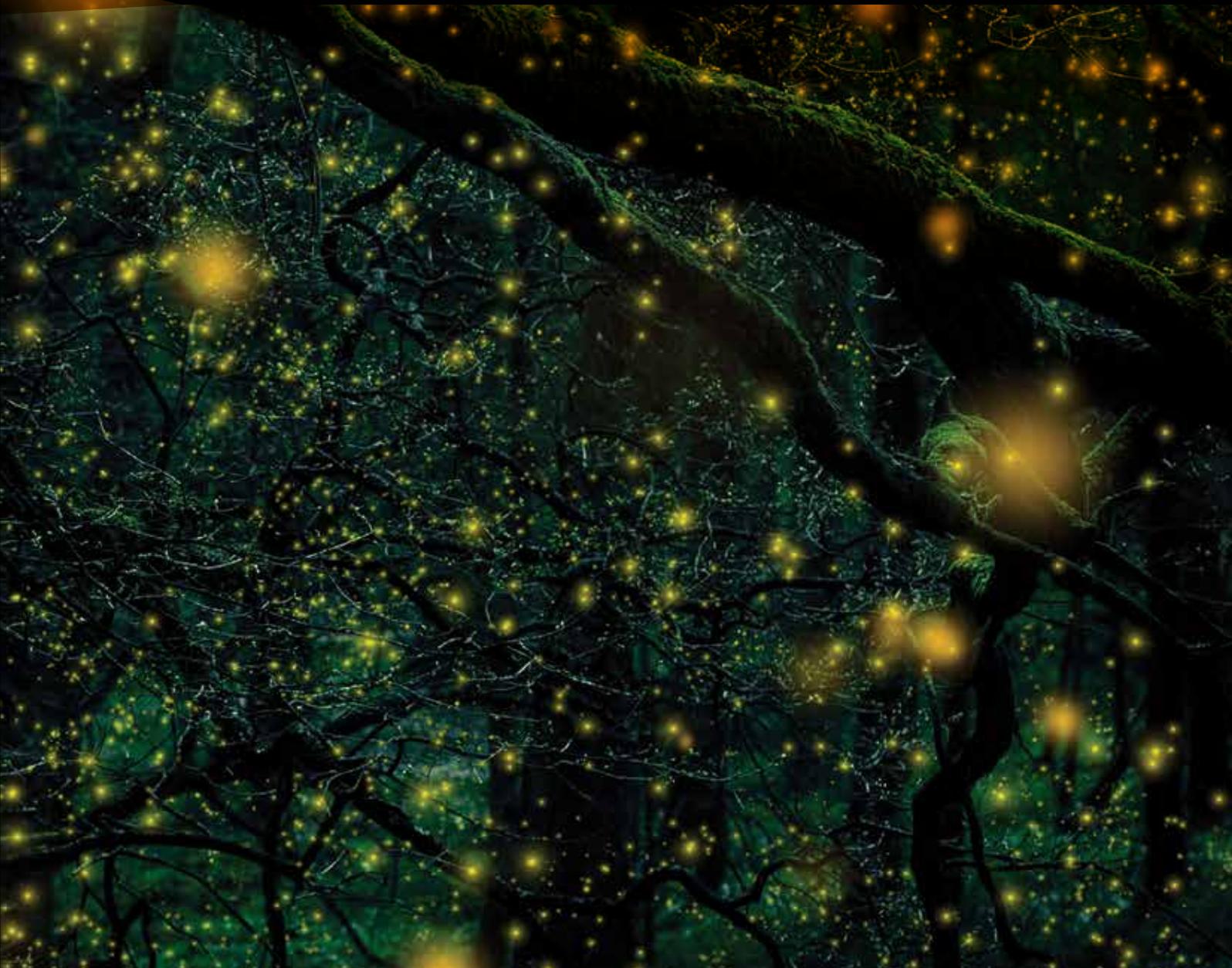


THE OLIVER WYMAN

ENERGY JOURNAL



INTRODUCTION

There is probably no industry on the planet more in the throes of transformation than energy. Major shifts in global supply and demand on almost every front are creating new threats and new opportunities for those companies that recognize they can no longer just continue with the status quo.

The climate agenda is center stage as calls for decarbonization and increasing regulation on the use of fossil fuels echo through governmental chambers worldwide. In the United States, renewable energy – generated by solar, wind, and hydro – already has begun to produce more electricity monthly than coal. And the next generations coming up increasingly make the environment a top priority.

At the same time, the electrification of transportation and technological advances make alternative propulsion increasingly competitive with gasoline- and kerosene-based internal combustion. This makes a transition away from oil more of a viable option than it ever has been.

As a result, almost every energy business and national oil company is revamping its business model. Upstream in oil and gas, shale oil producers are recalibrating for new supply and pricing cycles. Downstream retailers are remaking the customer experience to keep up with new competitors and the emergence of service on demand.

An insatiable demand for electricity to power our increasingly connected world is pushing utilities globally to find interim fixes while the traditional oil and gas players increasingly gear themselves up to play a broader role in the world of power distribution, as new technology adoption accelerates faster than predicted. Energy companies also must draw more from the hidden talents of their employees while developing value propositions attractive to a new generation and working out long-term infrastructure solutions.

Meanwhile, commodity traders are harnessing the power of artificial intelligence and predictive analytics to find ways to benefit from the current unprecedented disruption amid political uncertainty, amid intensifying margin erosion.

In the fourth edition of Oliver Wyman's *Energy Journal*, we have endeavored to provide perspective on the chaotic landscape and offer up some strategies for thriving in it. The next decade will no doubt test the industry like never before. We hope our insights help formulate a new vision of what's possible.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Francois Austin', with a horizontal line underneath.

Francois Austin
Head of Energy Practice

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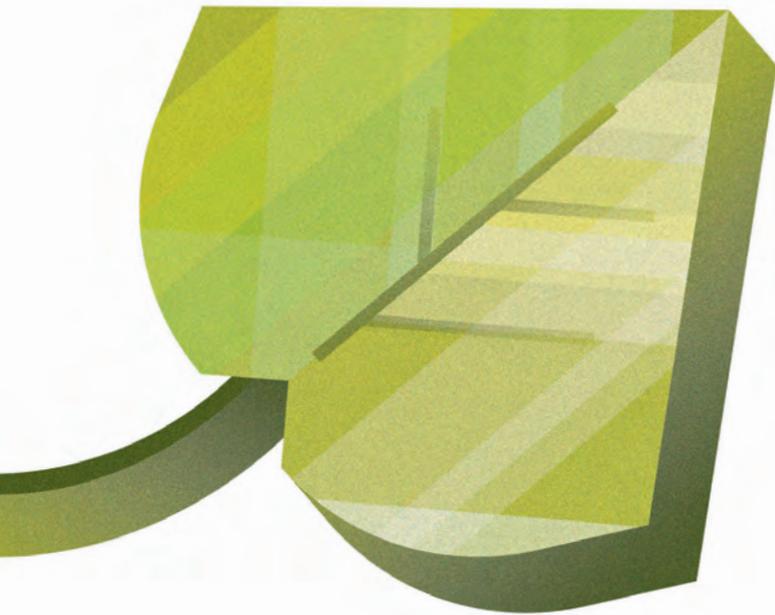
Power companies will have to make tough decisions about infrastructure investments to avoid widespread brownouts and blackouts

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IS THE ENERGY INDUSTRY MEETING ITS SUSTAINABILITY GOALS?

The transition to renewables will change the economics of the oil and gas industry

Francois Austin



The energy industry was vastly different 20 years ago, when two colleagues and I founded a consultancy, advising global oil and gas companies. Our work was primarily focused on reducing operational risks and addressing operational cost challenges. Since that time, concerns have evolved.

Back then, climate change and the push for renewables were considered to be inconsequential. They weren't the concern of oil and gas companies the way they are today. Now, however, acting fast is imperative, as the recent report by the UN Intergovernmental Panel on Climate Change (IPCC) shows. We have 12 years to keep global warming to a maximum of 1.5°C, beyond which even half a degree will significantly increase the risk of natural disasters.

Today, there's a heightened awareness among oil and gas companies of where they sit in society. They're trying to address issues around climate change through the transition to renewables and by reducing carbon emissions. They're not only concerned with what's happening inside their operations, but also the path to renewables via gas.

The realization that we are in an interconnected and global matrix of energy production and consumption is necessary, albeit complicated. In an exclusively fossil-fueled world, security was ensured by the reliability of energy supply. Today's energy security is implied in the flexibility of a diversified grid, something which is hard to measure and even harder to ensure. Everything must change - energy infrastructure, sourcing, and distribution.

EFFECTING CHANGE

The annual Energy Trilemma Index measures 125 economies on their ability to balance energy priorities according to security, equity, and sustainability. It reveals how economies are progressing and gives policymakers and

industry leaders the tools and information to collaborate and effect change. It enables policymakers to manage the energy transition and companies to increase their competitive advantage.

There are three principal topics that should be considered to ensure economies and societies harness new technology and opportunities, while keeping the Energy Trilemma in balance. Large industry players should continue to address the transition from fossil fuels through investment and development in renewables; policymakers need to work with utilities companies to address the infrastructure requirements of diversified sources of energy; and, since technology is driving better performance and reducing the cost of renewables, incumbent companies will have to evolve quickly, whether they're national utilities companies or global energy providers, to avoid being replaced by new, digitally savvy competitors.

Technology is helping to improve the performance and reduce the cost of renewables. Furthermore, climate change considerations, other environmental issues, and litigatory concerns are increasingly shaping investment fund decisions, with \$6 trillion of funds (led by the insurance sector, with \$3 trillion) committed to divestment from fossil fuel equity classes. Major energy companies have cited this divestment as a material risk to their business and are doing significant development in renewables. Meanwhile, investment in clean energy has grown at a 14 percent compounded annual growth rate over the past 10 years.

Coal-fired generation in OECD countries is in terminal decline. At the current rate, by 2050 up to 90 percent of OECD energy generation will be from renewables. And as the cost of renewables declines, the economics of new fossil fuel or nuclear investments become unviable, given there's no fuel cost for renewable generation.

While many developing economies will have to rely on coal in the near term, we can see that in the future this may shift. For example, China's use of coal has dropped to 56 percent, from 80 percent in 2007. This could be indicative of future trends in other economies still reliant on coal, as they focus on balancing the Energy Trilemma of security, affordability, and sustainability.

Shifts in electricity generation and transport fuels will help meet sustainability goals. The energy transition will change the economics of the oil and gas industry, and potentially those of entire cities and companies. Almost 400 global companies, cities, states, and regions recently set 100 percent renewable energy targets and/or zero emissions targets, including California – the world's fifth-largest economy – and businesses with collective annual revenues of \$2.75 trillion. Energy companies and regulators must adapt their strategies and innovate to respond to these goals.

GROWING ECONOMIES, TRANSFORMING SOCIETIES

Sometimes, the energy transition can seem unwieldy. But by measuring energy systems for economies around the world through the Energy Trilemma Index in terms of security, equity, and environmental sustainability, we not only can help grow economies, we can transform societies.

The complex issues facing the globalized energy industry are impossible for countries and companies to tackle in isolation. Navigating the evolving policy and regulatory frameworks across countries and regions, while being innovative in how we generate power, can achieve progress and maintain balance.

Francois Austin
is the London-based head of Oliver Wyman's Energy practice

This article first appeared on [*World Economic Forum Agenda*](#)

THE WORLD ENERGY TRILEMMA

Ranking the world’s top 25 sustainable energy systems

Francois Austin

Europe still leads the world in the provision of sustainable energy systems, with 20 European countries appearing in the top 25 ranking of the 2018 World Energy Council/Oliver Wyman Energy Trilemma Index. The Index ranks 125 countries on their performance in meeting and balancing the energy trilemma: delivering secure, affordable, and environmentally sustainable energy. **Denmark, Switzerland,** and the **United Kingdom** were the only countries to rank within the top 25 countries across all three dimensions, highlighting the continuing challenges for countries to meet energy goals.

The highest ranked non-European country is **New Zealand** which ranked at seven in the overall Index. **Canada, the United States, Singapore,** and **Israel** are the only other non-European countries in the top 25.

To continue to move forward on balancing the energy trilemma, each country must craft policies that will ensure secure, affordable, and environmentally sustainable energy as they make the transition to a low-carbon economy.

To further explore the Index, visit <https://trilemma.worldenergy.org>

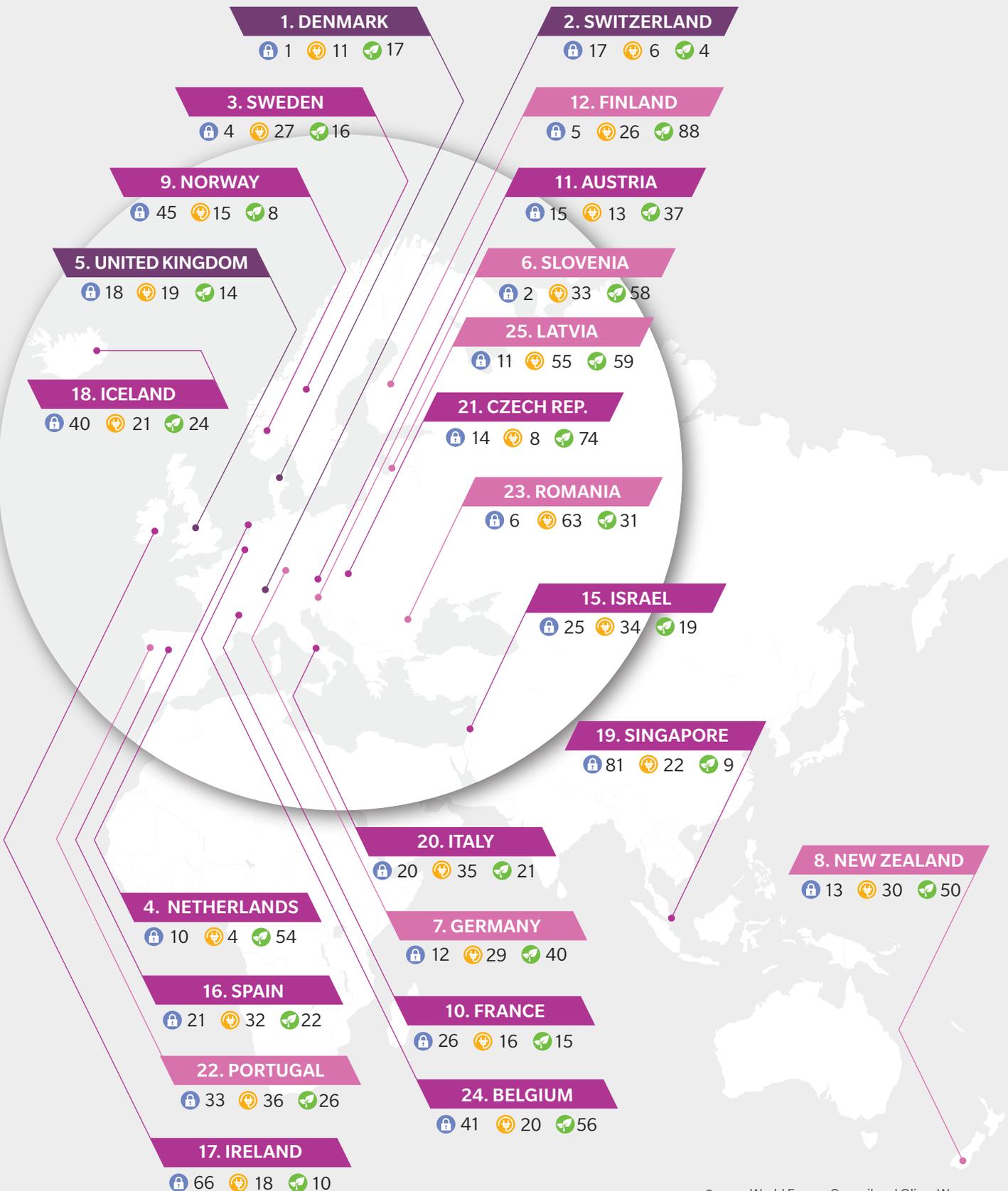


- Leader in each of three dimensions
- Leader across two dimensions
- Leader across one dimension

* Dimensional score ranks within top 25, and overall balance score is high

- 🔒 **Top 25: Energy Security**
 The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of participating energy companies to meet current and future demand
- 🏠 **Top 25: Energy Equity**
 The accessibility and affordability of energy supply across the population
- 🌱 **Top 25: Environmental Sustainability**
 The achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources

Francois Austin is the London-based head of Oliver Wyman’s Energy practice



Source: World Energy Council and Oliver Wyman



CLIMATE CHANGE HAS CLAIMED ITS BIGGEST CORPORATE VICTIM

Now banks are on alert

Rob Bailey

When PG&E filed for Chapter 11 protection in January, *The Wall Street Journal* dubbed it the “*first climate change bankruptcy*.” The Californian power utility was facing \$30 billion in potential liabilities following a series of devastating wildfires linked to its equipment – wildfires made more likely by a prolonged period of hot, dry weather that had reduced the surrounding forests to tinder and which *scientists have since attributed to climate change*.

CLIMATE’S TOLL ON BUSINESSES

PG&E may well be the largest corporate casualty of climate change, but it is not likely to be the last. Climate change is increasing the frequency and severity of extreme weather around the world, and other businesses have fallen victim to these trends.

Take 2017’s notorious hurricane season – the most expensive ever. Scientists believe that climate change is making hurricanes *more destructive*, and when Hurricane Maria hit Puerto Rico, thousands of businesses were literally wiped out.

In addition to the physical risks climate change poses to businesses, policies designed to drive the transition to a low-carbon economy create further risks. Consider the electricity sector again, but this time in Europe. Hundreds of billions of dollars have been wiped off the value of power utilities by the rise of renewable energy, which has disrupted electricity market economics and turned the incumbent business model on its head.

A ZERO-CARBON ECONOMY IS CERTAIN

The future is one of increasing physical and transition risks in a growing number of sectors and geographies. Physical risks will become increasingly severe as global temperatures continue to rise. So far, the world has experienced around 1°C of warming; despite national pledges to reduce emissions, we could see temperatures increase by around 3°C by the end of the century.

Transition risks will become more disruptive as efforts to decarbonize the economy gather pace, as they certainly will. Stopping global warming – whether at 2°C, 3°C, or more – requires reducing net global emissions to zero because, as atmospheric concentrations of greenhouse gases continue to rise, so will temperatures.

Put simply, the destination – a zero-carbon economy – is certain. It is just a question of how rapid and how chaotic the transition is. And therein lies the risk.

WHAT THIS MEANS FOR FINANCIAL INSTITUTIONS

These risks have implications for financial institutions. The performance of banks' loan books will be affected by the impacts of climate change and the low-carbon transition, as will the returns of asset managers' investment portfolios. Insurers will have to manage both the impacts on their assets and changing claims patterns, particularly from extreme weather.

Financial institutions will need to put in place frameworks to quantify and manage these risks. This was the conclusion of a [recent report](#) by Oliver Wyman, based on a survey of 45 global banks conducted with the International Association of Credit Portfolio Managers.

Most of the banks surveyed appear to accept this, with 39 responding that they plan to implement the recommendations of the [Task Force on Climate-Related Financial Disclosures](#) (TCFD) – either partially or in full.

The management of climate risks by financial institutions will inevitably create pressure for companies to do the same

TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

The TCFD, an initiative of the Financial Stability Board, sets out recommendations for the disclosure of climate-related risks according to four pillars of governance, strategy, risk management, and metrics/targets.

Similar trends are apparent in the insurance and asset-management sectors. At the time of writing, 35 companies from the insurance sector and over 100 from the asset-management sector have signed up as supporters of the TCFD. Last month, the United Nations Principles for Responsible Investment, to which well over 2,000 asset managers are signatories, announced that TCFD implementation would become [mandatory from 2020](#).

A growing number of regulators have also come to recognize climate change as a new financial risk. For example, the Prudential Regulation Authority of the Bank of England has proposed that climate change be integrated into the risk management of banks and insurers. And an informal club of regulators – the central banks' and supervisors' Network for Greening the Financial System – is exploring approaches to quantify climate risks and incorporate them into regulatory frameworks.

CLIMATE RISK NEEDS TO BE HANDLED FIRM-WIDE

The picture, then, is one of increasing scrutiny of climate risks by banks, insurers, and asset managers, as well as the regulators that supervise them. The management of climate risks by financial institutions will inevitably create pressure for companies to do the same.

The implications of this were explored at various sessions during GreenBiz 19 conference, which took place on February 26-28, 2019, bringing together more than 1,200 sustainability business leaders.

Interestingly, there was common consensus that responsibility for climate risk management should not be restricted to sustainability functions. This view is echoed in the Oliver Wyman report, which recommended board-level oversight of a “strategic, firmwide” approach to climate risk.

Three other key implications emerged over the course of the conference.

First, companies must become “data ready.” Banks and asset managers will need data that allows them to evaluate the transition and physical risks to which corporations in their portfolios are exposed. So, they will ask for it. Almost half of those banks surveyed for the Oliver Wyman report revealed they were already collecting additional climate-related data from borrowers. Conversations at GreenBiz 19 underlined how ESG (environmental, social, and governance) reporting is becoming mainstream. Companies will increasingly find themselves having to make climate-related disclosures, whether they plan to comply with TCFD or not.

Second, use data for scenario planning. In the medium to longer term, physical and transition risks threaten the viability of some corporations. Accordingly, the data that companies collect

should inform enterprise risk management and strategic planning, a key element of which will be scenario exercises. These tools can enable corporations to explore the implications of different climate change scenarios for their profitability and business models. At GreenBiz 19, there was widespread interest among corporates in scenario methodologies and the strategic insights that can follow.

Third, climate change risks will determine access to capital. This is an obvious consequence of climate change being incorporated into decision making for insurers, investors, and those who manage banks. The coal sector is already experiencing this shift, with numerous banks withdrawing financing for new plants and mining projects, insurers declining coverage, and investors offloading stock. Of the banks surveyed by Oliver Wyman, more than half were already considering climate risks when setting and monitoring lending limits, including sector exclusions.

HOW QUICKLY WILL THIS PROCEED?

It will take time to gather the data, build the models, develop the management systems, and set the necessary performance metrics. Most banks planning to implement TCFD expect to be done within three years, according to the result of Oliver Wyman’s survey. Given the scale of the undertaking, this is a rapid implementation.

In the meantime, climate change will continue. It may be debatable whether or not PG&E was the first climate-related bankruptcy. What is certain is that it won’t be the last.

Rob Bailey

is the London-based director of Climate Resilience at Marsh & McLennan Insights. Before this, he was the research director for Energy, Environment and Resources at Chatham House

This article first appeared on [BRINK](#)



COMMODITY TRADING GOES BACK TO THE FUTURE

As trading margins continue to decline, proprietary intelligence is once again determining which traders will thrive

Alexander Franke, Adam Perkins, Roland Rechtsteiner, and Graham Sharp

The combination of unprecedented political uncertainty, trade wars, and rapidly evolving technologies is making commodity markets almost as unpredictable as they were during the financial crisis. But the chances of repeating the industry's most profitable year to date are remote.

Black and grey swan events will continue to result in intermittent spikes in volatility. But these will only provide temporary relief from the relentless erosion in trading margins that started in 2014. In fact, we estimate margins could likely decline by at least another 15 percent over the next five years as commodity markets become more stable and more transparent and competition becomes more intense. (See Exhibit 1.)

This cutthroat environment will weed out the players that continue to follow the tactics of the past from those pioneering new trading strategies by investing in advanced predictive analytics to develop proprietary digital intelligence. As the amount of new digital data available continues to soar, the top players will return to their roots and rely more on developing information advantages from which they can increase their profits. The traders who develop the operating model to support these analytics will succeed and grow, while smaller players that can't afford to invest in new digital capabilities will be forced to retrench.

COMMODITY TRADING MARGIN MELTDOWN

Signs of the coming dramatic shakeout that will result from the commodity trading margin squeeze are already at hand. Trading margins have fallen by more than 20 percent from their recent peak in 2015.

This trading margin meltdown will continue as commodity markets become more mature, stable, and liquid. Over the past decade, the volume of commodity contracts traded nearly tripled, and the value of contracts traded on standard electronic platforms doubled. Commodity market data is also increasingly available and widely distributed, as greater numbers of players sell information and provide services to commodity traders. These new sources of data allow commodity traders to estimate more precisely events that impact their trading strategies, such as

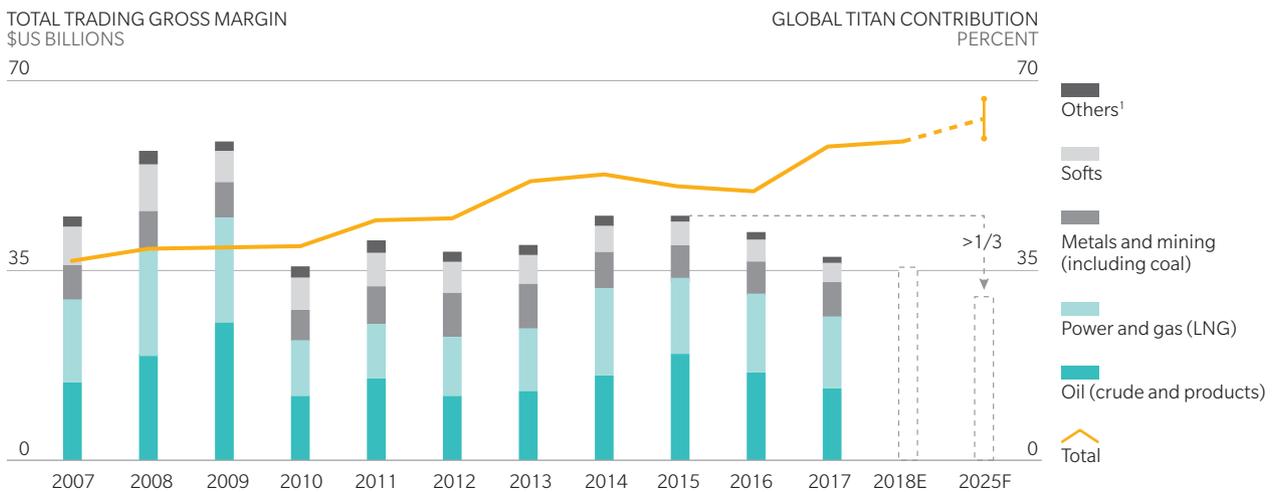
when commodities will arrive at a specific destination and when local stockpiles will be high or low.

The combination of increased transparency and gluts in almost every commodity should keep volatility in the relatively tight band it has been confined to since 2012. (See Exhibit 2.)

This means margin will continue to be taken away from traders. Major commodity producers and consumers such as national oil companies and miners will charge higher premiums and claim more margin as they expand their global reach and become more sophisticated market participants. Simultaneously, physical infrastructure-service providers and new online platforms will impinge on traders' traditional roles. These players are making traders less essential by removing bottlenecks to correct supply imbalances and connecting more commodity producers and consumers directly.

EXHIBIT 1: SHRINKING COMMODITY TRADING MARGINS

Commodity trading margins are collapsing, putting even greater pressure on players to achieve scale



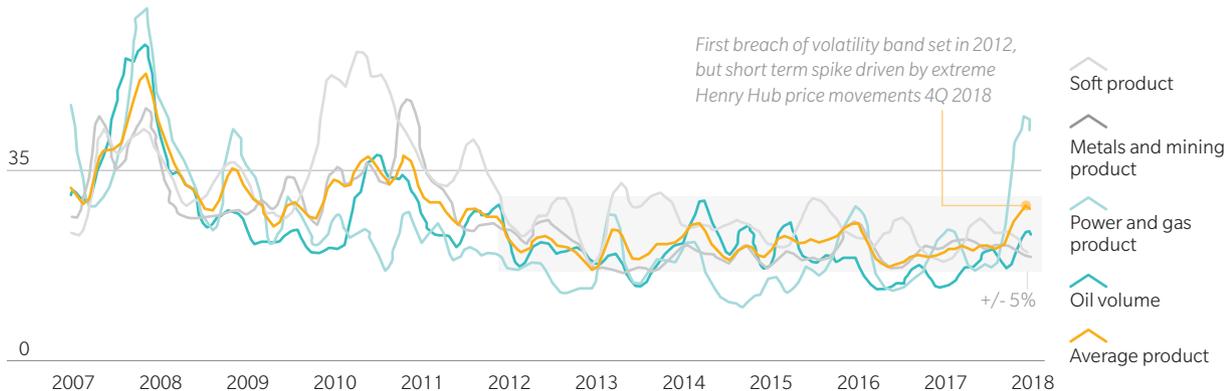
1. Others include Asia power and gas, emission, exotics, and investor products
 Source: Oliver Wyman proprietary data and analysis

EXHIBIT 2: MINIMAL COMMODITY PRICE VOLATILITY

Volatility spiked toward the end of 2018 to levels not seen since 2012. But it has remained within a comfortable 10 percent to 15 percent band since the end of 2012

ROLLING AVERAGE PRICE ADJUSTED VOLATILITY FOR KEY ENERGY FUTURES¹
PERCENT ANNUAL STANDARD DEVIATION, 12/31/2007 PRICES = 1.0

70



1. Average includes BRENT, WTI, ICE gasoil, EU Power, NYMEX HH, ICE NPB, CBOT Wheat, CBOT soybeans, ICE Cotton, LME Cu, LME Ni, LME AL, COMEX Au, NYMEX Pt, NYMEX Pd Average rolling 30 day volatility, 60 rolling average. Prices relative to Dec. 31, 2007

Source: Reuters, Oliver Wyman analysis

So traders are forced to do more and more to gain an edge by further increasing their scale. Top players are snapping up multibillion-dollar commodity assets to protect their positions, bulking up their massive trading portfolios. Medium-size traders are shutting down noncore businesses. Many small traders are pulling out of the commodity trading business entirely.

PROPRIETARY DIGITAL INTELLIGENCE

But the most important driver of this shakeout is trading giants' investments in predictive analytics, which are providing them with significant information advantages.

Large commodity traders once again consider proprietary intelligence critical. When

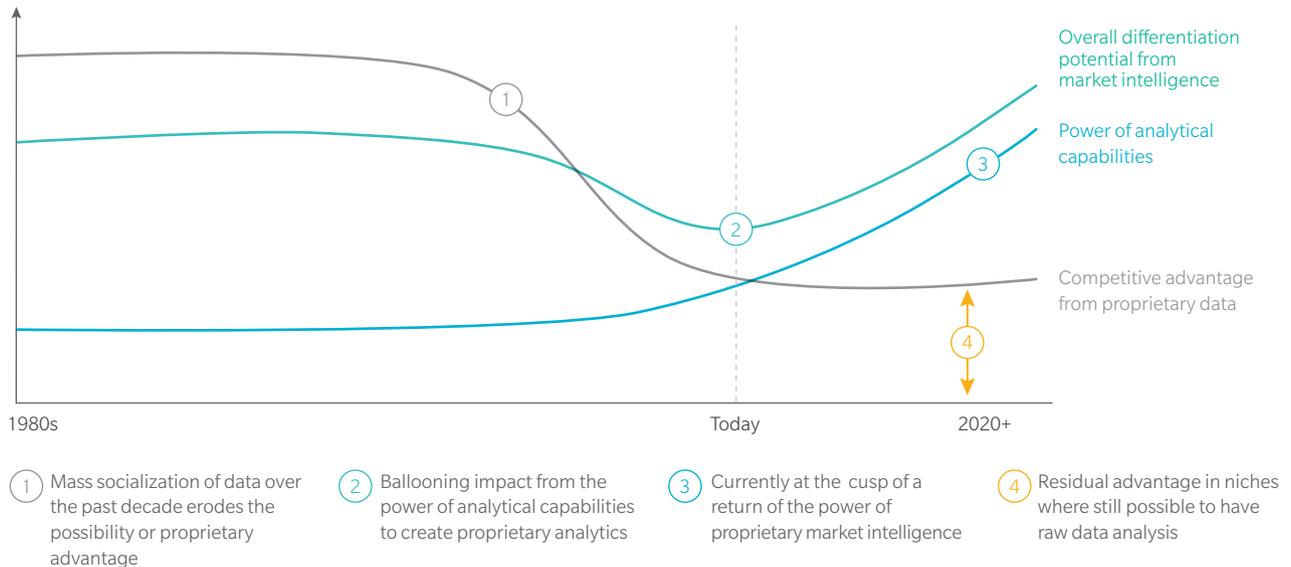
commodity trading firms as we recognize them today were first established in the 1970s and 1980s, top traders relied primarily on privileged information to outperform their peers. More recently, players have tried to gain an edge by focusing on ways that advanced technologies can improve their efficiency primarily through automation.

Now, commodity traders are going back to the future. Instead of relying on extensive traditional information networks to gain advantages from proprietary data, traders who are large enough to invest in the sophisticated systems and dedicated teams required to compete are focusing on how to use predictive analytics to draw valuable proprietary insights from common data sources. (See Exhibit 3.)

EXHIBIT 3: THE RISING IMPORTANCE OF COMMODITY TRADING PROPRIETARY INTELLIGENCE

Proprietary market intelligence will become even more important as advanced proprietary analytics improve

ADVANTAGE TO TRADERS FROM PROPRIETARY MARKET INTELLIGENCE – ILLUSTRATIVE



Source: Oliver Wyman analysis

Today's proprietary intelligence is obtained from a combination of more widely available data sources, such as sensors, geospatial satellites, and even social media run through advanced algorithms developed in-house by data scientists. These algorithms are run on hardware with exponentially greater processing power, to rapidly translate and interpret the huge volumes of data, enabling traders to formulate unique market views. Then, the results are monetized across major trader firms' expansive global trading portfolios. Large trading volumes are essential to ensure returns from advanced analytics. Without them, traders cannot generate enough value to cover their development costs.

As commodity markets become more liquid and accessible, commodity traders are relying more and more on algorithmic trading, coupling predictive analytics with robotic trade

execution. Traders are improving their ability to hedge and speculate by developing code that more nimbly identifies trades and executes them across a broader set of tradable instruments.

But this new digital approach to developing proprietary intelligence requires completely revamping traders' operating models. Commodity traders need to be willing and able to experiment in order to be players in the new and evolving world of predictive analytics. At a time when trading margins are razor thin, top traders often need to invest millions of dollars in multiple, large pilot programs to discover two or three viable new trading strategies. It is often unclear if anticipated relationships between data feeds and commodity prices actually exist; and even if they do, it is not certain the volume of data is sufficient to make meaningful predictions. For example, it is incredibly difficult to analyze global satellite

imagery to identify precisely the daily flow of commodities, given the frequency with which images are being taken. Depending on the specific market, these signals are often also relatively limited compared to just market sentiment when forecasting in the horizon of interest.

More broadly, commodity traders need to embrace new ways of working. Developing top-notch predictive analytics often requires setting up data science teams in a way that they can operate differently from traditional commodity trading organizations, while remaining deeply linked. So commodity traders are establishing incubators, entering joint ventures, and striking partnerships with consultancies and universities. In some cases, they are even pioneering ways that they can monetize proprietary intelligence outside of their own trading and sales activities.

Simultaneously, existing teams of traders, quantitative analysts, and developers must work more nimbly to make the most of short-lived information advantages. Until now, traders and quantitative analysts identified key metrics for trading strategies and then asked developers to provide them with forecasting tools over a period of weeks or months.

Moving forward, rather than spending time transforming spreadsheets into code, quants and data scientists must concurrently work in code and draw from shared data lakes to transform insights into pilots and proofs of concepts for trading strategies. To predict market behavior, they must use predictive analytics techniques, ranging from single factor analyses to more complex techniques such as convolutional neural networks. And quantitative analysts need to become more familiar with data science techniques, tools, and ways of working.

As commodity markets become more liquid and accessible, commodity traders are relying more and more on algorithmic trading, coupling predictive analytics with robotic trade execution

DIGITAL TALENT GAP

Commodity traders must also find new ways to attract and keep talent in an increasingly digital workplace. Commercially driven quantitative traders have worked in commodity trading organizations for decades. But to gain a competitive edge, commodity traders increasingly need data scientists in addition to their usual quant teams to transform much more complex and varied digital data feeds into trading strategies.

The challenge is that dedicated data scientists are universally in high demand. Generally, these digital data problem solvers prefer to work for prestigious tech giants and high-paying hedge funds rather than commodity traders. So commodity traders need to recalibrate their recruiting strategies to attract data scientists primarily by interesting them in pioneering digital solutions to seemingly impossible complex problems. After that, commodity traders need to make sure there is a steady flow of such challenges to retain their interest.

Commodity traders must also revamp their organizations so that the expertise of their data scientists can be spread broadly. For example, commodity traders should set up core teams of purely data scientists in data labs to tackle their toughest challenges and empower them to bring in external supplementary talent when

necessary. However, this team will not be as commercially driven as traders and analysts. As a result, in order to transform theoretical solutions into the practical profits, traders also need a deep “bench” of quants with commodity trading expertise that are fluent in the language and application of data science to partner with and be guided by a core team of data scientists.

These data science-infused quants should be deployed to work on developing or monetizing cutting-edge analytics with the data scientists. Much as banks, law firms, and consultancies recruit and train generalists, traders will hire quants for their raw capabilities and then assign them to the task where they display the greatest aptitude. The growing importance of these generalist quants will require a cultural shift for trading companies, which will need to hire them at an entry level and have their bench become part of the standard rotations of newly hired college graduates.

Members of the core team of data scientists will also have to be moved through different parts of the organization so that they can

Much as banks, law firms, and consultancies recruit and train generalists, traders will hire quants for their raw capabilities and then assign them to the task where they display the greatest aptitude

interact with the larger group of existing top quantitative analysts and traders. They can then mentor others who are just starting out on what will eventually become a broader shift for the industry, from developing analyses in spreadsheets to working them out in code. Once this happens, analysts with coding capabilities will be able to abstract and reuse solutions to improve traders’ strategies across the board or even move themselves into the front office, trading on the back of their models.

EXHIBIT 4: THE NEW COMMODITY TRADING LANDSCAPE

The return of the importance of proprietary market intelligence will force all commodity traders to adopt new strategies

SURVIVAL MECHANISM	GLOBAL TITANS	OTHER PLAYERS
PROPRIETARY INTELLIGENCE	<ul style="list-style-type: none"> Leverage scale of flows and possibility to invest by developing predictive analytics 	<ul style="list-style-type: none"> Figure out where core competitive advantage enables proprietary data or understanding
ECONOMIES OF SCALE	<ul style="list-style-type: none"> Continue the quest for scale Creation of digital operating model to monetize predictive analytics as best as possible Creation of fit for purpose digital talent model 	<ul style="list-style-type: none"> Reduce non-core activities (sacrificing marginal P&L to enable improved margin) Pursuit of cost savings through digitization – blockchain across companies and robotic process automation of internal processes

Source: Oliver Wyman analysis

RETURN TO THE CORE

Only the largest traders can currently invest in predictive analytics because they alone have the scale to monetize results profitably and the capital to invest in sophisticated systems and dedicated teams. This gives them a significant edge over smaller traders and will result in even more margin becoming concentrated in major players. Consolidation will accelerate, at least until the cost of advanced analytics decreases. Top traders will continue to gain an even larger share of the industry's profits by taking advantage of predictive analytics, while forcing other players to focus even more on only their core competitive advantages. (See Exhibit 4.)

To compete, commodity producers, national oil companies, large commodity consumers, and midsize traders will need to reassess their strengths and invest in them. They will have to be sure to optimize any advantages they have in terms of their access to assets, equity flows, proprietary data, niche trading capabilities, or differentiated business models. Advanced analytics may even enable players with sufficient scale in their niche to strengthen and defend their position. However, to do so, many may need to enter joint ventures or partnerships to achieve sufficient scale to monetize their advantage. At the same time, these traders will have to continue to lower costs and investigate operating and commercial models that give them an even bigger bang for the buck.

That means midsize players must shed noncore businesses, strike alliances to gain access to larger portfolios, and automate back-office functions. By relying more on robots to conduct basic tasks such as reconciling data and blockchain to manage intercompany paperwork exchanges, some commodity traders have lowered their costs by as much as 30 percent. But it's clear from the past several years that, like other industries, commodity traders cannot simply cost cut their way to success.

THE PATH FORWARD

Instead, traders need to make maximizing the potential of information advantages their top priority. Previously unthinkable digital capabilities will determine who will be the industry's leaders in the long term.

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OIL'S BOOM-OR-BUST CYCLE MAY BE OVER

Recent price swings highlight a new era of uncertainty

Saji Sam, Juan Trebino, and Bob Orr

In November of 2017, United States' crude oil production exceeded 10 million barrels per day for the first time since 1970, according to the US Energy Information Administration (EIA). Analysts have *predicted* that US could become the world's largest oil producer in 2018, surpassing Saudi Arabia and Russia. How did we get here, and what does it mean for the industry?

US shale oil and gas producers have been ramping up production to take advantage of rising crude oil prices – prices that had been rising in the wake of a deal between the Organization of the Petroleum Exporting Countries (OPEC), Russia, and other non-OPEC producers to reduce oil output. That deal sent the price of *Brent crude* oil to above \$70 a barrel in January of 2018, after the industry had suffered through \$54 per barrel oil on average in 2017.

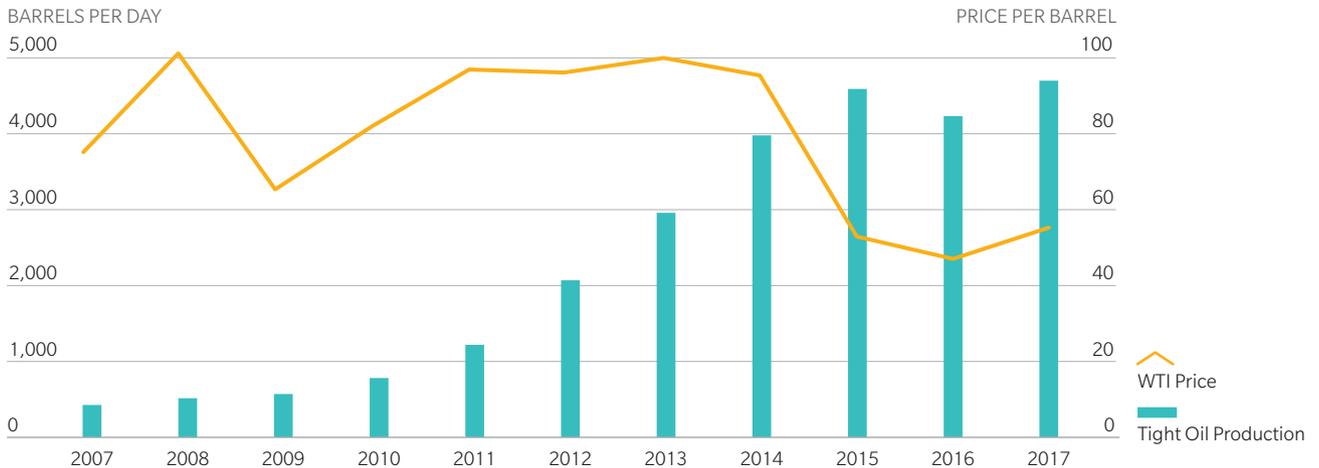
But with oil producers in North America expanding output, prices are likely to remain volatile. Unlike national oil companies and oil majors that typically take five to 10 years to develop conventional oil reserves, these independent and “unconventional” players have improved their drilling and fracturing technology to the point where they can respond within months to temporary spikes or dips in the market.

A NEW ERA OF UNCERTAINTY

The recent price swings highlight a new era of uncertainty gripping the world's energy markets. As global oil producers work at cross-purposes, the industry's traditional boom-bust cycle is being replaced by faster, shallower price rotations based on changes in production. (See Exhibit 1.) It makes price movements less extreme but also more difficult to predict. The constantly fluctuating number of barrels of crude available from nimble shale operations is a primary driver. But other factors are the long-term impact of increased fuel efficiency and the fits and starts of the global transition away from fossil fuels on world demand. The news is all good for customers, but it makes planning for industry players much more difficult.

EXHIBIT 1: THE NEW RULES FOR OIL

As North American output expands, the industry's traditional boom-bust cycle is being replaced by faster, shallower price rotations



Source: US Energy Information Administration

This unpredictability may only intensify as oil markets continue to adjust to shifting realities. Even more potentially destabilizing for major players, the expected surge in the US oil supply may be enough on its own to meet all of this year's growth in global oil demand. After being one of the world's largest net importers for decades, the US – while still a net importer of oil – is now selling millions of barrels of oil to China, Britain, Mexico, and India, a new reality made possible when restrictions on crude oil exports were lifted in 2015.

The soaring US output comes from fracking operations that have cut costs dramatically since slumping prices in 2014 forced dozens of companies into bankruptcy. These increasingly efficient survivors now represent half of U.S. oil production, up from a mere 10 percent just seven years ago in 2011. In fact, 2018 may mark the first year shale producers will be able to fund future expansions of drilling programs through their own cash flow.

While major oil companies plan to dramatically increase shale production in the *Permian Basin* in Texas and New Mexico, US shale production alone is unlikely to be enough to satisfy the world's growing oil needs – especially when oil reserves in shale may only get us another 10 years of oil and not necessarily 50. Oil companies will need to develop both new conventional and unconventional crude oil resources to keep up with current demand for roughly one million more barrels of oil every year, in addition to replacing the approximately four million barrels lost annually as reservoirs are naturally depleted. In total, we estimate that the oil and gas industry will have to replace about 40 percent of today's oil production over the next seven to nine years.

DIFFICULT DECISIONS

That means difficult decisions lie ahead for independent shale producers, national oil companies, and the major integrated companies. While they can start to tap into the

global reserves of shale oil, which exist literally everywhere, developing the reserves in most places will require a significant investment to build the shale ecosystem and supply chains needed, in addition to the infrastructure to gather, treat, transport, and store the crude oil. (See Exhibit 2.) Or they can develop conventional reservoirs where it will require long-term investments in new technologies to bring the cycle times and costs more in line with those of nimble shale producers. Most major producers with large balance sheets will likely hedge their bets and attempt both.

Generally, cheaper oil is certain to have at least one short-term impact: It will compete with and potentially slow down the world's expected transition to renewable, clean energy.

Transportation accounts for the majority of the world's oil demand, and as long as oil prices stay way below their 2008 peak crude oil price of \$145 per barrel, there's less economic urgency to switch to electric vehicles and hybrids, even in China and Europe where there has been governmental support to move away from internal combustion cars. Electric vehicles will only account for 7 percent of the cars on the road over the next 12 years, Morgan Stanley estimated when oil prices were relatively low in May in a report titled, "One Billion BEVS by 2050."

Long term, however, oil demand to operate cars is likely to decline as fuel efficiency for all manner of transportation increases, car ownership continues to fall, and electric and

EXHIBIT 2: THE WORLD'S SHALE RESOURCES BY THE BARRELS

The United States is the world's leading shale producer. But more than one trillion barrels of unconventional oil exists around the world. Here's how much tight oil could be recovered in 39 countries



Source: US Energy Information Administration

autonomous vehicles become more popular. By 2050, more than half of the world's passenger cars are likely to be electric vehicles, according to the Morgan Stanley study. With the right combination of technological advances, cost reductions, and integration with renewable energy and storage, the tipping point for electric vehicle adoption could potentially be much earlier. These trends will require oil producers to shift their focus away from transportation and diversify towards innovative petrochemical products to capture market share in diverse end uses, such as clothing and construction materials.

To match the new environment of constant, low-grade volatility in both prices and supply, producers and consumers of oil may need to re-evaluate assumptions and continuously adjust their strategies. Here are several ways that some forward-looking producers and customers are already beginning to do this:

Diversifying oil suppliers and sources. Major oil and gas producers are preparing for greater uncertainty by shifting their reserve portfolios toward unconventional oil and gas in order to respond nimbly and competitively to market shifts. Companies such as Exxon, Chevron, and Shell have all said they expect to expand their production in shale assets in the US, Canada, and Argentina.

At the other end of the spectrum, refineries and other industrial customers are starting to broaden their sources of oil supply and seek more favorable terms. Last year, for example, India, which imports about 80 percent of its crude requirements, began importing oil from the US for the first time in its history. More recently, Poland signed its first ever contract for US crude oil to diversify its supplies from Russia. Some independent refineries in China, Japan, and Poland are trying to secure spot crude oil cargoes to supplement their supplies from traditional long-term supply contracts.

Major oil and gas producers are using cutting-edge technologies to reduce development cycle times and costs for offshore conventional oil projects

Developing new digital efficiencies. Major oil and gas producers are now trying to apply lessons from the shale revolution's use of cutting-edge technologies to reduce development cycle times and costs for offshore conventional oil projects between 40 percent and 50 percent. Although the effort to digitize oil operations is still in its infancy, leading producers are working closely with oilfield services companies, engineering firms, and construction teams to incorporate artificial intelligence, robotics, and predictive maintenance into offshore operations. Drones are beginning to be used to check for pipeline leaks, self-driving trucks are moving tar sands, and Schlumberger is experimenting with a robotic drilling rig that will complete land wells in 30 percent less time than conventional rigs and require 30 percent fewer man-hours. All of this is with the aim of reducing the marginal cost of the barrel from the current \$70 a barrel to around \$40.

Major players are also optimizing their field development plans by tapping into new production data streams and developing three-dimensional digital models of their massive offshore platforms. By modularizing components, they hope that deepwater offshore developments can be prebuilt and assembled in three to four years instead of the current seven to nine years, at a fraction of the cost.

Investing in differentiating new services. At the same time, some national oil companies and oil majors are exploring new ways to differentiate themselves from shale producers by investing in refineries, pipelines, petrochemical production, and storage infrastructure close to their customers. Saudi Aramco, for example, is considering committing billions of dollars to expand its refining capacity in Malaysia and Indonesia, as well as a new refining and petrochemical plant in China in an effort to lock in customers.

Re-evaluating buffers to a more uncertain environment. As unpredictability becomes the industry's new normal, some oil and gas producers have started to rely more on hedging as a way to protect themselves from volatile crude oil prices by buying futures contracts that either lock in future prices or put limits on them all the way from their oil wellheads to their refined products. By placing upper and lower bounds on price volatility, producers can count on a more certain cash flow.

Some countries in Asia and the Middle East may come under social pressure to reinstate subsidies to shield their citizens from more frequent price swings at the fuel pump. Indonesia, the United Arab Emirates, and several others accelerated a process of retracting gasoline and diesel fuel subsidies and linking them to market price a few years ago to take advantage of the dramatic fall in oil prices while assuming that they would remain "lower for longer."

The first months of 2018 have shown that the oil industry has entered an era in which change will be the only constant for the foreseeable future. While oil prices will not spike to the peaks that they hit when OPEC and geopolitical events ruled the oil market, the oil markets will likely be unstable as the ranks of maverick shale producers swell, oil majors and national oil companies try out new digital techniques on their conventional fields, and new trade patterns emerge. As we have seen in other industries, to make the most of the new opportunities that lie ahead, oil companies will increasingly need to morph into agile organizations that can pivot to offset and even capitalize on disruptive new shifts. No one will be able to afford to stand still.

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TRANSFORMING UTILITIES FROM THE BOTTOM-UP

Tapping the power of people

Gerry Yurkevicz, Adam Smith, and John Gracie

Utilities face a double people challenge. They need to improve both their customer experience and raise productivity. We examine how both goals can be achieved in tandem.

Getting this right changes everything. Tapping the power of people can underpin the next great phase of utility performance. To paraphrase one utility, focusing on people provides the pathway to serving the new energy customer, saving the planet, and generating prosperity for all.

THE NATURE OF THE CHALLENGE

The transformation of the energy sector is well underway. Decarbonization is driving the shift toward lower or zero-carbon energy generation. Renewables continue to grow in importance. Electrification is driving the mobility sector. Decentralization is providing customers with increased availability and access to distributed energy resources. Meanwhile, digitalization and the Internet of Things are enabling smart grids, giving customers greater control over energy choices and usage.

This market transformation creates significant opportunities but has also given rise to challenges for utility strategies and operations. Utilities need to transform their business to address the attributes that customers, regulators, and stakeholders want from the future grid. The list of demands is long: keep the lights on, be resilient, be clean and sustainable, be economic, allow flexibility and choice, be equitable, and be cyber safe and physically secure.



A NEW APPROACH IS NEEDED TO TRANSFORM UTILITIES

Utilities, especially in North America, have performed superbly financially in the recent past. The rebuilding of the energy infrastructure, massive utility capital spending, creation of a constructive and supportive regulatory environment, and provision of low, consumer-friendly natural gas prices have combined to make the sector one of Wall Street's shining stars. Everyone is happy: consumers, regulators, and shareholders.

However, achieving the same stellar performance in addressing the forthcoming challenges is likely to prove more demanding. Despite efforts to become more customer-centric, satisfaction with utility service in general has been lower than other categories of consumer spending. Even after significant capital investment, there's been little

improvement in reducing the number of power outages per utility customer and cutting down on the time needed to restore the service once the lights go out. Natural gas incidents and safety make headlines. Technology investments have had little impact on workforce productivity. Operations and maintenance costs have proved difficult to control. And after multiple rounds of reorganizations over the years, utilities remain siloed, managing handoffs between functions poorly.

None of this bodes well for the future. Change is coming fast to the utility business – faster than many would like or are prepared for. There is a squeeze on the way, as energy use flattens out and regulators become reluctant to raise rates to recover investments, and unit and labor costs rise.

News from the cutting edge

So, what does this new wave of transformation look like on the ground? This is a snapshot from one utility company we worked with to address this challenge. The picture is taken partway in the journey, but it should give the flavor of what is happening.

Many hundreds of people throughout the utility have engaged in the bottom-up conversation around the vision, the desired future state for the company, the behaviors it would entail, and the roadmap for getting there.

The leadership team have all received coaching and personalized training, providing them with new skills vital to implementing the vision. The team is already modeling the new behaviors expected from the organization as a whole.

The entire organization has been energized by this interactive and co-creative process. All those working in the utility are not only aware of what is entailed in the forthcoming transformation but also have demonstrated their buy-in for the new vision. The new culture is already taking hold. Productivity is beginning to improve, even before pushing the start button.

CREATING A BOTTOM-UP PROCESS OF CHANGE

This is not to give the impression that transformation is easy. The very notion itself is often “countercultural.” By their very nature, utilities are most comfortable with implementing top-down, well-delineated solutions. Engineering and control are everything in ensuring reliable service. This is one reason that bottom-up, people-driven solutions don’t always fit easily with the existing culture at utilities. Our experience shows, however, that making people the owners and drivers of the solutions enables the expertise and talent within an organization to be unleashed and ensures a high level of buy-in.

The following gives a brief outline of the three main elements critical to the success of the change effort.

Creating purpose and developing leaders who inspire

Most utilities have done “the vision thing”: They have all put out statements saying something about serving the customers, something about service excellence, and something like, “our people are important.” This is NOT what we are talking about.

What we are talking about is a process designed to articulate what makes the company tick, its ambitions as an organization, and what motivates those within it. The goal is to galvanize the executive team and the organization as a whole by creating an overarching change narrative that connects everyone in the company with the business purpose, its vision and values – and to do so in powerful and provocative ways at both the business level and at the human level. Getting this process right will stimulate change, reduce noise, provide clarity, and move people emotionally.

A people-led, bottom-up, co-creative transformation approach provides the path to accelerate the outcomes that matter the most to leaders, employees, and customers

No business leader is superhuman. While business leaders are typically equipped with those abilities and skills necessary for rising to positions of authority, many of them are usually fairly ordinary people. When the goalposts shift, these same people may find themselves out of their depth and in need of new skills. This often proves to be the case when the business needs to operate in new ways in new territories. This is not a problem: this is the impetus for personal growth and development.

Our experience shows that even the most experienced leaders benefit from coaching and well-targeted training. The same is even more applicable to teams. We find the best technique is an active learning approach that gets to the root causes of current development challenges, while providing practices that shift underlying mindsets and behaviors. The net result is greater effectiveness.

Aligning, engaging, and communicating creatively to motivate belief and action

For many utilities, team alignment is the goal. But achieving alignment is no easy task. Technical specialization encourages activity silos, and this all too often produces a narrow, siloed mentality. Our experience shows that top-down processes are very unlikely to achieve full alignment, however well-intentioned and however much energy is put into them. Team transformation starts with alignment around

the behaviors designed to produce the desired end target state of the culture.

Culture is a slippery term, but here it is used to denote those aspects under the control of the utility that affirm, support, and encourage certain behaviors. Ensuring that the culture supports the right behaviors is key.

Analysis is needed to assess how the organization measures up against this and identifies the root causes of all the current performance issues, co-creating new structures and supports for the desired culture. For instance, while utilities might be justifiably focused on technical issues, the current culture may not be emphasizing cost and productivity issues sufficiently. This process first requires defining the target state. Then, it needs to encourage ideas and energy to bubble up from within the organization.

Communication around the change needs to be rational and emotive, meaningful and highly visual, graphic and interactive, bringing the why, what, and how of the culture change program to life. Each communication needs to leave the employee with a clear understanding the desired change: “So that’s what it means for me, my group, and the organization as a whole.”

Applying a co-creative approach to change to transform how utility employees work

To succeed in the new energy market, utilities will need to frame the future based on their own corporate DNA, and open minds to discover unexpected opportunities by bringing in expertise and insight from outside. Co-creative design applies an inquiry-based, collaborative approach to designing the future, one that not only harnesses the knowledge and experience of the organization but which also challenges this with additional external insight and know-how.

A variety of methods are used during the co-creation process, including: 1) immersion events designed to unearth collective insights from different audiences while building alignment and buy-in; 2) transformation hubs that keep initiatives extremely focused on outcomes; and 3) rich infographics, animations, videos, and apps to communicate and engage with the organization at all levels. Each method uses hands-on, collaborative, and purposefully designed ways of working to steer the change efforts with both agility and precision.

Once the path forward has been described, a second level of activity can create the right conditions for change to take hold. We have often used these conditions to build the organizational capability and muscle memory for new ways of working, new operating models, and new approaches to coaching and training. Embedding a co-creative approach will lead to a better set of outcomes, enabling utilities to adapt to and roll with change over the long term.

These are exciting times. Utilities have an opportunity to flourish in the new energy world. A people-led, bottom-up, co-creative approach provides the path to accelerate the outcomes that matter the most to leaders, employees, and customers. Utilities can frame the future, build the movement, and sustain the momentum to benefit all.

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RESTRUCTURING REGIONAL OIL GIANTS

To diversify, national oil companies will need robust, focused corporate governance systems

Volker Weber and Saji Sam

Before June 2014, running a national oil company (NOC) was certainly not easy, but it was less complicated than it is today. That month, the price of crude oil embarked on a yearlong freefall that crippled the revenue streams of many Middle Eastern NOCs – and ultimately the budgets of the nations that own them.

The crash left many NOCs more committed than ever to broadening their businesses downstream into refining and petroleum products. More than anything else, they knew they needed to become international players.

With that decision, the NOCs opened up new business opportunities – partnering across new global marketplaces with potential customers; attempting to achieve operational efficiencies through mergers; and even, in the case of two NOCs, raising funds by going public. But it also exposed NOCs for the first time to a whole new arena of risks and new rules on how to conduct business.

Suddenly, they were contending with a variety of unfamiliar foreign country-specific standards on business practices, the environment, health and safety, tax regulation, and government-reporting requirements.

MANAGEMENT STRUCTURE

Once on the international stage, NOC management teams found that they needed a corporate governance infrastructure that matched the elevated risk management and myriad regulations and bureaucratic processes required by the new countries in which they wanted to operate.

Where in the past problem solving or getting permission for certain projects meant negotiation with familiar agencies and trusted officials, NOCs are increasingly being



pulled out of their insular habitats and thrust into foreign environments where they do not know the officials and the officials do not know them – and where regulations compel them to produce data and documentation to back up claims being made or deals being struck.

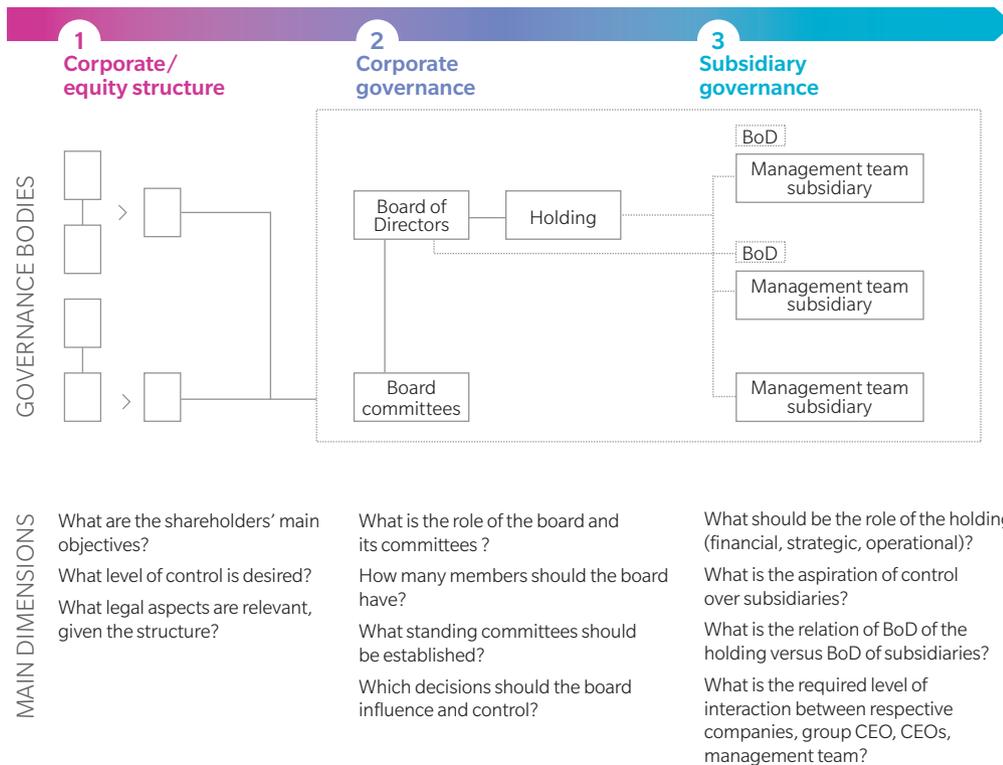
Most NOCs are finding they do not have the governance procedures in place to sufficiently cover their practices. As the business models for NOCs become more complex, governance structures originally built to handle managing oil and gas production and meeting national objectives rather than business performance goals must change.

If these NOCs hope to become publicly traded, diversified energy conglomerates, mirroring international oil companies, they will need the same kind of strategic, digitized, centralized and risk management-focused governance systems that their international counterparts have. (See Exhibit 1.)

CORPORATE GOVERNANCE

One of the first areas they must address is their management structure. Traditional governance models at most Middle East NOCs are based

EXHIBIT 1: A SYSTEMATIC GOVERNANCE FRAMEWORK IS REQUIRED TO MANAGE STAKEHOLDERS' INTEREST IN A CORPORATION



Source: Oliver Wyman analysis

on a holding company's structure controlling several operating subsidiaries. The reporting lines are lean and informal, often based on personal relationships or family ties.

While this works well at home, where the principal goal is meeting governmental budgetary targets and business is often concluded on a handshake or verbal agreement, it does not provide the managerial support, financial documentation, and risk management needed for projects far from home, particularly those with international joint-venture partners.

BOARD COMPOSITION

These joint ventures are prompting a few forward-thinking NOCs to modernize their governance structure, particularly at the operating subsidiary level. They are creating new, more formal governing boards based on reporting protocols and frameworks more familiar to their global partners.

This change involves recruiting directors with the appropriate technical expertise, whose positions are based on merit rather than political patronage. It also requires bringing in independent outsiders.

Abu Dhabi National Oil Company's (ADNOC) distribution operating subsidiary is a good example of how boards are starting to change. In 2017, the same year that the unit did an initial public offering of 10 percent of its equity, the CEO of Compania Espanola de Petroleos joined the ADNOC Distribution board as an independent director.

Changing the board composition is one of many necessary steps, which start with creating a systematic governance framework

National oil companies need the same governance systems that their international counterparts have

to manage stakeholder interests, giving more independence to operating subsidiary boards, and digitizing substantial portions of operations for efficient collection of data.

NOCs cannot just copy-and-paste the corporate governance structures used by international oil companies, as their mandates are different. Most NOCs are accountable to the government and national objectives, such as providing employment.

But if they want to raise capital on international markets and operate in other countries, their corporate governance structure must provide the same kind of transparency and accountability as their international counterparts or their efforts to go global may be stymied.

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SUPERMARKET

HOW TO KEEP THE LIGHTS ON AS ELECTRIC VEHICLES HIT THE ROAD

Power companies will have to make tough decisions about infrastructure investments to avoid widespread brownouts and blackouts

Thomas Fritz, Andrew Perry, Aditya Ranjan, Joerg Staeglich, and Curtis Underwood

The number of electric vehicles (EVs) on the road worldwide is expected to grow to 125 million by 2030, up from four million at the end of 2018. While it took 60 months to reach the one million mark in annual sales in 2015, going from three million to four million took just six months last year. With several large countries proposing bans on sales of fossil fuel-powered vehicles, Chinese low-cost EVs headed to the West in the near future, and several established automakers switching their focus to all-electric cars and hybrids, it's clear the trend toward EV ownership will accelerate even more in the coming years.

That means more and more EVs in urban and suburban neighborhoods worldwide could be plugging in daily to recharge. Most electrical distribution networks are simply not ready to provide the additional load – especially during peak evening hours when many EV owners are likely to first plug in to recharge their cars.

Currently, drivers in the United States log some three trillion miles annually in their automobiles. While currently less than two percent of the vehicles are electric, what happens when that number increases? One study estimated that if all the cars in Texas today were EVs, the state might need as much as 30 percent more power; California would need 50 percent more. Nationwide, we calculate that the conversion of all internal combustion engines to electric vehicles could add as much as 45 percent to electricity demand.

Admittedly, the US Energy Information Administration estimates seven out of 10 cars will still have internal combustion engines by 2050. Even so, the grid will no doubt feel increasing pressures if sales of electric vehicles accelerate as predicted.

Europe is likely to face more of a problem, given recent edicts that start banning sales of internal combustion vehicles over the next decade and beyond. In Germany, by 2035, 37 percent of cars on the road will run on electricity. Given the current German power grid and assuming no grid upgrades, our analysis shows a significant risk for widespread blackouts as early as 2032.

These estimates are based on the “average” community. For many years, the new demand generated by EVs will be uneven, with high- and medium-density residential parts of the distribution grid seeing the first pickup. For communities where there is a heavy preponderance of EVs, challenges to the distribution grid may arise much sooner.

IF NOTHING IS DONE

In the United Kingdom, brownouts from electric vehicles could begin by the time they represent 25 percent to 30 percent of cars on the road if no significant action is taken, according to our calculations. That’s expected by the early 2030s. Still, projections for EV adoption are notoriously hard to calculate and have generally underestimated the pace, because of the wide range of variables, including decarbonization policies, gasoline prices, the accessibility of charging stations, and the cost of EVs themselves. Today, in the UK, forecasts are wide-ranging, anticipating anywhere from 2.5 million to 10.5 million electric vehicles in the UK by 2030 and as many as 35 million by 2040.

The traditional response of distribution network operators, the businesses that manage electricity networks at the local level, would be to spend billions to reinforce residential networks. With this approach, by the time electric vehicles represent 50 percent of the cars and trucks on the road, German network operators would have had to spend an estimated 11 billion euros to prevent service interruptions, based on our data.

With the risk of outages and the danger that inadequate electricity networks may become a barrier to EV uptake, regulators and policymakers could be tempted to push for investment in residential networks to accommodate additional demand. This would be both expensive and disruptive because of the major roadwork required.

Networks last for up to 50 years, during which much can change to turn these investments into stranded assets unless carefully thought through. Given that costs are usually passed along, consumers will be the ones paying for any mistakes made.

CHARGING ALTERNATIVES

But there are incremental options to consider that don’t require substantial commitments of funds. Encouraging car park EV charging and en route rapid charging may mean that people would not need to charge at home. Alternatively, more ride-hailing might also mean fewer cars charging in the city if vehicles serving city residents are based elsewhere.

As autonomous vehicles develop and gain regulatory acceptance over the next 10 to 15 years, the result could be fleets of cars that charge in centralized depots rather than on the street, a much simpler and more efficient proposition from a charging perspective. On the other hand, if ridesharing and autonomous vehicles don’t take off as predicted, the

potential for power shortages in a world of individually owned electric cars becomes a more pressing and immediate problem.

Besides the sheer magnitude of investments potentially required, regulators are also confronted by two equally suboptimal possibilities: the disastrous impact of funding projects too late and the risk of stranded assets if made too early. Together, these scenarios leave networks and regulators in a quandary. Still, it is important that decisions not be rushed, so that the market can be allowed to develop as much as possible before commitments are made to large-scale infrastructure investments.

Adding to the confusion, the EV charging market is still nascent, with numerous business models competing for supremacy. Already automotive manufacturers, energy suppliers, technology players, and international oil companies are involved, adding another layer of complexity as individual players steer the market in different directions. Any major oil company with service stations has the capital to deploy a network of rapid charging stations and influence customer behavior. At the same time, partnerships involving car makers, supermarkets, and charging-point suppliers could lead to greater charging at “location” car parks.

INTERIM SOLUTIONS

Pursuing a smart charging option may offer one way to delay decision making long enough to allow various mobility scenarios to play out. The most economically attractive solution to better managing the electrical power supply involves incentivizing EV owners to charge their cars at off-peak hours and coordinating charging on a staggered basis with other local owners.

This approach requires charge-points, and their associated electricity meters, to be capable of sophisticated two-way communication, so they can be controlled and managed remotely by grid

The faster smart charging becomes standardized the better networks can manage the crunch of EV adoption

operators. Monetary incentives for EV owners may be needed to encourage participation, as well as penalty pricing to ensure compliance.

Another approach entails encouraging use of photovoltaics – solar cells – and the use of decentralized, local energy storage at the point of charging, including use of the car battery itself. These can act as a buffer to avoid overloading the grid at times of peak energy demand. In some markets such as Germany where there is a longer winter and fewer hours of sun, solar solutions would likely offer limited relief.

The faster smart charging becomes standardized and mandated for all EV charge-points, the better networks will be able to manage the crunch of significant EV adoption. Whether such solutions will ultimately solve the problem is unclear, but at the very least these approaches will ease the pressure on grids and provide the industry with the opportunity to make better decisions on infrastructure needs.

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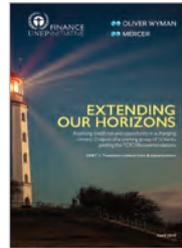
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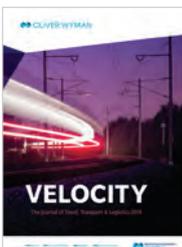
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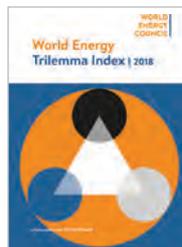
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