"The transition from an easy to a tough resource era will come at a high price."

The End of Easy Everything

MICHAEL T. KLARE

According to some experts, many of the world's key energy and mineral supplies are being rapidly depleted and will soon be exhausted. Other experts say that new technology is opening up vast reserves of hitherto inaccessible supplies. Oil, coal, uranium, and natural gas will soon be scarce commodities or will be more plentiful than ever, depending on whom you ask. The same holds true for copper, cobalt, lithium, and other critical minerals.

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Those unfamiliar with the distinctive characteristics of the extractive industries can find it difficult to make sense of all this. But in truth, the contending positions on resource availability largely obscure an essential reality: Instead of moving from plenty to scarcity or from plenty to even greater abundance, we are moving from "easy" sources of supply to "tough" ones. This distinction carries immense implications for international politics, the world economy, and the health of the global environment.

TOUGHEST FOR LAST

Extraction of resources, whatever the material, follows a predictable pattern. Whenever a natural resource is first found to possess desirable characteristics (whether as a trade commodity, source of energy, manufacturing input, or luxury product), producers seek out and exploit the most desirable deposits of that material—those easiest to extract, purest, closest to markets, and so on. In time, however, these deposits are systematically depleted, and so producers must seek out and develop less attractive deposits—those harder to extract, of poorer quality, further from markets, and posing hazards of various sorts.

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Very often technology is brought to bear to exploit these tougher deposits. Mining and drilling go deeper underground and extend into harsher climate zones. In the case of oil and gas, drilling moves from land to coastal waters, and then from shallow to deeper waters. Technological innovations allow increasingly unappealing sources of supply to be exploited—but they also pose ever-growing risks of accidents, environmental contamination, and political strife.

The Deepwater Horizon disaster that began on April 20, 2010, is a perfect expression of this phenomenon. Until relatively recently, offshore oil and gas drilling had been confined to relatively shallow waters, at depths of less than 1,000 feet. Over the past few decades, however, the major oil firms have developed incredibly sophisticated offshore drilling rigs that can operate in waters over one mile deep. One such rig, called Mars, was deployed in deep Gulf of Mexico waters six months before NASA's celebrated 1996 launch of its Pathfinder probe to the planet Mars. At a total cost of $1 billion, Shell's Mars platform was more than three times as expensive as Pathfinder, and its remote-sensing technologies and engineering systems are arguably more sophisticated.

The use of such costly and advanced technology has allowed BP, Shell, and other well-heeled companies to extract ever-increasing volumes of oil from the Gulf's deep waters, helping to compensate for production declines at America's onshore and shallow coastal deposits. But operating in the Gulf's deep waters is far more difficult and hazardous than doing so in shallow waters, and the deep underground pressures encountered by these rigs are proportionally more difficult to manage. Intricate safety devices have been developed to reduce the risk of accident, but, as shown by the fate of the Deepwater Horizon, these cannot always be relied on to prevent catastrophe.

Despite this reality, oil companies will continue to drill in the Gulf's deep waters—and other challenging environments—because they see no other choice. Most of the "easy" oil and gas deposits on land and in shallow coastal waters in the United States and in friendly countries around the world have now been discovered and exploited, leaving only "tough" deposits in deep waters, the Arctic, areas with problematic geological formations, and dangerous or inhospitable countries like Iran, Iraq, and Russia. However daunting a task, the giant firms must find ways to operate in such areas if they intend to survive as major energy providers in the years to come.

And there is no question but that a vast abundance of "tough" oil and natural gas remains to be exploited. Resources in this category, which are often grouped together as "unconventional" fuels, include Canadian tar sands, Venezuelan heavy oil, shale oil and oil shale (two different things), shale gas, ultra-deepwater oil and gas, and Arctic hydrocarbons. The Orinoco Belt of Venezuela, for example, is said by the US Geological Survey (USGS) to contain as many as 1.7 trillion barrels of oil equivalent—easily exceeding the world's 1.3 trillion barrels in "proven" reserves of conventional (liquid) petroleum. The Arctic region, claims the USGS, harbors an estimated 1,700 billion cubic feet of natural gas, or the equivalent of 320 billion barrels of oil.

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Even more astonishing is the amount of kerogen (an immature form of oil) contained in the oil shales of western Colorado and eastern Utah: as many as 2.8 trillion barrels of oil equivalent, or twice the tally of proven conventional reserves. Mature oil and gas deposits encased in hard shale formations, such as the Bakken oil formation of North Dakota, Montana, and Saskatchewan and the Marcellus gas formation of Pennsylvania, New York, and West Virginia are thought to be of a comparable scale.

Peak and Plateau

Such assessments of potential resource availability, coupled with recent advances in extractive technology, have led many energy experts to proclaim a new golden age of fossil fuel production—contradicting those in the field who speak of an imminent peak (and subsequent decline) in the output of oil, natural gas, and coal. Adherents of the "peak oil" theory see a significant contraction in petroleum supplies just around the corner, while the new-energy optimists believe that with sufficient investment, new technologies, and the relaxation of environmental regulations, all of humankind's future energy needs can be met.

Among the most vocal and prominent critics of production pessimism is Daniel Yergin, the author of a classic history of the oil industry, *The Prize: The Epic Quest for Oil, Money, and Power* and a just-published study of energy's future, *The Quest: Energy, Security, and the Remaking of the Modern World*. "The peak oil theory," Yergin writes in his new volume, "embodies an 'end of technology/end of opportunity' perspective, that there will be no more significant innovation in oil production, nor significant new resources that can be developed. . . . But there is another, more appropriate way to visualize the course of supply: as a plateau. The world has decades of further production growth before flattening out into a plateau—perhaps some time around midcentury—at which time a more gradual decline will begin."

To buttress this contention, Yergin highlights the promising outlook for deep-offshore drilling, shale oil, and Canadian tar sands. He also speaks with great enthusiasm about the "natural gas revolution"—the potential for recovering vast quantities of gas from shale rock through the use of horizontal drilling and hydraulic fracturing ("hydro-fracking," or simply "fracking"). When combined, these techniques allow for the extraction of gas from the shale deposits of the giant Marcellus formation, as well as others in the United States and around the world. "As a result of the shale revolution," he asserts, "North America's natural gas base, now estimated at 3,000 trillion cubic feet, could provide for current levels of consumption for over a hundred years—plus."

Yergin's writings, in turn, have spawned an outpouring of Pollyannaish commentary about the unlimited future for unconventional oil and gas production in the United States and elsewhere. Writing in *The New York Times,* columnist David Brooks has described shale gas as a "wondrous gift" and a "blessing."

That production of unconventional oil and gas is rising, and that these fuels will constitute an in-

creasing share of America's energy supply, are unquestionable—as long as we rely on fossil fuels for the lion's share of our energy supply. But to view such options as blessings, wondrous gifts, or even as easily obtainable resources is misleading. Even putting aside the fact that continued dependence on fossil fuels will lead to increased emissions of greenhouse gases and an acceleration in climate change, the extraction of these materials will involve ever greater cost, danger, and environmental risk as energy firms operate deeper underground, further offshore, further north, and in more problematic rock formations. Indeed, the Deepwater Horizon disaster may be the first ominous sign of what we can expect as we rely more heavily on unconventional fuels.

THE TURNING POINT

Perhaps the first person to grasp the significance of this shift toward tough energy was David O'Reilly, the former chairman and chief executive officer of Chevron. In February 2005, O'Reilly startled participants at an annual oil-industry conference in Houston by declaring that their business was at an epochal turning point. After more than a hundred years during which the global availability of petroleum had always kept pace with rising world demand, he said, "oil is no longer in plentiful supply. The time when we could count on cheap oil and even cheaper natural gas is clearly ending." In an open letter published in many newspapers, O'Reilly then put the matter in even starker terms: "The era of easy oil is over. . . . New discoveries are mainly occurring in places where resources are difficult to extract, physically, economically, and even politically."

Nations will fight for access to new supply sources as easy reserves are depleted.

A closer look at O'Reilly's speech and accompanying advertisements shows that he was less interested in defining a momentous historic transition than in lobbying for more favorable government policies and reduced environmental regulation. Nevertheless, his description of the global situation has been widely embraced as an explanation for prevailing energy trends. *The Wall Street Journal*, for example, recently summed up a story about the rise of unconventional petroleum in Saudi Arabia with the headline "Facing up to End of 'Easy Oil.'" As the paper explained, "As demand for energy grows and fields of 'easy oil' around the world start to dry up, the Saudis are turning to a much tougher source: the billions of barrels of heavy oil trapped beneath the desert."

The impact of the changeover from "easy oil" to tougher alternatives is partly financial and technical. Extracting light crude in Saudi Arabia once was accomplished for a few dollars per barrel, whereas making a barrel of usable liquid from sulfurous heavy oil requires sophisticated technology and can cost as much as $60 or $70 per barrel. But the pursuit of new petroleum sources to replace the exhausted "easy" deposits also has other costs, such as a growing reliance on oil acquired from countries in conflict or controlled by corrupt dictators.

Nigeria, for example, has become America's fourth-leading supplier of oil—yet Nigerian production is constantly imperiled by sabotage and the kidnapping of oil workers by militants opposed to the inequitable allocation of the country's petroleum revenues. Russia is another large source of oil and gas, yet Prime Minister Vladimir Putin's relentless drive to impose state control over the extraction of natural resources has resulted in the de facto seizure of foreign assets by government-owned firms. Iraq, with the world's second-largest petroleum reserves, is theoretically capable of producing three or four times as much as it does now, but any such increase would require a significant increase in domestic security as well as a predictable legal regime—neither of which appears in the offing any time soon.

The Arctic is another promising source of tough oil and gas. According to the USGS, the land above the Arctic Circle, representing about 6 percent of the world's total surface area, contains approximately 30 percent of the world's undiscovered hydrocarbon reserves. As the planet warms and new technologies are perfected, it will become increasingly possible to extract this untapped energy. But operations in the Arctic are exceedingly difficult and hazardous. Winter temperatures can drop to well below minus 40 degrees Fahrenheit, and severe storms are common. Thick ice covers the Arctic Ocean throughout the winter, and drifting ice threatens ships and oil platforms in the summer. Many endangered species inhabit the area, and any oil spill is likely to prove devastating—especially since the oil companies' capacity to conduct cleanup operations in the Arctic (such as those

performed in the Gulf of Mexico following the Deepwater Horizon spill) is severely limited.

Of all unconventional sources of oil and gas, none perhaps is more controversial than shale gas, when extracted by the hydro-fracking method. To obtain gas in this manner, a powerful drill is used to reach a gas-bearing shale formation, often thousands of feet underground, and then turned sidewise to penetrate the shale layer in several directions. After concrete is applied to the outer walls of the resulting channels, explosives are set off to penetrate the rock; then millions of gallons of water—usually laced with lubricants and toxic chemicals—are poured into the openings to fracture the stone and release the gas. The "frack" water is then pumped back up and stored on site or sent for disposal elsewhere, after which the gas is sucked out of the ground.

The big problem here is the risk of water contamination. Water extracted from the wells (or "flowback") contains toxic chemicals and radioactive materials released from underground rock and cannot be returned to local streams and rivers; any seepage, either from the well itself (due to cracks in the well bore) or from on-site storage ponds could contaminate local drinking supplies—a major worry in New York and Pennsylvania, where the Marcellus formation overlaps with the watershed for major metropolitan areas, including New York City. Cavities created by the fracturing process could also connect to other underground fissures and allow methane to escape into underground aquifers, with the same risk of water contamination. Dangers like these have led some states and municipalities to place a moratorium on hydro-fracking, or ban its use near major watershed areas.

Advocates of shale gas and hydro-fracking say that the technique can be performed safely and to great benefit—if only regulators and environmentalists will stand aside and let the companies get on it with it. "There have been over a million wells hydraulically fractured in the history of the industry, and there is not one, not one, reported case of a freshwater aquifer having ever been contaminated from hydraulic fracturing," said Rex W. Tillerson, the chief executive of ExxonMobil, in testimony before Congress. But investigation by reporters for *The New York Times* has uncovered numerous examples of contamination, including cases in which flowback that contained unsafe levels of radioactive materials has been dumped into rivers that supply drinking water to major communities.

Coal, too, is becoming increasingly difficult and dangerous to extract. In the American West, many once-prolific coal deposits have been exhausted, forcing miners to dig ever deeper into the earth—increasing the risk of cave-ins and seismic jolts known as "bounces," since less stone is left after the mining process to support the weight of the mountains above. The end of easy coal is also evident in a growing reliance on "mountaintop removal," a technique used to uncover buried coal seams in Appalachia by blasting off the peaks of mountains and dumping the rubble in the valleys below. While considered a practical method for reaching otherwise inaccessible coal deposits, the technique has devastating environmental consequences, such as the destruction of woodland habitats and the contamination of valley streams with toxic chemicals.

NEVER HAD IT SO HARD

What is true of oil, gas, and coal is also true of many other natural resources necessary for modern industry, including iron, copper, cobalt, and nickel. "With easy nickel fading fast, miners go after the tough stuff," read one characteristic headline in *The Wall Street Journal*, describing ongoing mining difficulties in the South Pacific islands of New Caledonia. At one time, New Caledonia's ore had been so rich—as much as 15 percent nickel—that miners could simply dig it out with pickaxes and haul it away on donkeys.

Those reserves are long gone, however, and the mine's current owner, the Brazilian mining giant Vale, has been left trying to extract the valuable metal from ores that contain less than 2 percent nickel. This requires treating the rough ore with acid under intense heat and pressure, an inherently costly and risky process. Massive acid spills have occurred on several occasions, delaying the opening of Vale's $4 billion nickel refinery in New Caledonia. Adding to the company's problems, indigenous groups have repeatedly stormed the site, demanding that Vale halt its operations and restore the original forested landscape.

Copper, another critical mineral, likewise is seeing the end of easy supplies. With many existing mines in decline, the major mining firms are searching for new sources of supply in the Arctic and in countries recovering from conflict. Freeport-McMoRan Copper and Gold, for example, has acquired a majority stake in the Tenke Fungurume copper/cobalt mine in the southern Katanga region of the Democratic Republic of the

Congo, one of the most war-ravaged countries on the planet. Said to contain ore that is up to 10 times as rich as copper found in older mines elsewhere, Tenke Fungurume was originally developed by other companies, but was abandoned in the 1990s when fighting among various militias and rebel factions made it unsafe to operate in the area. Freeport has now rebuilt much of the damaged infrastructure at the site and hired a small army of private guards to protect the installation and its staff from continuing outbursts of violence. But security conditions remain a concern.

As easy-to-access deposits of all these natural resources disappear, the price of many basic commodities will rise, requiring lifestyle changes from people in wealthy countries—and extreme hardship for the poor, especially when it comes to food prices. The cost of corn, rice, wheat, and other key staples doubled or tripled in 2008, provoking riots around the world and leading to the collapse of Haiti's government; then, after a brief retreat, food prices rose again in 2010 and 2011, reaching record highs and sparking a fresh round of protests.

Analysts have given many reasons for this alarming trend, including soaring global demand, scarcity of cropland, and prolonged drought in many parts of the world (widely attributed to climate change). But according to a World Bank analysis, the catastrophic 2008 spike in food prices, at least, was largely driven by rising energy costs. With oil prices expected to remain high in the years ahead, food will remain costly, producing not just hardship for the poor but also a continuing risk of social instability.

Ferocious competition

Skyrocketing commodity prices are among the most visible effects of the end of "easy" resources, and they will be felt by virtually everyone on the planet. But the transition away from an easy-resource world will not only affect individuals. It will also set the stage for ferocious competition among major corporations and for perilous wrangling among nation-states.

As existing reserves of vital materials are exhausted, the major energy and minerals firms will have to acquire new sources of supply in distant and uninviting areas—an undertaking that will prove increasingly costly and dangerous, exposing many smaller and less nimble companies to a risk of seizure by larger and more powerful firms. It has been reported, for example, that Shell and ExxonMobil both considered an unfriendly takeover of BP following the Deepwater Horizon disaster, when that company's stock fell to record lows. Many mining firms have also been targets of corporate attack as existing deposits of key minerals have been exhausted and industry giants compete for control over the few promising alternative reserves.

Nations, too, will fight among themselves for access to new supply sources as easy reserves are depleted and everyone must rely on the same assortment of tough deposits. This is evident, for example, in the Arctic, where formerly neglected boundary disputes have acquired fresh urgency with the growing appeal of the region's oil, gas, and mineral reserves. Canada and Russia have been particularly assertive in their claims to Arctic territory, saying not only that they will not back down in disputes over the location of contested offshore boundaries but that they will employ force if necessary to protect their Arctic space.

A similar pugnaciousness is evident in the East and South China Seas, where China has claimed ownership over a constellation of undersea oil and gas deposits but faces challenges from neighboring states that also assert ownership over the subsea reserves. In the East China Sea, China is squared off against Japan for control of the Chunxiao natural gas field (called Shirakaba by the Japanese), located in an offshore area claimed by both countries. Periodically, Chinese and Japanese ships and planes deployed in the area have engaged in menacing maneuvers toward one another, though no shots have yet been fired.

The situation in the South China Sea is even more complex and volatile. China and Taiwan claim the entire region, while parts are claimed by Brunei, Malaysia, Vietnam, the Philippines, and Indonesia—and here, shots have been fired on several occasions, when Chinese warships have sought to drive off oil-exploration vessels sanctioned by Vietnam and the Philippines.

The end of easy everything will not result in scarcity, as predicted by some—at least not in the short term. Instead, the use of advanced technologies to extract resources from hitherto inaccessible reserves will result in a continued supply of vital energy and mineral supplies. But the transition from an easy to a tough resource era will come at a high price, both in economic costs and in terms of environmental damage, social upheaval, and political strife. Only by reducing consumption of traditional fuels and metals and accelerating the development of renewable alternatives will it be possible to avert these perils. ■