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Oil Spheres of Influence

A New Age of Market Transparency

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Three revolutions are simultaneously transforming the oil sector—in supply, demand, and market transparency.

The supply revolution is widely understood. The U.S. shale boom has redefined the oil business and redrawn its map. Shale extraction technologies have unlocked vast reserves, changed the market's perception of supply scarcity to one of abundance, and propelled the United States from top importer to top producer. Following the fastest production growth in oil history, the United States has reached what the Trump administration billed as "**energy dominance**."

Having reached this newfound position of dominance, the United States finds itself immediately under threat from the revolution that is simultaneously taking place on the demand front, where the decarbonzation agenda is poised to erode the prevalence of fossil fuels in the energy mix. Growing evidence of climate change and increasingly frequent extreme weather events are giving climate policy worldwide a new urgency. At the same time, technological advances in electricity storage and the falling cost of renewable energy raise hard questions about the future role of oil in the fuel mix and the economy.

A third revolution is also on the march: New data sources—satellite imaging, geolocation, social media, ground sensors, drones, and the internet of things—combined with advances in computing capacity and the falling cost of data storage are casting a spotlight on a traditionally opaque industry. These unconventional data bring new transparency to the entire value chain, from extraction and processing to consumption, emissions, and carbon capture. Real-time measurements offer signals that can foster market efficiency, help investors make better decisions, and let nongovernmental organizations (NGOs) track the carbon footprint of the industry. This data revolution is bound to transform the oil business in many ways,

not least in reduce the climate footprint of the fossil fuel chain, accelerate the deployment of renewable energy, and manage the associated climate and energy transition risks.

The transparency brought by these new data comes at an opportune time. There are at least three ways in which oil risks are on the rise. First, despite the perception of abundance, supply disruption risks have never been higher. The **September 2019 attack** on Saudi Arabia's giant Abqaiq processing plant, which was previously thought impregnable, is a case in point. To make things worse, these heightened risks are occurring at a time when multilateralism is in decline and the oil security institutions inherited from the oil shocks of the 1970s are in many ways degraded.

Second, due in part to the impact of the shale industry, with its short lead times and low capex, the entire oil industry now works on a much faster cycle. The demand uncertainty brought by the decarbonization agenda is also narrowing the time horizon of new investments. Upstream investors are **turning away** from big-ticket projects with long lead times, thus depriving the market of the supply stability they used to provide. This makes for a more volatile and, in many ways, riskier environment, where decisions are made in an abbreviated time frame. For all the talk of abundance and transition away from fossil fuels, the risk of supply shortfall due to **underinvestment** runs high. Cooperation in supply management between Russia and Saudi Arabia, which are the second and third producers after the United States, adds another risk factor, as these two low-cost producers could opt to let the market take another plunge in a bid to regain market share and weed out higher-cost competitors.

Lastly, the energy sector faces heightened risk of extreme weather events due to climate change even as the decarbonization agenda carries obvious existential risks for oil companies. Although oil demand continues to grow, many investors are turning away altogether from the oil sector, which is seen as a bad climate actor threatened by the energy transition, and thus faces both reputational risks and stranded asset risks. Policy support for decarbonization and the electrification of transport is gaining momentum, notably **in Europe**. Yet while climate activists might wish to abolish oil overnight, the global economy simply cannot free itself from it at the flip of a switch. Oil's place in the global economy is just too large.

While oil cannot all at once be purged from the fuel mix, neither can oil companies survive without adapting to the requirements of a carbon-constrained economy. Having been "part of the problem," these companies must become "part of the solution." There will be losers and winners among them. Those that make the cut will be able to show their low carbon footprint; others will perish.

Across all these dimensions, the transparency and immediacy brought by new data technologies will be key. Participants will depend on these data to make better decisions in a constrained environment. Real-time satellite measurements may not prevent oil disruptions but will certainly minimize their impact and let the market rebalance as swiftly and efficiently as possible. Nor will they relieve industry decision-makers from the time pressures of a compressed business cycle, but accurate and timely data help them manage these pressures, speed up their decisionmaking process, and achieve the required reactivity.

New data will enable the energy transition. They will help industry participants rise up to the strictest environmental, social, and governance (ESG) standards and prove it. Only through objective, accurate, real-time, and sufficiently granular data on commodity flows and industrial processes can the global economy hope to cut greenhouse gas (GHG) emissions in a meaningful way. While some companies have taken steps to show a reduction in their carbon footprint, corporate self-reporting is inherently biased and may not be taken at face value. Objective third-party measurements are a must to spot candidates for decarbonization, recognize progress, and grant oil companies their license to operate. Governments will best be able

to champion their domestic hydrocarbon industries not by promoting climate skepticism but by helping them cut their carbon footprint and independently document their achievements. To facilitate this process, governments may consider supporting the creation of a new International Carbon Agency dedicated to setting worldwide emission standards, monitoring their implementation, certifying carbon measurement methodologies, and promoting best practices.

Risky Business

U.S. liquids supply (including crude, condensate, and natural gas liquids (NGLs)) averaged **17.16 million barrels per day (mb/d)** in 2019 and reached an all-time high of about **18.03 mb/d** in early 2020, making the United States by far the world's largest producer followed by Russia and Saudi Arabia. Russian supply has not stood still and reached an annual average of **11.58 mb/d** in 2019, close to the Soviet Union peak production of 11.4 mb/d in 1987. Saudi supply peaked at **12.3 mb/d** in 2018—its largest market share in nearly three decades—but has subsequently fallen back with the collective production cuts of OPEC+ (the informal alliance between the Organization of the Petroleum Exporting Countries and Russia).

Despite the phenomenal growth in U.S. production and the perception of long-term oil-supply abundance it has made possible, oil remains a risky business. In many ways, it has never been riskier.

The last few years have been punctuated by major supply disruptions which were mostly due to above-ground events. In 2011, at the dawn of the Arab Spring, the Libyan revolution **removed 1.5 mb/d** of Libyan exports from the Mediterranean market for many months. Production has yet to return to pre-civil war levels. Starting in July 2012, international sanctions slapped on Iran by the P5+1 removed an average **1 mb/d** of oil exports from the market. The Joint Comprehensive Plan of Action cleared the way for **their return** in January 2016, but sanctions introduced by the Trump administration **decimated** Iran's oil exports beginning in May 2018. Civil wars in Yemen and Syria, which are both small producers, shut off virtually all of their **respective supplies**. The Islamic State's takeover of Mosul in June 2014 caused exports from northern Iraq to be **discontinued** for months. A **U.S. embargo** cut off Venezuelan heavy crude exports to the U.S. Gulf Coast in February 2019 and, later, to the rest of the world.

For the most part, the global oil market took these disruptions in its stride, a resilience commonly credited to the offsetting impact of record U.S. production growth. The price response to the Libyan disruption caused by the civil war was so tepid that when the International Energy Agency (IEA) in June 2011 decided on a **collective action** (i.e., a release of petroleum stocks) to prevent a feared run-up in oil prices during the seasonal peak in demand in the summer months, several IEA member countries deemed the move superfluous. In September 2019, when a spectacular drone and missile attack at the heart of Saudi Arabia's oil infrastructure, the giant Abqaiq crude processing plant, left oil markets **relatively unfazed**, a U.S. government official was prompt to credit the muted price response to the rise in U.S. supply. Indeed, reduced U.S. dependence on oil imports and a perception of "energy dominance" likely encouraged Washington to multiply the use of oil sanctions in the last three years. As Richard Nephew has **noted**, "Since taking power in January 2017, the Trump administration has overseen a dramatic escalation of sanctions to pressure and punish U.S. adversaries, including high profile cases against Iran, North Korea, Russia, and Venezuela." For two of these countries, the measures **revolve around** the prohibition of oil exports and the threat of secondary sanctions on importers of oil from the targeted countries. The export **volumes at stake** are substantial: up to 2.8 mb/d for Iran and 1.2 mb/d for Venezuela.

Yet this feeling of immunity can be deceptive. The United States itself is not exempt from supply risks. Hurricane Harvey in 2017 revealed the unsuspected vulnerability of the Permian Basin—the most prolific

and fastest-growing tight oil basin—to extreme weather disruptions, when record rains and flooding in the Gulf Coast **cut off its access** to the market for a while. Twelve years earlier, **Hurricanes Katrina and Rita** knocked off several major Gulf Coast refineries for months and disrupted crude oil production and access to the Strategic Petroleum Reserve, or SPR (whose crude would, in any event, have been of little use to shuttered refineries). An IEA-coordinated release of strategic oil reserves in early September 2005 **helped minimize** the price effects, and heightened product shipments from IEA countries and Latin America helped meet U.S. demand that fall and early winter but stretched East Coast import capacity. While Gulf Coast refineries subsequently upgraded their hurricane resilience, U.S. production growth also generated new vulnerabilities (as seen during Harvey) while the frequency and violence of extreme weather events also intensified.

In September 2019, the attack on Abqaiq revealed the surprising vulnerability of the world's largest crude processing facility and unsuspected gaps in Saudi air defense. Pushed against the wall by Washington's policy of "maximum pressure," Iran stopped short from directly claiming responsibility for the attack but left its fingerprints all over it. While the damage inflicted on Abqaiq's spheroids and compression towers turned out to be relatively benign and the loss of supply **was limited**, the very fact that the assault could be perpetrated shows that the world's largest oil exporter is not immune from the possibility of another attack. In 2012, its national oil company, Saudi Aramco, had already been targeted by a cyberterrorist attack also attributed to Iran, when **30,000 of its computers** were crippled by a virus and had to be replaced. Cyberterrorism is a new risk facing oil facilities around the world.

THE SPR IS NOT KEEPING UP WITH THE RISKS

These heightened supply risks are occurring at a time when multilateralism is eroding, and the oil security architecture established in the aftermath of the Arab oil shock of 1973 is being somewhat degraded.

Flush with a feeling of energy abundance, the United States has started selling its SPR established in 1974. Under **IEA rules**, member countries must hold 90 days of net oil imports. In 2005, when U.S. net oil imports peaked around **13 mb/d**, the SPR held roughly 700 million barrels of oil , or 56 days of imports, but much more with the inclusion of stocks held at refineries. SPR stocks later grew even as net imports started falling back. At its peak in 2009–2011, the reserve held **726 mb**, while net imports had dropped below **10 mb/d**. Since then, rising domestic production has cut net imports to **less than 2.5 mb/d** in 2018. In September 2019, for the first time in decades, the United States became a net exporter (of **90 kb/d**). Over that period, the SPR plunged by 90 mb—or 12 percent—to **636 million barrels**. **More sales** are scheduled for the next few years.

While SPR levels are being trimmed, the reserve has become **unfit for purpose**. Its stated drawdown capacity of 4.1 mb/d is nominal and cannot be sustained in practice. Its connections with pipelines, refineries, and commercial terminals have not kept up with the sweeping changes that have transformed the U.S. oil industry and infrastructure.

Meanwhile, the IEA, which is another byproduct of the Arab oil shock that was established in 1974, has its own problems. IEA membership **represented** more than 62 percent of the market at its creation but has fallen below 46 percent despite more than doubling its membership. China, which is the world's largest oil importer, and other developing economies whose oil consumption now exceeds that of many IEA countries are not technically eligible for full membership as they are not members of the Organisation for Economic Co-operation and Development (OECD). To get around this problem and bring these countries under its tent, the IEA came up with the idea of associate membership. In 2015, following years of negotiations, **China became** an IEA associate member and the IEA opened a local office in Beijing. Since then, however,

IEA engagement with China has been ostensibly muted in the wake of the trade war between China and the main source of IEA funding, the United States.

Unlike other multilateral organizations, the IEA has kept out of Washington's crosshairs and was not targeted for criticism or defunding by the Trump administration. But IEA-U.S. engagement has arguably suffered from U.S. unilateralism and climate skepticism. When former president Trump tweeted that he might order a release of SPR stocks "**if needed**" in the immediate aftermath of the Abqaiq attack, no mention was made of consultations with the IEA. At the same time, the Agency issued its **own statement** asserting that the market was well supplied and that no release was necessary. The dissonance was audible. In the past, Washington and the IEA would have coordinated their messages. Indeed, in the event of a global disruption such as the Abqaiq attack, a collective, coordinated action between IEA members is far more effective than a unilateral release by a single member, however large it may be, or even a series of uncoordinated releases by individual members.

MARKET TRANSPARENCY AND OIL SECURITY

Against this backdrop of mounting supply risk, rising unilateralism, and eroding emergency preparedness, the real-time transparency provided by new data technologies is invaluable. Daily updates on the situation on the ground, satellite assessments of the scope of damages, status of the repairs, and availability of alternate supply sources help the market adjust and reallocate supply where needed more swiftly and efficiently than would have been possible at any time before the advent of these technologies.

The Abqaiq attack is a case in point. There are few higher-profile targets than the Saudi facility. The idea that it could be targeted seemed unthinkable. The tepid market response to the incident came as an even bigger surprise. Saudi Aramco and the Saudi oil ministry's handling of the incident was exemplary. The company wasted no time to contain the damage, expedite the repairs, reallocate supply, and keep the impact on exports to a strict minimum. It also did an excellent job of communicating effectively about its response and progress. That the damage turned out to be relatively superficial certainly played a role. But at least equally important was the transparency provided by satellite imaging and other new technologies.

The Abqaiq attack is the first major disruption in the age of satellite imaging. The **U.S. military released** high-resolution optical images of the attack immediately. Planet, a leading provider of satellite imagery, made its images **freely available** to the print and television media. Unconventional data providers added more in-depth coverage and analysis. **Kayrros released** daily optical imagery and analysis of the targeted facilities, documenting the extent of the damages and day-by-day progress of the repairs; processed radar imagery to assess changes in crude oil inventories at every single Saudi storage facility, including refinery tanks and export terminals both in-kingdom and out-of-kingdom; and reported on the storage availability of possible substitutes for Saudi grades in other countries.[1] The heat signature of processing facilities and flaring signals at onshore and offshore oil fields were monitored to detect changes in activity and production levels. Repair crews were tracked around the facilities, and the shifts in the number of overnight work hours put in at various units were analyzed.

The information thus provided did not depart from the statements put out by Aramco and the oil ministry. But it added granularity to them and helped verify and validate their message, thus helping reassure the markets. Daily reports on inventory movements outside of the kingdom also let market participants identify arbitrage opportunities and reallocate supply with unprecedented timeliness and efficiency. The impact on the market's calm reaction was likely considerable.

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1 The author is affiliated with Kayrros. The views expressed here are his own and do not necessarily reflect the views of Kayrros.

An Oil Market on an Increasingly Tight Leash

Beyond the rising disruption risks due to armed conflict, terrorism, or catastrophic weather events, the oil market and industry are becoming structurally more unstable and operate on a much shorter cycle than in the past. With climate policy and new technologies casting doubt on future oil demand, the perceived risk of "**stranded assets**" is on the rise. But so is the risk of **underinvestment** and of a shortfall in supply. To respond to these volatile conditions, industry participants more than ever depend on the timeliness and reliability of their information.

ACCELERATING BUSINESS CYCLE

The tight oil industry ("shale") has not only changed the oil market in unlocking vast reserves and turned a perception of supply scarcity into one of abundance. Its short lead time and payback time, low initial capital requirements, and general nimbleness have also challenged the business model of the traditionally slow-moving, deeply conservative, deep-pocketed, and capital-intensive oil industry. The short-cycle nature, flexibility, and price responsiveness of shale oil is often seen as a factor of market stability due to the assumption that shale oil producers could operate as swing producers by quickly turning supply up and down in response to market signals. The opposite is true.

The shale industry has in some ways undermined market stability in forcing the entire oil industry to adopt a shorter business cycle. Because of its perceived price elasticity and quick payback times, the shale industry has discouraged longer-term investments in high-capex projects and diverted investment capital from large-scale developments with the promise of faster returns. Non-shale investments since the price crash of 2014 have not only plunged overall but have also focused on shorter-term developments that tap into existing infrastructure, satellite developments at the margin of mature or producing oilfields, and enhanced oil recovery projects.

Uncertainties about future oil consumption and rising expectations of "peak demand" are further discouraging long-term investments. While global oil demand **keeps growing**, upstream investment has declined. This raises the risk that supply could fall faster than demand, leading to yet another "super-cycle" before spiking oil prices accelerate the move away from oil and help make alternatives more cost-competitive. Recently, even shale oil investment has **slowed down** as lenders and investors have turned from rewarding production growth for its own sake to demanding budget discipline, free cash flow, and return on investment from operators.

OPEC UNCERTAINTIES

OPEC production policy poses a further risk to oil supply. As U.S. oil production **expanded** in the last 10 years, so did Russian supply. This growth, coupled with falling production costs due to the devaluation of the ruble, has closely aligned Moscow's interests with those of other large, low-cost oil producers, effectively turning Moscow into a de facto member of OPEC. Since 2016, when it reversed the market-share policy it had adopted during the oil price crash of 2014, OPEC has included Russia in an **enlarged coalition** of producer countries dubbed OPEC+. For all practical purposes, OPEC as a coalition of dominant, low-cost producers has effectively given way to a new and more informal partnership of Russia, Saudi Arabia, and to some degree other Gulf producers (Kuwait and the United Arab Emirates).

From its formation in late 2016 until the outbreak of the Covid-19 pandemic in early 2020, this new coalition of dominant oil producers has consistently pursued a price-support policy aimed at tightening oil balances through production cuts. OPEC+ supply cuts were even deepened at the OPEC **ministerial meeting** of December 2019, a move that oil markets then greeted **with a shrug**. After the oil price collapse of early

2020, Saudi Arabia and Russia were again instrumental in steering a grand coalition of producers to adopt the **deepest production cuts** ever agreed in oil market history. Saudi Arabia later surprised the market by unilaterally contributing **a voluntary supply cut** of 1 mb/d, effective February 2021, on top of those agreed on by OPEC+.

Continued OPEC+ and Saudi commitment to price support should not be taken for granted, though. In fact, mean-field game theory suggests the interest of a dominant production "cartel" is not in keeping markets stable but, on the contrary, in managing a momentum of market instability so as to undermine investment efficiency from their higher-cost competing fringe. A game-theory **model of the oil market** suggested in late 2019 that Russia and Saudi Arabia could soon find it in their interest to bring prices down to flush out their higher-cost competitors, a move that could prove devastating for shale oil producers. In 2020, the Covid-19 outbreak provided the two producers with an opportunity to do just that. Even as it became clear that the pandemic would cause severe oil-demand losses and most analysts were expecting OPEC+ to respond by deepening their production cuts, Russia and Saudi Arabia in March 2020 instead shocked the market by **launching a seemingly ill-timed price war**. While decried by most analysts as a historic blunder, even a suicidal step, the move could in fact be seen as a "**game theory masterstroke**": the depth of the Covid-19 demand losses provided Saudi Arabia and Russia with a unique chance to test oil storage capacity limits, inflict huge losses on high-cost producers and drive them out of the market for a long time. **Negative pricing** seemed in the cards, and indeed came to be on April 20.

While prices have since bounced back to pre-crisis levels and OPEC+ succeeded in partially reversing earlier stock builds and nursing the market back to health, the group's recent swings in market management and associated price gyrations may not be the last. Indeed, the very scope and speed of the decarbonization measures called for by the energy transition will inevitably fuel considerable market volatility: far from resulting in a smooth shift away from fossil fuels, increases in renewable electricity generation capacity and the buildup of electrification infrastructure will necessarily be lumpy, staggered, and somewhat unpredictable, causing sudden swings in market conditions to which OPEC+ may choose to respond in different ways depending on the circumstances.

REAL-TIME INFORMATION FOR RAPID RESPONSE

Again, in this context of structural unpredictability driven by a faster business cycle, OPEC's interest in keeping competitors on their toes, and the rolling-out of the energy transition, the market's ability to adjust to rapidly changing conditions as changes occur is of the essence. Here, too, real-time information from new data technologies is invaluable.

Unconventional data have proved in the last two years to be the most trusted source of information on shale production. Self-reporting by companies to FracFocus and state commissions has not only lagged but is **unreliable** as many companies fail to file in a timely manner or neglect to do so altogether. As a result, official statistics from the U.S. Energy Information Agency (EIA) and many private data aggregators and analysts only capture a portion of actual field activity. Kayrros has detected roughly **20 percent more** completions in the Permian than captured by public agencies, a trend that continued in 2019. Failure to accurately capture field activity and well completions leads to an overstatement of inventory of drilled and uncompleted wells (DUCs) in public data. These DUCs are often interpreted as a form of oil storage, a safety cushion ready to be tapped in short order if the market calls for it. These DUCs are largely fictional, a byproduct of **flawed public data**. But while the U.S. EIA claimed DUCs peaked in July 2019, Kayrros **observed the opposite**. The backlog of DUCs has recently been **creeping up**—albeit from a low base—driven largely by ExxonMobil in the Permian.

The ability to accurately monitor OPEC production in real time is also critical. OPEC supply as reported by the six secondary sources used by the producer group is largely driven by expert judgment based on background information provided by international oil companies active in OPEC countries, national oil company disclosures, and tanker-tracker assessments of OPEC crude shipments. In contrast, new data technologies permit real-time supply measurements and/or the elaboration of mass balances based on the triangulation of multiple metrics captured in real time. In a highly uncertain market, the provision of these data is essential to ensure that demand is met and to allocate upstream investment in a short timeframe.

Managing the Energy Transition

Over the longer term, the biggest risk to the oil industry arguably comes from climate policy and the transition to a cleaner, lower-carbon fuel mix. For the world as a whole, global warming is an existential crisis, **threatening** the very survival of the species. For leading oil producers, it is an existential threat in more ways than one, as the cure can seem as worrisome as the disease.

The four great powers that tower over the oil industry are all dealing with the prospect of climate change and decarbonization in different ways. The three top producers, the United States, Russia, and Saudi Arabia, vary greatly in their response. Both Russia and Saudi Arabia are pure petrostates—the latter since World War II, the former since Vladimir Putin—that overwhelmingly depend on oil revenues and thus would be directly threatened by the end of oil. Russia has done little to prepare for decarbonization other than to let its state-owned oil company Rosneft lock-in Asian market share through the **purchase** of India's second-largest refiner, Essar Oil (renamed Nayara Energy Limited), jointly with Russian investment fund United Capital Partners and global commodity trading firm Trafigura. Indian oil demand is widely expected to **keep growing** even in the context of an overall decline in global oil consumption.

Saudi Arabia's planning for the energy transition is more visionary. Riyadh has **taken steps** to diversify its economy and develop new sectors, including tourism, entertainment, manufacturing, and the development of the futuristic city Neom. It is also diversifying financially through the **partial privatization** of Aramco by investing the proceeds in non-oil foreign assets through its sovereign fund, the PIF. Like Russia, it is locking in downstream market share through refinery investments both at home and in Asia, including a **proposed tie-up** with India's top refiner and petrochemical company Reliance, among many others. It aims to capture more of the value chain through aggressive investments in petrochemicals, a non-combustive use of oil, and is trying to develop a new oil market through investments in new materials such as cutting-edge plastics and non-metallic materials and advanced transportation technologies. Last but not least, it plans to leverage the low carbon footprint of its oil production, **billing its crude** as the cleanest form of oil available.

The United States is yet another case. Under President Joe Biden, Washington has **rejoined** the Paris Agreement and is taking a sweeping, **all-of-government approach** to climate policy, in a sharp change from former president Trump's climate and energy policies. Aside from federal policy, individual states, big cities, and smaller localities have been pushing ahead with climate policy, however, and private sector companies have made well-publicized inroads into renewable and electricity, integrated environmental, social, and governance (ESG) goals in their strategic planning and made decarbonization targets part of their compensation incentives. ConocoPhillips and other U.S. independents are also announcing **bold plans** to achieve net zero targets.

Meanwhile, China—the world's top oil importer and a large second-tier producer in its own right—has been betting on the energy transition as a way to advance its strategic interests. The country has become the world leader in solar panel, wind turbine, electric vehicle, and battery **manufacturing** and has a lock on the

supply of rare earth minerals and other critical materials for renewable energy. At the same time, alarmed by its oil import dependence in the wake of the Sino-U.S. trade war, China has taken steps to boost investment and President Xi Jinping **has made** the reduction in oil import dependence a top priority.

THE TRAIN HAS LEFT THE STATION

Regarding state policies, decarbonization is driving the future of the oil industry. The impetus for a transition to a cleaner fuel mix is no longer in the hands of the capitals, if it ever was. It is driven by the public, consumers, NGOs, climate scientists, and multilateral organizations. Europe is ahead of the pack. Christine Lagarde, the head of the European Central Bank, launched her presidency by **pledging** to make ESG goals part of the bank's monetary policy, a first for a central bank and a step ahead of former Bank of England governor Mark Carney's move to mandate climate-risk disclosures. The EU Parliament **has declared** a global "climate and environmental emergency" and urged EU countries to commit to net-zero GHG emissions by 2050. New European Commission head Ursula von der Leyen **promised** a European Green Deal to tackle the climate crisis. Meanwhile, equity investors are turning away from oil. At its trough, the oil and gas sector's weighting in the S&P 500's market capitalization sank to **less than 3 percent from 13 percent** in 2008 when oil prices were at their peak.

While climate activists might wish to abolish oil overnight, the global economy simply cannot move from oil to electricity at the flip of a switch. The share of oil in the global economy is too big for the world to go cold turkey, but neither can the oil industry survive without adapting to the requirements of a carbon-constrained economy. Companies will need to demonstratively reduce their carbon footprint to keep their social and legal license to operate and maintain their competitiveness and access to market. Already the European Union is preparing **regulations** that would restrict imports of oil and gas products on the basis of their carbon footprint. Regardless of U.S. federal policies, U.S. companies will need to rise—and be held—to the strictest ESG standards. Their compliance must be independently verifiable.

CARBON IS THE NEW METRIC

Here too, new data technologies have a critical role to play. Current carbon assessments based on self-reporting by companies is inherently biased and unreliable. Companies that report Scope 1 emissions as per UN requirements do so based on engineering rules of thumb and outdated emission factors rather than actual measurements. The Volkswagen "Dieselgate" **scandal** was an eye-opener in revealing the extent of fraud that a blue-chip company was willing to engage in in portraying its environmental performance. Some perfectly legitimate reporting can be equally misleading in practice: under **UN reporting principles**, companies are entitled to exempt from their Scope 1 emissions those produced by joint-ventures in which they are a shareholder but not the operator.

ESG investors have so far had to rely for their analysis of companies on the ratings of specialized agencies whose findings have yet to elicit a strong consensus. **Two such agencies, MSCI and Sustainalytics**, have been the main trailblazers in the market for ESG notations. Most of their assessments cover the G (governance) of ESG rather than the E (environment). The correlation between their ratings is significantly lower than, say, between those of Moody's and Standard and Poor's, revealing notable differences in methodologies and sourcing of information. ESG notations by rating agencies are so wildly **varied** that many "serious" ESG investors claim to ignore them and work their own ratings.

As long as emissions are not properly, objectively, transparently, and accurately measured by impartial third-party observers, it will be impossible not only to invest in oil companies on ESG principles, but also to combat climate change. Thankfully, the technologies to measure emissions are now commercially available. Some are still being developed, such as the Environmental Defense Fund's **satellite** for methane mea-

surements, scheduled to launch in 2022. Others are already here. Recent innovations in signals processing and systems integration have made it possible to extract precise signals from various existing satellites and build the first **global methane detection, measurement and attribution system** with global coverage and near continuous surveillance capacity.

Countries would do well to incentivize the adoption of tough, verifiable international emission standards in a bid to help their oil sector and other domestic industries compete on climate grounds on a level playing field—and discourage the access of carbon-intensive products to their own markets. While the private sector will eventually push for such standards on commercial grounds, policymakers have a role to play and can speed up the process. There is not a second to waste in fighting climate change. To facilitate the adoption of such standards, governments could consider the establishment of an International Carbon Agency to set carbon standards, monitor their implementation, certify verification processes, and promote best practices. Unlike the International Renewable Energy Agency, this agency would be technology neutral. Unlike the IEA, it would not be limited to the rich-country club and would include net-oil exporters as well as consumers.

The Data Revolution, Oil, and Climate

The oil industry has never been a pure resource-based industry. It has also long been a knowledge industry, requiring feats of engineering to extract hard-to-get-to barrels safely and on a large scale. More technological prowess will be needed in the near future to help decarbonize oil and reduce its climate footprint. But the oil industry is also increasingly an information industry. The provision of real-time, comprehensive, granular, and accurate data is increasingly essential to its functioning and its efficiency at every link of the supply chain. "Data is the new oil."

The data revolution made possible by satellite imaging, artificial intelligence, and other technologies is in the midst of revolutionizing the oil industry and transforming the role of its stakeholders beyond recognition. The secrecy that for decades shrouded oil operations is vanishing. **Corporations** and **governments** are subject to unprecedented scrutiny and can be held to the toughest standards. Political and corporate power no longer controls access to the flow of so-called "market sensitive" information. New stakeholders such as environmental groups and other NGOs are becoming empowered to monitor the performance of industry participants, including their emissions, in a way that until recently was unthinkable. Asset managers and producers benefit by optimizing their operations, monitoring their assets through 3D reconstruction and digital twins in real time, reducing costs, and minimizing their footprint.

New data technologies will also be key in the energy transition to a decarbonized economy and in helping reconcile the reality of a fossil fuel-based economy with the aspiration towards a clean, low-carbon future. To save the planet, it must be measured. These measurements are now becoming a reality. ■

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