bcg.perspectives
by THE BOSTON CONSULTING GROUP

THE NEW LANDSCAPE OF GLOBAL ENERGY

By Iván Martén and Philip Whittaker

The energy sector regularly makes the front pages, not just for its cutting-edge technology and multibillion-dollar investments but also for its price spikes and occasional high-profile accidents. The coverage generally illustrates the strain on the increasingly overstretched global energy system. But beyond the headlines, broader structural changes are reshaping the energy world, among them major shifts in the geographical sources of demand, increasing supply shortfalls, an evolving geopolitical context, and intense scrutiny of the energy industry's environmental impact.

As a result, today's energy landscape exhibits growing complexity, increasing fragility and volatility, and a broad trend toward higher prices. These trends pose profound challenges for energy producers and consumers, and businesses must consider how they can adapt and succeed.

A New Global Landscape Is Emerging

Over the last 20 years, energy consumption outside of Organisation for Economic Co-operation and Development (OECD) countries has surged, transforming the landscape of global demand. Since 1990, energy consumption in India, Indonesia, and the Middle East has tripled, for example, and Latin America's energy use has doubled. Further, by 2009, China had overtaken the U.S. as the world's largest energy user; its total consumption increased by fourfold from 1990 through 2011.

In contrast, demand for energy within OECD countries has fallen, for several reasons: a shift away from energy-intensive industries, government policies that encourage energy efficiency, and slower economic growth exacerbated by the prolonged economic slump.

This trend is set to continue: approximately 90 percent of the growth in energy demand through 2030 is expected to come from outside the OECD countries, with 50 percent of demand arising from India and China alone.

These changes in demand have increased the demand overall, and the global energy supply has struggled to keep up, in part because of the fundamental limits on the supply of oil and other conventional energy sources. Although global liquids output has increased during recent decades, the underlying production of conventional crude oil has been static at approximately 70 million barrels per day (MB/D). Conventional production of oil and natural gas in mature basins such as the North Sea is falling fast—output dropped by nearly 10 percent in 2011 alone. The world is running out of oil that can be cheaply and easily produced.

Access to energy sources is also constrained. The new landscape of demand is not well matched to the existing supply map. Among the problems posed by that mismatch is the fact that Asia's new economic giants lack key domestic resources. India relies on imports to meet three-quarters of its oil demand, for example, and China, a net exporter of oil until the early 1990s, imported more than 5.5 MB/D of oil in 2011. The major exception is coal, the supply of which is well matched to demand in terms of geography and which has fueled much of the rise in Asia overall. China alone now accounts for half of the world's coal consumption and meets that need with domestic supply.

Nationalism and other political factors can also constrain access to energy resources if resource-holding countries choose to restrict foreign involvement in their energy sectors. The decision by Argentina's government to expropriate Repsol's stake in the energy company YPF is only the latest in a long line of examples.

An additional consideration is that the world's existing conventional-energy infrastructure is ill suited to respond to growing environmental concerns. The concern that greenhouse gas concentrations above 450 parts per million CO_2 equivalent will have a severe and potentially irreversible impact on the earth's climate implies the need for a radical transformation of the world's energy mix.

This global challenge is yet to meet with global resolution. The world's governments came together in Rio in 2012 for an annual environmental meeting, but in the two decades since the original Earth Summit, progress on global emissions reduction has been halting. The Kyoto Protocol, an attempt to create binding global agreements on climate change, did succeed in reducing emissions from participating countries, but that impact was outweighed by higher emissions from nonparticipating countries (notably China and the U.S.), and the plan to extend the Kyoto Protocol has faltered. It now seems more likely that progress will be made at the regional and national levels. The European Union, for example, has established ambitious energy targets for 2020, and individual countries such as South Korea have taken steps to curtail emissions.

Growing Complexity. One striking characteristic of today's challenging global energy landscape is its growing complexity. This is largely a consequence of the energy industry's need to employ ever-more-sophisticated technology to access new resources and meet new demand.

In upstream oil and gas, technological advances have allowed companies to identify previously unseen hydrocarbon deposits and extract previously subcommercial resources. The ability to accurately map structures beneath salt layers, for example, led to major finds such as Brazil's 8.3-billion-barrel Lula oil field (formerly known as Tupi). In the U.S., improved geological understanding, more accurate horizontal drilling, and the effective application of hydraulic fracturing unlocked the potential of shale gas; shale gas now makes up 35 percent of U.S. natural-gas production. Technology is also reshaping power generation, particularly in renewable-energy sources: existing technologies are being refined, and newer technologies, such as concentrated solar power, are undergoing commercial-scale development.

Many of the world's current energy projects are striking for their sheer scale

and complexity. Shell's pioneering Prelude floating liquefied natural gas (FLNG) vessel, for example, is nearly half a kilometer in length and is expected to be the world's largest floating offshore facility, weighing in at 600,000 tonnes. Meanwhile, in Finland, Areva's Olkiluoto 3 nuclear-reactor project requires enough steel for six Eiffel Towers and features the largest instrumentation and control systems ever programmed.

Beyond mere size, many projects are hugely challenging for other reasons. Development of production facilities for the giant Kashagan oil field, discovered in 2000, has required the construction of multiple artificial islands located 70 kilometers from the Kazakhstan coast to cope with the harsh climate, for example. And Brazil's Lula oil field is located some 250 kilometers offshore, beneath 2,000 meters of ocean and a further 5,000 meters of rock and salt, in a challenging high-pressure reservoir.

Greater complexity comes not only in individual projects but also from the growing interconnectedness of the global energy system. Natural gas, for example, has historically been divided into regional markets defined by pipeline networks. However, the burgeoning LNG market, which doubled in size from 2001 through 2010, has created growing interregional ties. While the LNG market is not yet as comprehensively interconnected as the oil market, it is growing, which means that local events that affect LNG supply or demand will increasingly have a worldwide impact.

This trend toward greater global interconnectedness is also visible in power generation and transmission. As renewable-energy sources assume a larger role, the global energy landscape will likely see a shift: now, power plants are few, large, and centralized; eventually, there will be many, smaller facilities. With growing requirements for storage and flexibility, power grids will become more complex. Their international reach will also grow, partly to balance out uneven electricity-generation patterns from renewables and partly to connect to optimal locations for renewable sources. For example, ten European countries have agreed to the construction of a North Sea high-voltage grid that will connect disparate offshore wind generation, hydro storage, and consumers. Other ambitious "supergrid" plans include the Desertec scheme to link solar-generation potential in North Africa to Europe's markets and an Asian supergrid initiative that will span East Asia.

Increasing Fragility and Volatility. The growing strain and pressures on the global energy system have led to heightened fragility and uncertainty. Increasingly large, intricate, and challenging projects often face major delays. The Kashagan oil-field development is now running approximately eight years behind its original time frame and has yet to produce any oil, for example. Meanwhile, Europe's landmark generation III+ new nuclear projects face severe delays and cost overruns.

In the interconnected energy world, local sparks can light global fires. Despite being the result of unique local circumstances, the Fukushima Daiichi nuclear-reactor meltdown had worldwide repercussions. The disaster accelerated the shutdown of reactors not only in Japan but also in faraway (and tsunami-free) Germany and Switzerland; other countries reevaluated their plans to build new nuclear plants. In Japan, which was forced to turn to alternative energy sources, LNG imports rose by more than 12 percent in 2011, driving up prices and having a dramatic effect on the world market.

The global markets for oil and gas are highly susceptible to the impact of local shocks. This was demonstrated in 2006 and 2009, when conflicts between Russia and Ukraine disrupted supply to 18 European countries for two weeks. Disruptions to global oil supply, such as those caused by recent conflicts in Libya and the Republic of South Sudan, can have even more severe effects on the world's energy system, given the limited spare capacity,

which is almost entirely in the hands of Saudi Arabia.

In total, nearly half of the world's oil demand flows daily through just six key chokepoints. So great is the significance of these routes that the mere suggestion of disruption to supplies—such as Iran's threat to close the Strait of Hormuz in early 2012—can have major implications for supply and prices globally.

The increase in oil and gas production in the U.S. and Canada—largely driven by tapping unconventional sources of oil and gas—has raised the possibility that North America will become less reliant on globally traded energy supplies. Moreover, a possible future shift from fossil fuels toward renewables could conceivably reduce the reliance of all major energy-consuming economies on the world's less politically stable regions.

However, renewables will increase rather than decrease the vulnerability of the overall energy supply, through their own inherent fluctuations in supply; their inclusion in increasingly complex, interconnected energy grids; and their reliance on changeable government subsidies. Volatility will therefore remain a key feature of the energy landscape.

Rising Costs. The increasing fragility of the global energy system has led to more volatility in pricing; price spikes are increasingly familiar. But longer term, the trend is toward increased costs. The growth in worldwide demand, led by non-OECD countries, has collided with constrained supply, necessitating a shift from conventional to unconventional, from simple to complex, and from easy to difficult.

For oil, this has meant moving up the steep shoulder of the supply curve, tapping more expensive sources to maintain global supply. Canada's oil-sands developments, for example, tend to break even at approximately US$80 per barrel, and gas-to-liquids projects require an oil price of US$100 per barrel. OPEC producers can, of course, still pump oil much more cheaply than their competitors from other parts of the world. However, many Arab countries have quickly become accustomed to the higher-price environment and have increased domestic spending to the point that even Saudi Arabia now requires a price of US$80 per barrel to balance its budget.

That energy is becoming more expensive is not surprising, considering the scale of investment involved in megaprojects worldwide. Shell's Prelude project, for example, is forecast to cost more than $10 billion. Meanwhile, Petrobras recently announced plans to spend $65 billion to develop Brazil's deep-water presalt fields over the coming five years—and that investment is only a small fraction of the anticipated $283 billion overall that will be invested in offshore Brazil in the next ten years.

But not all energy sources are becoming more expensive. One example is U.S. natural gas, which, isolated from the world markets, has collapsed in price through oversupply; whether this shale-gas-driven boom can be exported remains to be seen. Another is renewables: wind turbines' unit costs have halved since 1984 through innovation and increasing scale and experience, and the unit costs of solar photovoltaic thin-film technology have fallen by two-thirds since 2006.

However, renewables generally remain more expensive than key conventional electricity sources; switching more of the world's fuel mix to renewables is likely to increase energy costs, at least in the immediate future.

In a Changing Energy Landscape, Adaptability Is Key

Companies must be able to manage the challenges of the new landscape to flourish. For upstream producers, this means both optimizing their assets and managing the multiple dimensions of risk, be it commercial, technical, operational, or political. Energy utilities and consumers alike will also increasingly need to build

flexibility into their energy strategy, understanding the value of optionality and, where necessary, broadening their portfolios and actively hedging against hazards.

Essentially, in the newly complex, volatile, and costly global energy landscape, both producers and consumers need two fundamental capabilities: a sound strategic outlook and the ability to adapt.

All stakeholders—from governments to power utilities; from oil and gas supermajors to commodities traders—must shape their strategic outlook, formulate long-term plans, and prepare for the unexpected. Through scenario analysis, wargaming, and creative strategic planning, stakeholders can ensure that they are equipped to navigate an increasingly complex and uncertain energy future.

A look back at recent decades clearly reveals that it did not take long for the old certainties of the energy world to be overturned. So, no sound strategic outlook should assume that the new landscape of global energy is immutable.

About the Authors

Iván Martén is a senior partner and managing director in the Madrid office of The Boston Consulting Group and the global leader of the firm's Energy practice. You may contact him by e-mail at marten.ivan@bcg.com.

Philip Whittaker is an associate director in the firm's London office. You may contact him by e-mail at whittaker.philip@bcg.com.