DCA and economic calculations, Gardner and the Cyrq team decided to modify PHDWin, a full-featured commercial software program designed for the oil and gas industry.

Gardner said, "This was probably the first time anyone had attempted to forecast declining steam production with a standard reserves software," he said. "The workaround turned out to be similar to our normal approach for forecasting oil and gas. There were just different production streams and slightly different decline characteristics."

While not part of the project scope, it appeared that economic calculations would also be similar to what an evaluator sees in an oil and gas reserves project. Gardner indicated the potential to incorporate prices derived from electricity sales, operating costs, maintenance capital, and so on.

Some considerations during the audit also included depth, temperature, intensity of the heat source and rate of recharge and/or re-heating of the water.

"It is common for geothermal projects to outrun their heat supply either by withdrawing water faster than it is recharging

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Cyrq Energy Inc. produces from geothermal deposits in the Hudson Ranch field more than 100 miles east of San Diego in the Salton Sea area of California. Pictured are cooling towers emitting water vapor at the plant. Flashing of high-temperature, hyper-saline brine from the Hudson Ranch field results in a major buildup of iron-rich silica scale. Many fields use downhole scale-inhibitor injection to reduce wellbore scaling and associated clean out costs.

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Dynamic duo: Oil/gas and geothermal

Greater capital discipline and mitigated project risk have leaned up the current E&P sector. As economics begin to line up post pandemic, industry has set its sights on getting back to the business of pumping $70-a-barrel oil and building up returns to investors.

Business as usual, though, may have a few obstacles this time around. A push from investors is driving industry to realize that oilfield capital is contingent on demonstrable ESG (environmental, social and governance) programs and records.

Case in point is Exxon Mobil Corp. Activist hedge fund Engine No. 1 flexed its muscles this year after bulking up on institutional investment, including pension-fund backing. The "little engine that could" bought big chunks of Exxon equity and last May, voted in board members aligned with ESG.

Oil and gas companies now face the real prospect of change from the inside out. With little choice but to comply, industry has to take a serious look at renewable resources, including offshore wind energy and increasing stakes in solar energy.

The sun beneath our feet

Perhaps the most natural fit for energy diversification is the extraction of heat from hydrothermal reservoirs where water in the host rock is heated by a high geothermal gradient in the earth's crust. Tapping into the earth's natural heat to power residences and businesses is the essence of geothermal power.

Geothermal, considered a niche industry, is often overlooked. It only accounts for 0.4 percent of net electricity generation in the United States, which produces the most geothermal electricity in the world: more than 3.5 GW or enough to power about 3.5 million homes.

"How Geothermal Energy Works," published by Save on Energy LLC, outlines three main types of geothermal energy plants – dry steam, flash steam and binary cycle.

Expansion Pipework at the Nga Awa Purua geothermal power station in Taupo, New Zealand. Courtesy Creative Commons by Geothermal Resources Council; Licensed under CC BY-NC-ND 2.0

Binary ORC plants

Binary cycle plants circulate hot subsurface waters or steam in closed-loop systems (similar to a radiator). Water/steam is pumped to a heat exchanger where it heats a second liquid — an organic fluid, such as isobutene, which boils at a lower temperature than water. The Save on Energy primer summarizes open- and closed-loop systems.

Closed-loop systems with power generation based on Organic Rankine Cycle (ORC) are making it possible to produce electricity from low-temperature geothermal resources less than 100º C.

This opens up vast opportunities worldwide for geothermal energy. ORC has generated more than 2.7 GW of installed capacity for more than 700 power plants worldwide.

Focusing on ORC, **Mariia Shmeleva** wrote "Geothermal Energy Production from Oil and Gas Wells," an MS-degree thesis at the Gubkin Russian State University of Oil and Gas in 2018.

The thesis summarizes in more detail the ORC technology used to maximize thermal energy from oil and gas wells.

"ORC power generation using low-temperature geothermal resources is one of the most common geothermal power generation technologies," she writes. "The extracted water from a well is pumped to the evaporator where it transfers its heat to the organic working fluid. Shell and tube heat exchangers are widely used.

The Raft River geothermal plant, constructed in 1979, was the first binary-cycle commercial power plant in the U.S. Courtesy Creative Commons by Idaho National Laboratory; Licensed under CC BY 2.0

The heated organic fluid boils and high-pressure vapor drives the axial flow or radial inflow turbine, which is coupled to a generator. So, mechanical work is converted into electrical power. Then organic fluid is cooled and condensed. From the condenser, it is pumped back … (as) the cycle repeats again."

Crossover potential

For oil and gas drillers, geothermal developments have good crossover potential.

"No one is better at digging holes than the oil and gas sector. Over the last century, the industry has perfected the art of extracting fossil fuels many miles below the surface. Its future, however, may be in digging for heat," stated climate reporter **Michael J. Coren** in an article published by *Quartz Media Inc.* this year.

For oil and gas personnel in transition, geothermal makes use of many of the same skills.

"The transition from oil and gas to deep geothermal is a big opportunity for a highly skilled workforce that operates the drilling platforms," **Igor Kočiš**, CEO of Slovakia-based GA Drilling, told *Rigzone* recently. "On the side of upstream, the jobs are the same or similar – drilling, casing, cementing, drilling muds, logging, reservoir, production, etc."

Bottom line in kWh

In the renewables world, geothermal is a fledgling unable to compete with solar and wind, as measured by lobbying budgets and political pull. Solar and wind energy have historically raked in higher subsidies and incentives than geothermal companies.

Solar and wind also are reigning in costs more rapidly than geothermal.

The latest report from the International Renewable Energy Agency recently reported that solar and onshore wind remain as the cheapest new energy sources. Solar photovoltaics (PV) shows the sharpest cost decline over 2010-2019 at 82 percent, followed by concentrated solar power (CSP) at 47 percent, onshore wind at 40 percent and offshore wind at 29 percent.

Electricity costs from utility-scale solar photovoltaic cells fell 13 percent year-on-year, reaching nearly 7 cents per kWh in 2019. Onshore and offshore wind both fell about 9 percent

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year-on-year, reaching 53 cents per kWh and more than 11 cents per kWh, respectively, for newly commissioned projects. Costs for CSP, still the least developed among solar and wind technologies, fell 1 percent to 18 cents per kWh.

Costs for utility-scale geothermal energy are as high as 17 cents per kWh for greenfield developments in remote areas. Where the costs begin to become more interesting to the oil and gas sector is second-stage development of existing fields for a rock-bottom 4 cents per kWh.

Wind and solar are developing and using battery back-ups, enabling those industries to provide more reliable power generation whether the wind blows or sun shines.

Nevertheless, geothermal is the most reliable source of renewable energy during various base- and peak-load cycles for electricity. Geothermal has a vital role in the energy mix that powers electrical generating plants during critical periods.

"Over the last few years, a number of start-ups in the geothermal space have gained traction, such as Eavor Technologies, Fervo Energy, Sage Geoystems, and GreenFire Energy," stated **Katie Brigham**, a *CNBC* producer, in May. A video accompanied the summary.

The new ventures are not big companies, but have the financial backing of several IOCs (international oil companies).

Petroleum-geothermal mix

The cost of drilling geothermal wells is 30 to 70 percent of the total investment to establish an industrial plant. That has given rise to a renewed interest in repurposing abandoned oil and gas wells for geothermal purposes.

"Practically, however, it's not that straightforward," according to an article by **Irina Slave** this year in *OilPrice.com* that answers the question, "Can Abandoned Oil Wells Be Used To Generate Geothermal Power?"

"For starters, flow rates from such wells are much lower than from newly drilled geothermal wells," **Jamie Beard** told *Oilprice*. She is executive director of the Geothermal Entrepreneurship Organization at the University of Texas at Austin.

"Then there is the issue of heat: most oil wells are simply not hot enough to make sense if we are talking about electricity generation, said Beard. "Existing wells often suffer from well integrity issues that will make them ill-suited for a 20- to 40-year lifespan as a producing geothermal asset."

Another article this year considered the repurposing of abandoned oil and gas wells. **Matthew Veazy** at *Rigzone* interviewed **Karl Farrow**, CEO of the geothermal project development firm CeraPhi Energy Ltd.

"So, we shouldn't expect that a repurposed oil well will replicate the results you would expect from a purposely drilled geothermal well in a geyser zone in California," said Farrow. "However, consider the repurposing of oil and gas

Derrick at St. Gallen geothermal project. Courtesy Creative Commons by Kecko; Licensed under CC BY 2.0. Geothermal drilling rigs are indistinguishable from oil and gas rigs. St. Gallen in Switzerland was temporarily sealed in 2013 after a gas kick and earthquake, and is now used for research.

wells effectively as having pilot test wells or the wildcat already-drilled well – following from which you then have the ability to prove up a new commercial case to help decarbonize a business model on that site and, if commercial, you have scalability and can drill new wells specifically for the production and configuration you require."

The politics of oil well abandonment will also influence the future of retrofitting for geothermal, as lawmakers and regulators erect hurdles.

In an *OilPrice* article last May, "How Canada Could Repurpose Oil Wells for Its Renewable Revolution," **Felicity Bradstock**, a freelance writer, examines the tradeoffs.

In the article, **Regan Boychuk** at the Alberta Liabilities Disclosure Project said, "It's a transparent attempt to pass this liability to someone else."

Bradstock points out that repurposing the wells in Canada "would effectively shift the clean-up burden from the government to private companies, taking away the cost to the taxpayer," which is estimated at $166 billion.

Watered out, not down for the count

In some cases, operators of mature oil and gas fields with high water cut can use produced water as a carrier of heat.

Industry has established hydrothermal projects with low-temperature energy recovery in several regions of the world. Potential candidates for this conversion are mature oil and gas wells with adequate exit pressures, surface temperatures greater than 135º C, 10,000 B/D total fluid-flow rates and water cuts of more than 50 percent. Conversion of heat to electricity is used to power the field or nearby host communities.

"A high bottom-hole temperature, reliable wellbore integrity, and large production capacity make a well a viable candidate for geothermal energy extraction. Because geothermal energy has caught the attention of the oil and gas industry, there is interest in modifying existing wells. …Abandoned oil and gas wells can play a vital role in geothermal resource utilization," stated the authors of "Potential for heat production by retrofitting abandoned gas wells into geothermal wells," a paper published by Public Library of Science, 2019.

Outside ring of fire

California is the epicenter in the U.S. for shallow, hot reservoirs suitable for economic generation of thermal energy. Sliding through the state is the "ring of fire" created by the interaction of the Eurasian, Pacific and Indian-Australian tectonic plates.

The ring enables California to be the No. 1 source in the world for electricity from geothermal energy. The Geysers in northern California comprise the largest dry steam field in the world.

Not every geothermal energy producer can be located in the ring of fire. Oil and gas companies looking at opportunities have no further to go than their own backyards, in some cases.

For instance, the deepest, hottest reservoirs in the Permian Basin are in the Delaware sub-basin, and are the focus of a well repurposing study by TGS, an energy data and intelligence company headquartered in Oslo, Norway.

The company published a technical article this year on oil and gas well data for use in geothermal prospecting.

"There is a vast resource of data and analyses utilized by the oil and gas industry that may be effectively repurposed for other industries, such as developing geothermal resources," the report stated.

Useful information includes oil and gas well performance and production data, well completion data and basin temperature data and models.

"Combining end of life economic data with well depth, producing formations, completion intervals, and maximum production rates within a stratigraphic framework offers value to companies interested in assessing alternatives to abandoning their assets," the TGS article stated.

TGS plotted decline curves of Delaware Basin production wells for comparative analysis of potential fluid flow rates to evaluate repurposing. The firm also built a temperature model.

Artificial hydrothermal reservoirs

Industry and government have collaborated in developing engineered enhanced geothermal systems (EGSs) that, in some cases, make use of oil and gas wells and technology.

The EGS concept is to extract heat by creating a subsurface fracture system and adding water through injection wells. Creating an enhanced, or engineered, geothermal system requires improving the natural permeability of rock, which is dependent on fractures and pore spaces between mineral grains.

In a dual-well system, an injection well pumps water into a thermal reservoir of hot, dry rocks. That opens natural fractures and creates new fracture networks and flow paths that intersect the wellbore. The increased permeability maximizes heat exchange and output.

A two-way circulatory flow system includes bringing steam to the surface through a production well. After the heat energy feeds into a turbine for electrical power, the leftover condensed water is collected and reinjected downhole.

"The implementation of enhanced (or engineered) geothermal systems, following the original hot dry rocks (HDR) two-well or doublet model, has been met with technical and economic challenges, lower-than-expected performance and limited public acceptance, as they typically require the 'engineering' of the reservoir by artificial stimulation to create the necessary heat exchange in the subsurface," stated a U.S. Department of Energy paper, "Assessment of Deep Geothermal Energy Exploitation Methods: the Need for Novel Single-Well Solutions," Volume 160, October 2018.

However, the energy landscape and politics have changed dramatically in the three years since the DOE publication. Energy providers are seriously assessing the scalability and profit potential of EGS.

For one, it makes it possible to tap into deep high-temperature reservoirs that are much more abundant than shallow hydro-geothermal energy sources, such as hot springs, volcanoes, geysers and other tectonically active areas.

Secondly, drilling-and-completion technology developed for shale plays is successfully used in geothermal projects. Most production wells have been vertical, but horizontal wells hold more promise. Geothermal projects can make use of

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A section of the Hellisheidi geothermal power plant complex. Courtesy Creative Commons by Martin V. Morris; Licensed under CC BY-SA 2.0. Hellisheidi, the newest and largest geothermal project in Iceland, is a flash steam plant that can generate 300 MW of power and 400 MW thermal.

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hydraulic fracturing developed and refined over the past 15 years to tap into tight oil and gas plays.

Shale plays have become proving grounds for staging repeatable "manufacturing" processes. Geothermal is poised to be scaled that way.

Some indirect evidence in models predicts multi-stage horizontal wells will experience early thermal breakdown along higher-conductivity fractures, and as such, will need intervention.

EGS can produce from a greater "inventory" of dry thermal reservoirs with wider ranges of porosity, permeability, fracture distribution and connectivity than conventional hydrothermal accumulations. Lower reservoir-risk profiles also reduce exploration-and-development uncertainties.

High heat

Three "classes" of fluid temperatures at the wellhead are high (>180° C), intermediate (100 to 180° C) and low (30 to 100° C). High-temperature geothermal resources generate energy for industrial power plants, while low and medium temperatures typically are used for small-scale local power and heat pumps.

The offshore oil and gas industry has developed high-temperature, high-pressure (HTHP) drilling, completions and downhole tools, which are essential in geothermal energy extraction.

This year, an article published in the *Journal of Petroleum Technology*, introduced the growing concept of applied HTHP technology for geothermal projects.

Judy Feder wrote the January article, "Geothermal Well Construction: A Step Change in Oil and Gas Technologies."

She stated, "The cutting-edge technological developments in geothermal are devoted to drilling into deeper, hotter and harder rock. Oil and gas expertise and know-how holds the key to cost reduction."

The service companies are taking the lead on this technical front.

"Numerous oil and gas service companies are contributing to game-changing capability and cost improvements in deep (especially horizontal) well construction, logging, and materials that enable completions in ultrahigh-temperature regions; high-temperature cement and well casing that increases long-term well integrity; research ... on different working fluids, such as water and supercritical CO^2 (sCO^2)—that is, above the temperature at which it is neither gas nor liquid, but has properties of both," wrote Feder.

Hotter rock may be the future of EGS. Japan, Iceland, Mexico, Italy and New Zealand are investigating the development of very high temperature geothermal resources greater than 400° C using EGS methods.

A technical paper by **Susan Petty**, et al., "Technology Needs for Superhot EGS Development," explores the potential of harnessing the thermal energy of superheated rocks in brittle-ductile transition zones some of which are 5- to 6-km deep.

The paper, presented at the 45th Workshop on Geothermal Reservoir Engineering last year at Stanford University, delves into three areas of short- and long-term development needs: Wellfield development, reservoir characterization and creation, and long-term resource management.

The following chart from the paper shows relative megawatts (MW) of energy per well.

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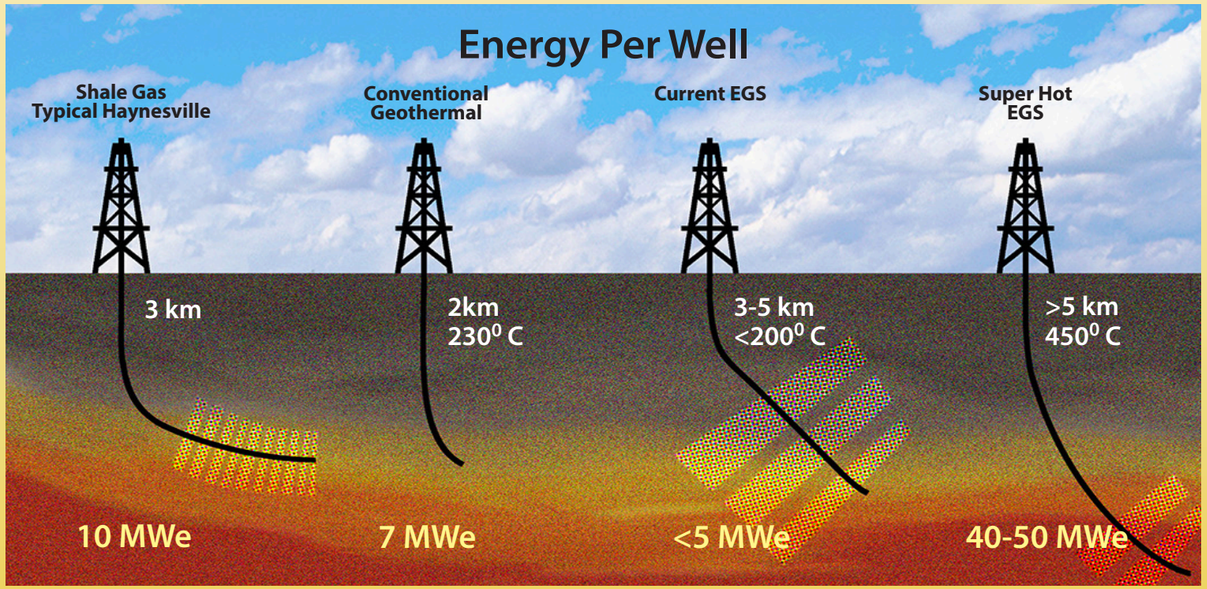


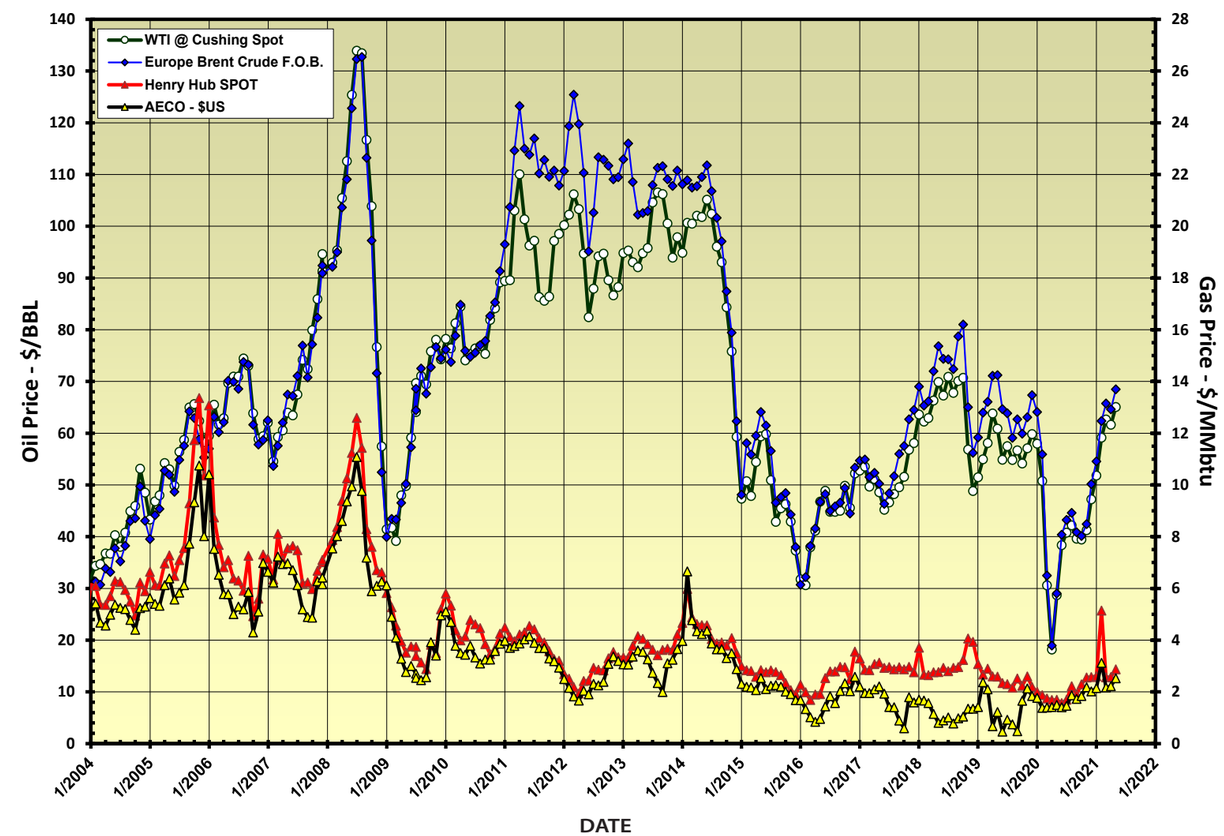
Why is earth hot inside?

The heat of earth's interior comes from a variety of sources. These include the heat contained in the objects that accreted to form earth, and the heat produced when they collided. As earth grew larger, the increased pressure on earth's interior caused it to compress and heat up. Heat also came from friction when melted material was redistributed within earth, forming the core and mantle.

A major source of earth's heat is radioactivity, the energy released when the unstable atoms decay. The radioactive isotopes uranium-235 (235U), uranium-238 (238U), potassium-40 (40K), and thorium-232 (232Th) in earth's mantle are the primary source. Radioactive decay produced more heat early in earth's history than it does today, because fewer atoms of those isotopes are left today (Figure 3.14). Heat contributed by radioactivity is now roughly a quarter what it was when earth formed.

– Article courtesy of Karla Panchuk permitted under Creative Commons license (CC BY-NC-SA 4.0).

Price History of Oil & Gas Benchmarks in U.S. Dollars



Published, monthly-average, cash market prices for WTI crude at Cushing (NYMEX), Brent crude and Henry Hub and AECO gas.

E&P companies work to get ahead of GHG standards

The "greening" of the petroleum industry is accelerating now as oil and gas companies showcase their plans to reduce greenhouse gases (GHGs).

In that vein, Ryder Scott presented a two-hour webinar May 11. The participants presented industry efforts to cut upstream emissions, manage data on sustainability and independently validate renewable energy processes.


Julie Mulkerin

Julie Mulkerin, general manager - energy transitions strategy at Chevron Corp., kicked off the webinar with the company's "market-based approach" for decreasing emissions and increasing returns.

Chevron aims to reduce upstream CO_2 emissions intensity by 40 percent for oil and 26 percent for gas under a 2016-to-2028 schedule. The company also plans to reduce the much more harmful GHG, methane, by 53 percent under that schedule. Chevron plans to lower emissions from flaring by 66 percent, said Mulkerin.

The company said it has invested $1 billion in carbon capture, utilization and storage (CCUS).

Carbon pricing is the primary policy tool for Chevron to achieve GHG emission reduction goals while increasing returns. There are two main types of carbon pricing: emissions trading systems (ETS) and carbon taxes. An ETS – sometimes referred to as a cap-and-trade system – caps the total level of greenhouse gas emissions and allows those industries with low emissions to sell their extra allowances to larger emitters.

"Establishing a High Quality Sustainability Data Management Program," was presented by **Adrian Wain**, carbon advisory & solutions lead at Underwriters Laboratories (UL).

Consumers universally are familiar with the UL logo and fine print inconspicuously etched on the back of electrical products, stating that the device meets safety standards.

"Underwriters Laboratory has 120 years of experience testing and inspecting products for safety," said Wain. "We don't have the same recognition for ensuring safety through a stable climate, removal of toxic substances and other activities."

UL-inspected products are used at oil and gas drilling sites, refineries and on- and offshore facilities. The company tests and certifies sustainability of products and services. UL also furnishes software platforms that help companies track and measure environmental, health and safety (EHS) management and sustainability data.

"The cost of capital is based on sustainability measures," said Wain. "Companies that do not conform to sustainability-related metrics and standards may not be able to do business with potential partners."

He also pointed out that companies that report poor results in sustainability performance management run the risk of being sold off.

UL has restructured, so the advisory services unit, which handles decarbonization and renewables, is separate from certification services. Ryder Scott and UL plan to assist oil and gas companies and collaborate to validate and verify emissions targets and the diversification of energy resources, said **Dean Rietz**, CEO at Ryder Scott.


Herman G. Acuña

Herman G. Acuña, executive vice president at Ryder Scott, presented "Third-Party Validation and Verification Process," which summarized the firm's GHG management services and renewable energy consulting services.

"GHG is not a fad. A GHG statement is a factual, objective declaration made by the responsible party," he said. "The company should be capable of consistent measurements against suitable criteria by a validator or verifier."

Acuña drew a distinction between validation and verification. Validation involves the evaluation of the reasonableness of assumptions, limitations and methods that support the statement on future outcomes. Verification is evaluating a statement of historical information to determine if it is materially correct and conforms to criteria.

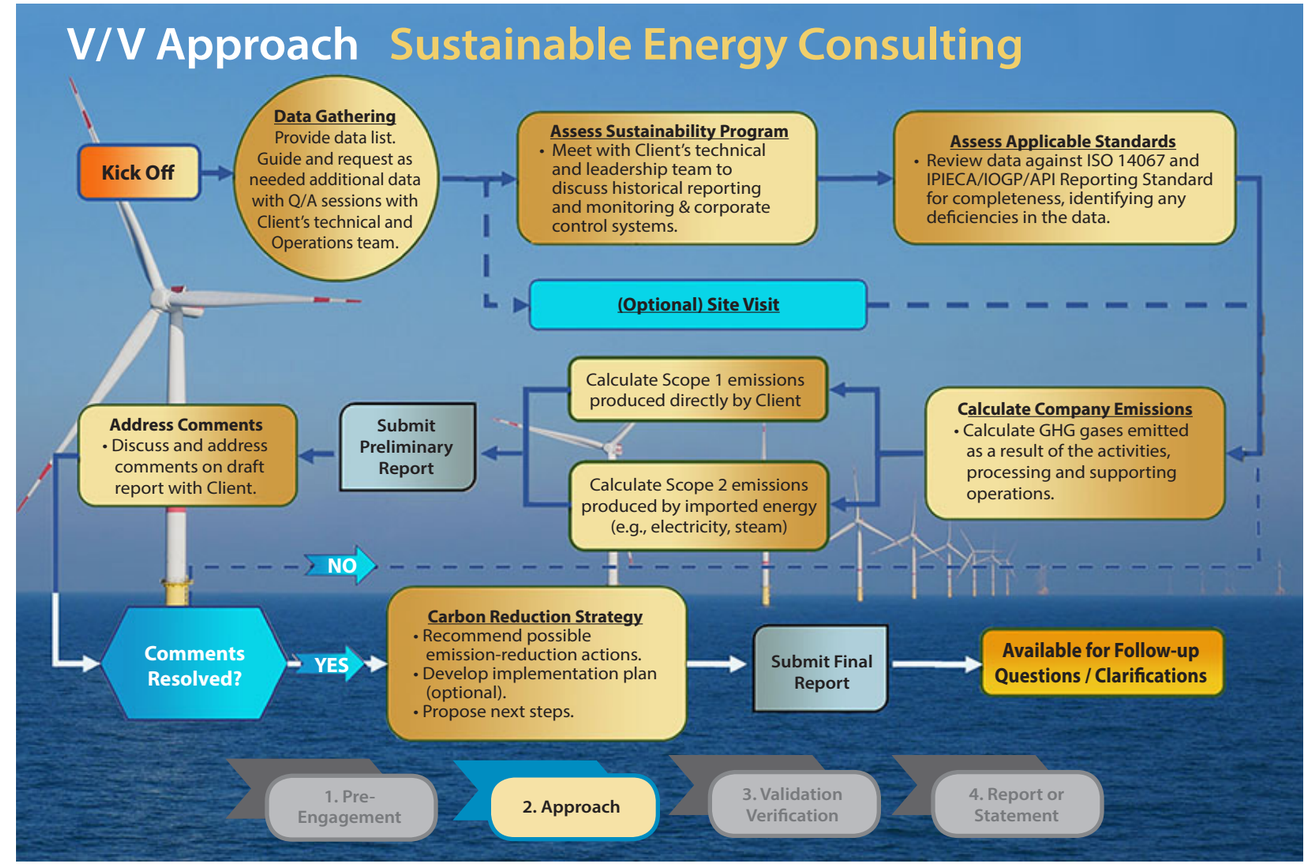
Acuña showed a flow chart (next page) of the validation and verification (V&V) approach, starting with data gathering and ending with submission of the final report and follow-up questions and clarifications.

"Ryder Scott provides added assurance that GHG forward-looking statements are consistent with activities associated with reserves and resources disclosed to the public and financial markets," said Acuña.

Ryder Scott estimates GHG emissions through direct measurement, stoichiometric calculations and emission factors and follows guidelines of the International Petroleum Industry Environmental Conservation Association, International Association of Oil & Gas Producers and American Petroleum Institute.

V&V engagements vary in scale and scope. Establishment of the evaluation boundaries and inventories is key to the success of the evaluation.

For more information, contact Acuña at herman_acuna@ryderscott.com or **Sandeep Khurana**, head advisor–integrated services, at sandeep_khurana@ryderscott.com.



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Petty, et al., state that water at 450º C has four times the energy density of water at 200º C while the energy conversion efficiency is 2.5 times that of ORC. Energy density is the amount of energy stored in a given system or region of space per unit volume. Energy conversion efficiency is the ratio between the useful output of an energy conversion machine and the input, in energy terms.

"While the U.S. DOE is focused on EGS at lower temperatures, the international geothermal community understands the economic value of producing supercritical fluid," stated Petty, et al.

No looking back

SPE is co-sponsoring the second part of a high-temperature well cementing workshop Oct. 7 to 9 in San Diego.

The event will be an opportunity for the petroleum and geothermal industries to share knowledge on the latest technical innovations, advancements, and best practices.

In addition to well completions events, SPE has presented the drilling side at the SPE/GRC (Geothermal Resources Council) Workshop, "High-Temperature and Corrosion in Drilling and Production - Exploring Geothermal and Oil and Gas Synergies," in March 2017.

The new name of the GRC professional association is Geothermal Rising.

If the pundits are right, the upstream industry will have to embrace change to survive long term. Undoubtedly, geothermal fills in all the blanks for the petroleum industry and its future. Crossover potential includes leveraging oil and gas technology developed over more than 75 years to scale up geothermal development.

SPE-AAPG merger talks reflect industry downturn, pandemic

The Society of Petroleum Engineers and American Association of Petroleum Geologists announced May 25 that they are exploring a potential merger.

SPE said, "A new, combined organization is in response to an evolving energy sector and challenging Covid-impacted market environment."

Revenue has been down dramatically for virtually all associations.

"Many associations depend on net revenue from in-person events to make up much of their annual budgets," said the American Society of Association Executives (ASAE).

Neither SPE nor AAPG cited financials in their press releases, but public disclosures point to declining sources of income. Tough times for the petroleum industry and its affiliated organizations began well before the pandemic.

Over the past five years in the industry, profit margins narrowed, stock prices tumbled, EBITDA and revenues plummeted, write-offs proliferated and investors suffered heavy losses. As industry goes, so does its organizations.

The latest blows were social distancing and quarantines that effectively canceled face-to-face events -- traditional cash cows for SPE and AAPG.

SPE

SPE hemorrhaged $3 million in total net losses from operations during April 2019 to March 2020, right before the global shutdown.

At press time, the society had not published its consolidated statement of financial position ending March 31, 2021.

During the pandemic, SPE had to resort to virtually hosting its two most attended events -- annual meeting and offshore technology conference.

The latest published IRS Form 990 for 2018 shows that SPE took in more than $20 million in revenues from meetings, which accounted for 44 percent of almost $46 million in total revenues. Meetings were the No. 1 income item for SPE and AAPG.

The SPE 2019-2020 annual report shows proceeds of $13.4 million for "meetings and training courses," a big drop from the earlier Form 990 amount.

AAPG

The latest financial statement published by AAPG accounted for a period from July 1, 2018 to June 30, 2019. Conferences and meetings accounted for $7.4 million of operating income from $16.3 million in total income. The result is AAPG took in 45 percent of its revenue from conferences.

A year before that, sponsored events were relatively an even bigger moneymaker for AAPG. In its 2018 Form 990, revenue from meetings was $9.6 million or 56 percent of total revenues of $17 million.

The latest published information shows that AAPG cut its losses to $18,600 during 2018-2019. For the previous fiscal year, the association posted a shortfall of almost $600,000.

Beyond the numbers

In a joint statement, the organizations said, "The industry relies on subsurface geoscience and engineering teams rather than siloed disciplines. The new organization would reflect this interdisciplinary approach."

Synergies would reduce operational overlap and redundancy, thereby increasing efficiency and return on investment for members.

"Many of our stakeholders have made it clear that they do not have the resources to support as many professional organizations going forward," said **Tom Blasingame**, 2021 SPE president.

Income taken in by SPE has been about three times that of AAPG, so the merger would not be between equals, which raises some questions on how the organizations would structure the union. On paper so far, losses by SPE are heavier proportionately and in absolute terms than those of AAPG.

Soon-to-be-released annual reports will reveal more about the fiscal management and financial accounting of the two organizations.

An SPE-AAPG steering committee will seek input from each organization's membership and expects to present recommendations to its respective governing bodies late this year or early next year.

The ASAE stated that some mergers necessarily require that the stronger association not overplay its dominance, while the weaker association must be realistic and not seek more from the deal than is fair or achievable. Neither SPE nor AAPG are as strong as they once were, but if the current rebound in the industry has staying power, both stand to get back on their feet separately or together.

With hopes for a fading pandemic, both associations are poised to welcome back the crowds that disappeared. SPE has scheduled its annual technical conference and exhibition Sept. 21 to 23 at the Dubai World Trade Centre. For more information, go to https://www.atce.org/.

AAPG has already started a merger of annual meetings with the Society of Exploration Geophysicists. They have planned the first of two joint annual meetings to be held at the Colorado Convention Center in Denver from Sept. 26 to Oct. 1.

The event will mark the first time the two organizations have jointly hosted their annual conventions since 1955.

Rick Fritz, AAPG president, said, "It represents a strategic response to shifting industry conditions. I think our members and clients will enthusiastically embrace the benefits of one annual meeting to connect with fellow geoscientists."

For more information, go to https://ace.aapg.org/2021.

Ryder Scott promotions announced

The board of directors promoted the following personnel:

- **Dave Haugen** to managing senior vice president
- **Jean LiuHalfe** to senior vice president
- **David Garcia, Sandeep Khurana, Mark Nieberding** and **Hugo Ovalle** to vice president
- **Yao Tian** and **Jeremy Xia** to senior engineer
- **Hanna Ottoson** to engineering analyst

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or by causing the heat source to cool in some manner," said Gardner. He added that injected water, in some cases, is not given enough time heat up before being produced again.

"Voidage in the reservoir can lead to problems, too," said Gardner. "Considering the depletion of enthalpy, an operator could theoretically shut in a field for a decade or more, and potentially recover the heat supply."

No SPE-PRMS equivalent

Gardner said the standards for estimating, categorizing and reporting geothermal reserves are not as well developed as those in oil and gas.

"That has been identified as a gap that needs to be addressed to cultivate common understanding within the sector and to compare opportunities and companies," he said.

In the audit, Gardner classified resource volumes as conservative, mid-range and aggressive.

In the oil and gas sector, SPE has been the organization responsible for issuing industry guidelines for classifying and categorizing petroleum reserves. No geothermal organization has developed an industrywide, robust system to estimate resources and reserves.

That is not to say that the geothermal industry hasn't used certain reserves definitions that may gain acceptance.

"Geothermal reserves are defined as quantities of thermal energy which are expected to be recovered from known reservoirs of a given date forward. The reserve is part of the resources which is currently known and characterized by drilling, geochemical, geophysical and geological evidence and could be legally extracted," stated a 1978 USGS geothermal resource **assessment** by L. J. Patrick Muffler.

SPE, through its members, has presented and discussed the concept of geothermal reserves, but the society has not proposed a reserves system. The U.S. SEC has "punted" on this.

In 2019 mining guidelines, the SEC states, "In a change from the proposed rules, the adopted definition of mineral resources does not include geothermal energy. We have been persuaded to exclude geothermal energy from the definition of mineral resource due to the lack of consensus regarding how to regulate the disclosure of geothermal energy resources."

Four established geothermal resource classifications are summarized in what is now a five-year-old paper from Ametis Institute, **"Geothermal Resource Classifications: Can We Talk the Same Language?"**

This paper provides an overview of "thin" standards from the Australian Geothermal Energy Association and Australian Geothermal Energy Group, Geothermal Energy Association, United Nations Framework Classification and Indonesian National Standard.

As established as they are, the systems do not approach the breadth and depth of SPE-PRMS guidelines or SEC regulations on oil and gas.

Engineer joins RS upstream/midstream integrated services group

Alexander MacKay joined the Ryder Scott Houston office in June as a project engineer. He will work in the upstream/midstream integrated services group.

Alexander MacKay

MacKay previously worked at Granherne, a consulting subsidiary of KBR Inc., for six years. He conducted energy planning and due diligence studies.

MacKay also executed feasibility and front-end engineering studies for onshore and offshore developments as a pipeline engineer, subsea engineer and field development planner for an LNG terminal.

He worked on various front-end and desktop studies of on- and offshore properties in Ghana and Senegal-Mauritania in West Africa. That included supporting the BP Tortue project from concept definition through FEED with project engineer roles, including subsea, umbilicals, risers and flow-lines engineering.

After that, he worked with Lixia Capsia Gestionis LLC to analyze the planned development of infrastructure for an LNG facility in Morocco. The project included an energy-planning component for supporting infrastructure development. MacKay also evaluated the development of the Alumar aluminum smelter in Brazil.

In addition, he conducted a feasibility and front-end study for the Vaalco Etame offshore project in Gabon. For that assignment, MacKay developed reconfiguration concepts for replacing the current FPSO with an FSO and platform extension.

He has a BS degree in mechanical engineering from the University of Texas at Austin and is a member of the American Society of Mechanical Engineers. MacKay was recognized this year as a member of the founding class of the OTC Emerging Leaders program.

Publisher's Statement

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