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AFTER THE FALL
THE NEW WORLD OF OIL

By Bhushan Bahree

A new world oil order based on price and cost has evolved in the 15 months since November 2014, when OPEC abandoned its policy of supporting oil prices by reducing supply. To understand this new world of oil, it is necessary to accept that some distinctions no longer make sense. What distinguishes OPEC members from other exporters in terms of production now that the group sets neither prices nor output quotas? The answer is nothing, really. This lack of distinction may portend profound change in the industry, including fundamental relationships between countries and companies and more competition for investment among resource-holding countries.

Illustrations by Alex Williamson

In the current context, the old classifications of OPEC and non-OPEC do not work. What that means in practical terms is that the traditional calculation of the "call on OPEC," or the volume of oil that OPEC needs to produce to meet the shortfall between demand and non-OPEC supply, is not useful. There is a familiarity with these terms to be sure, but they can be distracting because OPEC members these days are not in the business of managing supply as a group — nor assigning individual quotas. Even the vestigial notion of an output target was abandoned at OPEC's latest meeting in Vienna in December 2015.

A statement by Iran's Oil Minister Bijan Namdar Zanganeh exemplifies the shift. Iran intends to simply "inform" OPEC of a production increase. Zanganeh said he does not need the permission of any organization to do this because it is, as he put it, Iran's "sovereign" right, as it is of every other OPEC member. And at the end of December, Saudi Arabia's Oil Minister Ali al-Naimi said the kingdom would produce as much oil as its customers want. Current discussions to freeze output at January 2016 levels do not change that basic policy.

Every extra barrel produced by Iran, Saudi Arabia, or indeed any other relatively low-cost producer will displace a high-end barrel elsewhere or add to the current glut and affect prices. It does not matter whether a producer is a member of OPEC — the discipline of price and cost applies to all.

Some OPEC oil is at the high end of the cost curve, and its development will be jeopardized by low prices along with non-OPEC high-cost oil. But much OPEC oil, particularly in the Middle East, is relatively low-cost, and its owners unsurprisingly see no reason to cut output and let higher-cost producers take their share of the market.

MARKET SHARE AT ISSUE

Al-Naimi first elaborated on this issue in an interview published by several news organizations in December 2014, a few weeks after OPEC's fateful decision in Vienna. He said, "If I reduce (production), what happens to my market share? The price will go up, and the Russians, the Brazilians, U.S. shale producers will take my market share." He added, "We want to tell the world that high-efficiency producing countries are the ones that deserve market share. That is the operative principle in all capitalist countries."

Could Saudi oil policy change? Riyadh has indicated that it would consider production limitations if all the other relevant parties did the same, but that it does not want to make room for "others."

Oil policy is not exclusive of all other considerations, even in a country as beholden to oil exports for its well-being as Saudi Arabia. It depends on what is at stake for the rulers, both domestically and abroad. Existential issues will always trump oil policy if it comes to that in the life of any nation. The country's oil policy could change if that was deemed necessary to address larger domestic, regional, or geopolitical considerations. Last week, Russia and Saudi Arabia agreed to freeze oil output, locking in market shares, if other producers do likewise. Still, Saudi Arabia seems to be girding for a period of low oil prices. It is cutting back spending, using up financial reserves, and considering large-scale privatizations, including parts of Saudi Aramco.

Similar scenes are playing out among other commodities producers, with the end of a commodity "supercycle" that began more than a decade ago and concluded when Chinese commodity demand tapered a few years ago.

There is no equivalent of OPEC in markets for such commodities as iron ore, aluminum, and copper. Yet statements by low-cost producers echo those by al-Naimi as they also refuse to reduce their output on the assumption that high-cost producers will have to shut down uneconomic capacity. "Why should I make cuts?" the head of copper at Anglo-Australian mining company Rio Tinto asked recently, which would open space for higher-cost rivals to step in?

A FLOOR PRICE?

Without OPEC or another entity managing the world's oil supply, there is no real or imagined "floor price" in markets. There is a clearing price for oil in financial markets, and this depends on myriad inputs and is prone to volatility. No model can fully, instantly, or reliably capture and process every input that goes into price formation.

To maximize revenues, low-cost suppliers have an incentive to increase output. Higher volumes will earn a producer higher revenues at any given price. Growing uncertainty about the prospects for long-term oil demand because of climate and other environmental concerns and new technologies is an added incentive for large resource holders to produce as much as they reasonably can in the near and medium terms. One hears less of the rhetoric of earlier decades about preserving resources for the "grandchildren's generation" or reserving them for "noble" purposes.

Yet, of course, an increase in collective supply will result in lower prices, all else being equal. In such a world, the highest-cost producers at any given time will be the most vulnerable. What could be the consequences? One outcome could be a wider opening of low-cost reserves to international investors and companies in countries that have petroleum resources but not the wherewithal — economic, technical, or organizational — to exploit them fully.

Such a development would be the reverse of the resource nationalism that gripped oil producers, notably many members of OPEC, in the late 1960s and 1970s. A trend toward a bigger opening of resources is not evident yet. As evidenced in Iran, even discussions of such an opening can arouse fierce domestic opposition. International oil companies instead have been cutting back investment and spending to live through the lean times. But the longer the period of low prices and pressures on the budgets of developing-country petroleum resource holders, the more likely it is that such a scenario could unfold. Because international oil companies have been cutting their E&P budgets, competition to attract them would be intense among resource holders.

Bhushan Bahree is Senior Director of IHS Energy.

To Readers

The oil price collapse, along with economic uncertainty and roiled geopolitics, is driving turbulence in the energy industry. These developments raise important questions: How will the extended period of low prices affect the overall global energy industry, as well as companies, countries, and regions that produce oil and gas? Will the global economy regain higher growth rates or will it remain mired in the new normal of "the new mediocre"? Are there new transformative innovations on the horizon that could have an impact comparable to that of hydraulic fracturing, which came to be adopted at scale less than a decade ago? At what rate will renewables gain market share in the years ahead? And finally, what role will policy and regulation play, especially in light of the agreement at the U.N. climate talks in Paris last December and the U.S. Clean Power Plan? These will be among the many questions and topics at IHS CERAWEEK 2016.

This special section, *Energy Transition: Strategies for a New World*, addresses several key issues at the heart of the current energy picture:

- The new world of oil, in the aftermath of OPEC's recent decision to eschew production quotas that have been a core element for more than three decades;
- Europe's green-brown contradiction, in which a strong push for renewables is concurrent with coal retaining a central role in the continent's energy mix;
- The five factors that will determine the impact of the December 2015 Paris climate agreement;
- Energy "revolution" or "evolution"? — insights from IHS's Global Energy Scenarios.

Tomorrow's special section will examine the changes underway in the liquefied natural gas (LNG) industry, evaluate prospects for the U.S. electric power industry, and describe the shifts underway in China's economy and their impact on energy demand.

We are pleased to partner again in these special sections with *The Wall Street Journal* during the 35th IHS Energy CERAWEEK conference, February 22-26, in Houston, Texas. IHS CERAWEEK is recognized as the preeminent gathering for the global energy industry. This year's conference will feature presentations and interactive sessions by more than 200 senior executives, government officials, thought leaders, and IHS experts. We anticipate attendance of more than 2,500 participants from more than 55 countries.

As we embark on our 35th IHS CERAWEEK conference, we invite you to share new perspectives on the energy future through the insights in these pages.

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This special section was prepared by IHS research staff and did not involve *The Wall Street Journal* news organization.

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IHS ENERGY CERAWEEK

Europe's Green-Brown Energy Contradiction

By Susanne Hounsell, David Price, Catherine Robinson, and Shankari Srinivasan

Since 2000, Europe has poured more than €1 trillion into renewable electricity investment, primarily wind and solar. This is in response to aggressive incentives for renewable electricity, with the goal of reducing greenhouse gas emissions. After all this investment, non-hydro renewables last year provided 17 percent of Europe's power, compared to 7 percent of U.S. power and only 5 percent of China's. Despite the spectacular growth of the renewables sector, the electricity source that emits the most carbon — coal — also remains a key component of Europe's energy mix. In 2015, coal accounted for 26 percent of Europe's power generation, only 5 percentage points lower than in 2000.

The combination of rapid growth in renewables and continued burning of coal means Europe today faces a green-brown energy contradiction. Thanks to renewables and the economic downturn, Europe will easily meet its 2020 greenhouse gas emission reduction targets — 20 percent below 1990 levels. But meeting the more stringent 2030 emission reduction target — 40 percent below 1990 levels — will be more difficult as currently planned measures are projected to yield emission reductions of only 27-30 percent.

Reduced reliance on coal would allow Europe to meet its long-term climate targets, but whether this will happen remains far from clear. In recent years, a combination of low coal prices and low carbon prices in the EU's Emission Trading System have favored coal over natural gas — which emits only about half as much carbon as coal in power generation. Indeed, the share of natural gas in Europe's electricity mix has gone down from a pre-recession peak of 24 percent to only 17 percent in 2015.

Some European policymakers favor taking strong measures to reduce the role of coal. But energy security considerations and the prospect of higher electricity prices weigh heavily in coal's favor. What will be the role of coal in Europe's energy future? The situations of two countries taking very different approaches to this question — Germany and the United Kingdom — may provide insights.

GERMANY: COAL-FIRED GENERATION REMAINS A BACKBONE AMIDST THE *ENERGIEWENDE*

Germany's prominent policy of *Energiewende* — energy turn — has at its core the goal of a long-term transition to a renewables-based power system. Last year, one-third of German electricity was supplied from wind, solar, biomass, and other renewable energy sources. But even as the role of renewables increased, the old bulwark of Germany's electricity sector — coal — also remained central. Domestic brown coal (lignite) and imported coal today account for more than 42 percent of German power generation. Meanwhile, natural gas has felt the squeeze; in 2015, the share of gas in Germany's power mix dropped to its lowest levels since 2000.

The primary reason for coal's resilience is the same as it is in Europe as a whole: Coal is cheap. In Germany, this is particularly the case for domestic brown coal. But because of its reliance on coal-fired power, Germany will have difficulty meeting its self-imposed 2020 emission reduction target of 40 percent below 1990 levels. At the moment, Germany is not on track to meet this goal, and the Ministry of Economics and Energy has been looking for ways to fill the gap.

One proposal, for a tax on coal-fired generation, was dropped after opposition from the coal industry and regional governments. Notably, North Rhine Westphalia, a key industrial and mining state, has emphasised that a parallel phaseout of both nuclear and coal power plants could jeopardize Germany's industrial competitiveness.

Germany's current plan is to shut down some of its oldest coal plants between 2016 and 2019, while keeping them in reserve for four years in case they're needed to meet peak demand. The cost is estimated at €1.6 billion and will be paid for — just as renewables subsidies were — by Germany's electricity consumers. There is some debate about whether to close more plants, which would be more expensive. With retail electricity prices already at record levels and support for coal mining still strong in some regions, additional closures seem unlikely. Germany will start the next decade with a far more carbon-intensive generation mix than might be expected from a global leader in renewables deployment.

UNITED KINGDOM: A DASH FOR GAS?

Until 2015, low coal prices also boosted coal-fired generation in the U.K. But for the last few years, London, unlike Berlin, has shown a strong commitment to reducing the future role of coal. In 2013, the British government introduced a carbon tax of £5 per metric ton (mt), which increased sharply to £18 per mt from April 2015 onwards. This was a sizeable tax; when burned, each mt of coal emits 2.5 mt of carbon. So since mid-2015, the tax has been equivalent to £45 per mt, when the price of coal used for power generation in the U.K. averaged £56 per mt.

The imposition of this tax allowed gas-fired generation to compete on even terms with coal starting in mid-2015. The U.K. government's policy to target coal stems in part from very limited domestic production and an explicit desire to increase the use of natural gas. In November 2015, the U.K. Secretary of State for Energy and Climate Change, Amber Rudd, delivered a major speech on the future energy policy for the U.K., in which she announced an ambitious plan to close all U.K. coal plants by 2025. In practice, all but a few are likely to close or switch to biomass within the next 2-5 years, their operators having read the runes some time ago, though some of these plants may have to stay in operation for a time to meet peak demand.

A GREEN-BROWN FUTURE?

Given Europe's commitment to emission reductions and its mature electricity market, many observers until recently believed coal would have only a limited role in Europe in the future. But the absence of a strong carbon-pricing signal to balance the playing field for natural gas means coal will remain a big part of Europe's energy picture for much longer than expected. Coal combined with a growing renewables sector is consistent with Europe's environmental goals to 2020. But in the years beyond that, meeting the longer-term ambitions with a green-brown fuel mix will become increasingly challenging.

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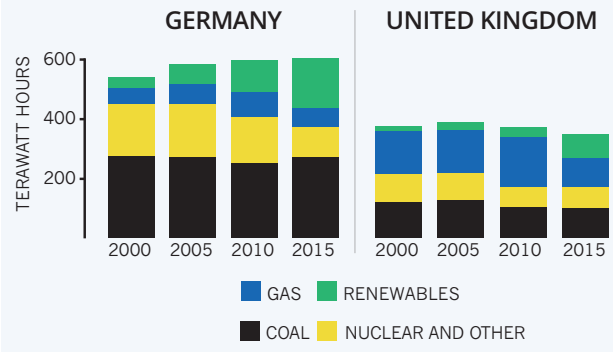
EVOLUTION OF NET GENERATION IN GERMANY AND UK, 2000-2015



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Rising to the Low-Carbon Challenge

By Carlos Pascual and Antonia Bullard

The U.N.'s Paris Climate Conference in December created an unprecedented global mandate to arrest climate change. Whether it succeeds will depend both on commercial realities and on the public policies that will determine how quickly and at what scale low-carbon energy systems can compete with traditional energy sources.

Each year since 1995, the United Nations has held a conference seeking an international agreement to reduce greenhouse gas emissions. Prior conferences stalled, in large part because developed and developing countries advocated quite different approaches. This time, in Paris, all members of the U.N. Framework Convention on Climate Change — countries rich and poor — agreed to reduce emissions.

Already some 185 countries have signed on to emission-reduction pledges called "Nationally Determined Contributions" (NDCs). The NDCs submitted so far will not meet the Paris agreement's stated goal of limiting temperature increases to "well below" 2 degrees centigrade. But the nations unanimously agreed to meet every five years to revise their pledges. Rather than seeking perfection, the parties in Paris chose to get emissions reductions going on a national basis and then build on the momentum.

Reaching the goals agreed to in Paris requires solving a conundrum. On the one hand, delivering economic and human development to a global population growing by 2 billion through 2050 will require using more energy. Today, 80 percent of that energy is supplied by fossil fuels. On the other hand, climate models generally predict that if the world continues to rely predominantly on fossil fuels to produce energy, delivering more energy to a growing world will have unacceptable implications for global living conditions. To solve this problem, future systems to produce and use energy will need to be decoupled from GHG emissions.

The Paris Agreement provides a mandate and framework for reducing these emissions. But it does not tell us how actually to achieve the target reductions. For the world to meet the ambitious goals set in Paris, five key strategic challenges must be surmounted: (1) managing policy risk, (2) figuring out how to price carbon, (3) deciding the role of natural gas, (4) providing sources of baseload power to support intermittent renewables, and (5) closing the gap between the costs of renewables and traditional energy sources.

First among these is managing policy risk. The NDCs presented in Paris are not binding under international law. With each nation setting its own NDCs, there are few common methodologies and no agreement on such key issues as carbon tariffs. With current economics still favoring fossil fuels, changing patterns of energy use will require national laws, regulations, and other incentives to become reality. This will require political will, social support, and effective enforcement at a time when many countries face challenging macroeconomic conditions. And at a time when energy companies are subject to exceptional strategic stress from falling commodity prices, they now face additional risks from new, varied, and potentially fast-changing climate policies. The planning challenge for national governments and energy companies is far greater than before for them to achieve cost-effective and commercially sustainable paths to reducing emissions.

Second, nations will need to price carbon effectively if they want to use markets to incentivize emission reductions. Carbon pricing figures prominently in the Paris Agreement; indeed, one-quarter of NDCs make reference to emissions trading. But while carbon pricing has broad support in principle, the carbon-pricing and emissions-trading regimes implemented to date have had limited effectiveness, due to political reluctance to impose meaningful prices. While details remain to be worked out, the Paris Agreement supports the development of an international market in GHG credits by recognizing that countries may use "internationally transferred mitigation outcomes" to achieve their NDCs — that is, one country can pay for emission reductions that occur in another country and get credit. An increasing number of jurisdictions are likely to adopt carbon taxes and emissions trading, and more companies will prepare themselves for a carbon-constrained future by incorporating shadow carbon pricing in their planning and investment decisions. But moving from national carbon-pricing schemes and corporate practices that price carbon internally to an efficient global market that delivers clear and effective signals to optimize investment decisions across countries and companies will be a controversial and time-consuming undertaking.

> Commercial realities and public policies will determine how quickly and at what scale low-carbon energy systems can compete with traditional energy sources.

Third, nations and energy developers need to reach a clearer agreement on the potentially transitional role of natural gas. Shifting primary energy supply from oil and coal to natural gas (currently around 20 percent of global primary energy) reduces GHG emissions since, per unit of energy, using gas generates about half as much carbon dioxide emissions as coal and three-quarters as much as oil. Thus, switching from coal-fired power generation to gas-fired power generation, for example, can be a pragmatic and relatively low-cost carbon dioxide abatement option. But concerns about locking in hydrocarbon energy and the methane emissions associated with natural gas could create a bias toward policies that favor zero-emissions renewables and limit incentives for conversion to natural gas.

Fourth, decarbonization of energy creates opportunities for renewables in the electricity sector. Not surprisingly, over 80 percent of NDCs make reference to clean energy. The IHS base case scenario forecasts the share of global power generated from renewables (primarily solar and wind) to grow from 7 percent today to 15 percent in 2030. But for countries to deliver on their NDCs, renewables would have to grow much faster, as envisioned in the IHS "Autonomy" scenario (for more, see article below on the IHS scenarios). Depending on location, today's wind and solar typically dispatch power just 25-35 percent of the time, so an investment in 1,000 MW of capacity delivers just 250-350 MW of power. Growing the share of renewable power may therefore require providing supplemental fossil fuel power. Nations will need to take a systemic rather than ideological approach to optimize renewables with other fuel sources for reliability.

Fifth, meeting the low-carbon challenge will require that low-emission alternatives compete on cost with fossil fuels in the power generation and transport sectors. In Southeast Asia today, for example, the use of coal in the fuel mix is projected to grow from 15 percent in 2013 to 29 percent in 2030 unless commercial incentives change massively. Financing terms can make a difference for renewables, where upfront capital investment accounts for most of the costs, while the wind and sun are free inputs after initial construction has been completed. Here, there is space for public and private sector energy companies to work with each other and with governments and investors.

In Paris, political leaders signaled an end to business as usual in the energy system. But they also need a robust energy sector to deliver the healthy low-carbon economy the world needs. That will not go forward without development of rational priorities, sensible transition paths, effective policies and incentives, and substantial advances in technology. These are the practical market considerations that will determine whether nations can deliver on what was promised at the Paris accord.

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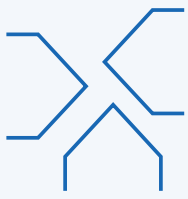
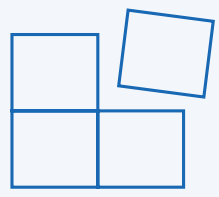
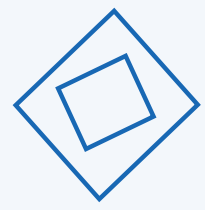
DEFINING CHARACTERISTICS OF IHS LONG-TERM ENERGY SCENARIOS TO 2040



RIVALRY
Most intense competition in history among energy sources for market share, which fuels evolutionary change in energy mix and demand



AUTONOMY
Transition to an energy mix away from fossil fuels at a faster pace than many thought possible



VERTIGO
World economy like weather on a mountaintop — sunny and pleasant one moment, then engulfed in fog and rocked by hurricane-force winds the next

ENERGY EVOLUTION OR REVOLUTION? *A QUESTION OF PERSPECTIVE*

By James Burkhard and Richard Vidal

Will the future of energy be evolutionary or revolutionary? The agreement reached at the U.N. climate talks last December in Paris (see accompanying article above) represented an effort to move toward a less carbon-intensive economy. But reducing the use of fossil fuels requires enduring change. Since 1990, the share of fossil fuels in total global energy consumption has held remarkably steady at around 80 percent. The future, however, will not necessarily follow historical trends. Nor will the path be a smooth one.

There are a number of "known factors" that will shape the future of energy, such as demographics, existing infrastructure, and current policies, prices, and costs. But there will also be unknown or unpredictable factors that alter the energy picture. Given the difficulty of predicting the future, are we fated to rely on gut instinct or extrapolation when it comes to investment and policy choices?

When developments occur that surprise us, it is because our assumptions turned out wrong or because the key drivers of the future had been missed or were out of sight. Yet the consequences can be severe, as events of recent years demonstrate. The use of scenarios to consider different futures provides a way to challenge "conventional wisdom," to test company doctrine and baseline thinking, and ask fundamental, sometimes uncomfortable questions about the future. Scenarios provide a framework for turning uncertainty into a decision-making tool.

The IHS Global Energy Scenarios provide three distinct views of the future of energy to 2040 (see figure, above). Many factors shape these outlooks; among the most important will be generational change, environmental measures, and advances in technology.

THE IMPACT OF GENERATIONAL CHANGE

Population data and age group breakdowns are well understood. But generational change is not just numerical; it implies the emergence of different perspectives and values. Historically, there have been times when a particular generation has had great impact on society and markets. The Revolutions of 1848 are a famous historical example in terms of politics. The 1960s is another in terms of culture.

People born between the early 1980s and the early 2000s, known as Millennials, have different views and priorities than their parents and grandparents. Millennials tend to be more comfortable with technology and social media. They have grown up with environmental issues discussed at home, online, and in schools. Many have grown up in societies where rising environmental and safety standards are taken for granted. As more Millennials become decision-makers, their impact will grow in the world — and in energy. Many find "freedom" and an "open road" in social media, not behind the wheel of a car.

ONE-WAY STREET: ENVIRONMENTAL MEASURES

Since the modern environmental movement took shape in the 1960s, measures to reduce pollution have typically traveled on a one-way street. Lead will not be put back into gasoline. Regulations to reduce noxious emissions from power generation are often strengthened over time, not reversed.

Historically, movement toward tighter environmental rules has been concentrated in North America, Europe, and Japan. But this is changing. As incomes grow in emerging markets, they develop a growing will and means to address environmental concerns. In 2014, Chinese Premier Li Keqiang said the time had come to "declare war" on pollution. Environmental issues have also become more important in India, where air pollution levels in Delhi recently led to vehicle restrictions. Climate change was the top global threat cited in a recent Pew Research Center survey of Chinese and Indians, beating out economic instability and terrorism. Views across Asia, Africa, and the Middle East are of great importance to the energy industry, since the vast majority of future demand growth — up to 85 percent — will occur there.

THE UNYIELDING MARCH OF TECHNOLOGY

Technological innovations do not respect market cycles or borders. The great revival of U.S. oil production was a principal catalyst behind the 2014-15 oil price collapse. It took root during the Great Recession of 2008-09 and deployed technologies that were already around.

Among renewables, the capital cost of solar photovoltaic (PV) panels is 70 percent less today than in 2006. And the cost of lithium-ion batteries is down 50 percent since 2010. Of course, further declines in costs are not preordained, and integrating new technologies into existing energy systems is far from a cost-free endeavor. But if costs for green (low or no carbon) energy technology continue to fall, it will influence a growing swath of consumers. But oil and gas markets have also moved from fear of too little supply to too much — with downward pressure on prices. And lower prices tend to support consumption unless outweighed by other factors.

So back to the question of whether the future of energy is evolutionary or revolutionary. The energy mix — absolute shares of demand by source of energy — will not change quickly because of the vast amount of existing fossil-fuel infrastructure and availability of fossil fuels. But lower costs for renewable energy combined with climate change and pollution concerns increase the likelihood of lowering the share of fossil fuels over the next several decades. The composition of energy-demand growth could be revolutionary, even if change in shares of consumption by energy source is evolutionary.

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