New Realities:
Energy Security in the 2010s and Implications for the U.S. Military

John R. Deni
Editor

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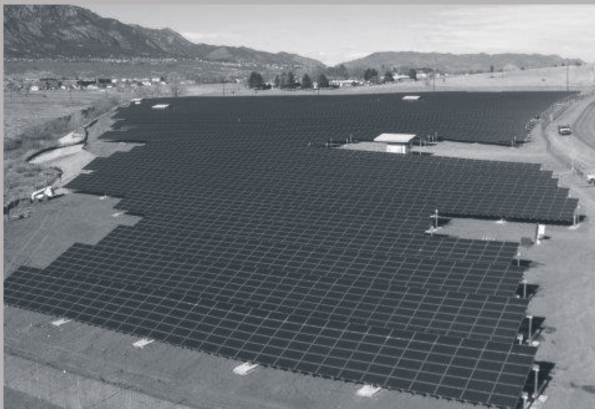

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Comments pertaining to this report are invited and should be forwarded to: Director, Strategic Studies Institute and U.S. Army War College Press, U.S. Army War College, 47 Ashburn Drive, Carlisle, PA 17013-5010.

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FOREWORD

Global energy markets are undergoing dramatic shifts. Developing countries are beginning to outpace their more developed counterparts in energy demand, the result not simply of higher economic growth rates in the former, but also due to increased efficiency in the latter. Traditional producers of hydrocarbons in places such as Latin America, Eurasia, North Africa, and the Middle East face a host of political, economic, technical, and societal challenges that could potentially lead to major disruptions in the global energy supply. Meanwhile, the unconventional fossil fuels revolution has led to major changes in the flow of the global energy supply, seemingly overnight.

All of these changes will have implications for U.S. security generally and the U.S. military specifically. Evolving energy-based U.S. national interests in Africa or the Middle East may shape the degree to which the U.S. military becomes involved in political or humanitarian crises in those regions. Tightening energy supplies may alter fundamentally the way in which the United States wields military force in a contingency operation. And closer to home, increasingly vulnerable domestic energy infrastructure may undermine military installation operations and security.

To further investigate the changes among energy producers and consumers and to subsequently assess the implications for the U.S. military, the Strategic Studies Institute—the research arm of the U.S. Army War College—organized a conference in November 2013 entitled, "New Realities: Energy Security in the 2010s and Implications for the U.S. Military." That event, which included North American and European experts from government, the military, academia, the private sector, and think tanks, was hosted by the Reserve Officers Association in Washington, DC, and funded through the generous support of the U.S. Army War College Foundation. The chapters in this edited volume are based on the presentations of those experts at the New Realities conference, and the Strategic Studies Institute is pleased to offer them as part of the ongoing discussion over the future of the U.S. Army in American national security.

DOUGLAS C. LOVELACE, JR.
Director
Strategic Studies Institute and
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CHAPTER 1

The Military Implications of 21st Century Energy Security

John R. Deni

Dr. Deni would like to thank the following individuals for their invaluable support in organizing, enabling, and conducting the November 2013 conference for which the chapters of this edited book were written: Lieutenant Colonel John Colwell, Mr. Jacques Chretien, and Colonel Scott Weaver of the Strategic Studies Institute; Mr. Bob Feidler of the Reserve Officers Association; and Ms. Ruth Collins of the U.S. Army War College Foundation.

Global energy markets have changed significantly in recent years. New consumers such as China and India have arrived on the scene, displacing other leading countries, reshaping competition over limited energy supplies, and potentially worsening human-induced climate change. In other countries, efficiency gains, increased reliance on renewables, and burgeoning domestic production of unconventionally-sourced fossil fuels have dramatically altered the consumption patterns in much of the West. At the same time, the development of unconventionally-sourced fossil fuels, among other events, has also altered the production side of the energy equation, as North America becomes a leading producer and exporter of oil and gas. Moreover, declining production in Africa, renewed instability in the Middle East, and inhibited energy development in Latin America all reflect shifting patterns of production as well.

These many factors on both the consumption side and the production side of the energy equation add up to a new energy security reality, in some ways unexpected from what was foreseen just a few years ago. Obviously, the implications of this new reality are significant for the United States, especially for its economy and the average American consumer. However, there are also some profound implications for the U.S. military, especially as it embarks on a period of austerity and restructuring following over a decade of war. For example, the shale gas and tight oil revolution in North America may cause Washington to reappraise U.S. interests in the Middle East, resulting in less willingness to wield military force in the Persian Gulf. Burgeoning demand in China, India, and across the developing world may cause oil prices to remain stubbornly high, increasing the cost of fuel-intensive military operations in remote, austere environments. Decreasing oil production in Sub-Saharan Africa, coupled with reduced saliency of those same resources in America's energy import mix, may severely limit U.S. interests in the region while simultaneously increasing the risk of socio-political instability in Africa due to decreasing state revenues. The growing risk of cyber attack on vulnerable energy infrastructure may inhibit U.S. military operations conducted from installations dependent on the civilian energy grid. These are just some of the examples of how broader energy market issues may impact the U.S. military.

In November 2013, the Strategic Studies Institute (SSI)—the research institute of the U.S. Army War College—convened a conference, free and open to the public, to address the major "new realities," both geographically and technologically, and some of the related military implications. The conference—hosted by the Reserve Officers Association in Washington, DC, and funded through the generous support of the U.S. Army War College Foundation—featured experts from the policymaking community, academia, think tanks, the private sector, and the military services. The SSI gathered this diverse array of individuals together to address the rapidly changing global energy supply situation; the social, political, and economic challenges facing consumer states; and the subsequent implications for the United States generally and for the U.S. military specifically. The chapters in this edited volume are based on the presentations delivered at that conference, and they offer a multitude of original, impactful insights relevant to the Department of Defense (DoD) generally and the U.S. Army specifically.

The volume opens by surveying the most significant changes among energy producers, with Dr. Theresa Sabonis-Helf examining the role of Russia. Vladimir Putin has largely succeeded in placing Russia's petroleum and gas sectors in service of the state and hence of underwriting Moscow's interpretation of its political and economic interests. However, she questions whether the Kremlin will continue to be able to effectively wield energy as a political tool, given significant issues surrounding Russia's ability to maintain and grow its energy exports at a reasonable price. Western know-how and capital are necessary, particularly in the petroleum sector, where the Russian state realizes a high percentage of its revenue. In addition, long-standing inefficiencies in production, the non-transparency of both the petroleum and gas sectors, limits on foreign investment, and outright corruption all have contributed to a worsening of energy relations between Russia and its most important market, Europe. Sabonis-Helf concludes that Moscow's inability and/or unwillingness to plan for the future has committed Russia to a questionable and likely unsustainable, future in terms of energy production.

In his chapter addressing the implications of political instability in the Middle East and North Africa (MENA) on hydrocarbon production, Dr. John Calabrese argues that the effects of the Arab Spring on the region's energy sector vary greatly by country. These varying implications of the Arab Spring will mean that some MENA states will continue to fill the gaps created by drops in production by other states such as Libya, Syria, and Iraq. In part, this explains why the Arab Spring's effects on MENA producers have not substantially jeopardized U.S. energy security—at least not yet. Even though the share of hydrocarbons imported by the United States from the MENA region continues to decline, Washington will still have an interest in the steady, stable flow of oil from major production areas such as the Persian Gulf because oil prices are set by a global oil market. This means that instability in any region affects oil prices everywhere.

Meanwhile, just to the south of the MENA region, Sub-Saharan Africa's role as an energy producing region is undergoing a significant shift. Declining production among major African hydrocarbon producers, as well as declining American demand for the same, means that Sub-Saharan Africa is likely to see less attention from the United States overall, argues Dr. Ian Taylor. A rational assessment of U.S. interests in Sub-Saharan Africa will likely lead American decisionmakers to pursue very limited involvement in the region, relying instead on the African Union and the European Union. Nevertheless, it is possible that decreased hydrocarbon production and lower oil prices might precipitate social, economic, and political instability in Sub-Saharan African countries that were formerly important U.S. suppliers like Nigeria and Angola. Subsequently, this instability could lead to humanitarian crises of varying size and form across the continent, which a future U.S. President may consider becoming involved in, militarily or otherwise.

Closer to home, Latin America has significant potential, writes Dr. David Mares, in terms of both unconventional oil, shale gas, and renewables, but an array of technical, market, and societal challenges within the four largest energy producers—Venezuela, Brazil, Argentina and Mexico—will likely prevent the region from achieving all that it might. One of the most important challenges is the lack of incentives provided by these countries to convince outside investors to bring necessary capital, skills, and technology to the region. If they wish to overcome this challenge, one of the most significant things Latin American governments could do would be to increase capable, transparent, responsive governance. On this point, the U.S. military may have a role to play in terms of security cooperation aimed at increasing civilian control of regional militaries and educating partner militaries on the proper role of the military in a democracy.

Meanwhile, the North American unconventional fossil fuels revolution is the most transformative socio-political-economic event of the last several decades, with the possible exception of the invention of the internet, according to Mr. Robert Manning. Significant developments in shale gas and tight oil exploitation over the last 7 years alone have led to dramatically altered energy predictions for the United States in terms of production as well as consumption. The shale revolution is creating millionaires across the United States, turning rural villages and towns into 21st century hydrocarbon boomtowns, rearranging the politics within the United States as Great Plains politicians focus on energy issues unlike ever before, and keeping energy prices relatively low as the West continues to struggle against the aftereffects of the Great Recession. This likely presages a period of American economic resurgence, and will alter fundamentally U.S. relations with the Middle East. Nonetheless, as noted earlier, the United States will still care about stability and security in and among traditional petroleum producing countries, thanks to the increasingly global nature of energy markets.

As with the shale revolution, there has been great hope that renewable energy capabilities might ameliorate energy security challenges posed by U.S. and allied reliance on conventional fossil fuels from the Persian Gulf or elsewhere. However, Dr. Karan Smith Stegen argues that there are significant risks associated with renewable technology, especially in terms of the rare earth metals that constitute some of the necessary components of these technologies. Indeed, rare earth elements are critical to a wide variety of applications, such as lighting, solar panels, wind turbines, electric vehicle motors, and batteries. The greatest of these risks centers on the fact that a single country—China—holds most known deposits of critical rare earth elements as well as much of the processing capacity for the same. Unfortunately, there are limited alternatives.

Another non-hydrocarbon energy source—nuclear power—faced incredibly bright prospects just a decade ago. But Ms. Jane Nakano argues that, since then, several factors have served together to dampen prospects for nuclear power in the United States. Domestically, the economic slowdown in the United

States, coupled with increased efficiency and competition from cheaper natural gas, have led to reduced expectations for future nuclear plant construction. On the international scene, U.S. nuclear manufacturers have had difficulty competing with state-led companies from countries such as France, Russia, and South Korea, some of which offer cradle-to-grave programs that include power plant construction, operation, and spent fuel disposal.

Following this extensive treatment of changes on the production side of the energy equation, the volume turns next to changes on the consumption side, as Dr. Michal Meidan examines the implications of China's burgeoning energy demand. She finds that, despite efforts to spur development and production of domestic energy sources, China is likely to remain dependent on foreign oil and gas for the foreseeable future. In terms of that reliance on foreign sources, Beijing has endeavored to diversify its energy suppliers, but progress here has been very limited. This means that China will continue to rely on potentially vulnerable sea lanes of transit for its energy needs, and that Beijing will continue to view supply security as a major, strategic vulnerability. In order to mitigate this vulnerability, China will look to Southeast Asia and the South China Sea as important transit regions and potential sources of energy. Although its major suppliers are found in the Middle East, past experience indicates that China is unlikely to become very involved in the politics of the region, in part because it lacks the tools to do so. Instead, Beijing—spurred on by its national oil companies and the Chinese navy—will seek to maximize Chinese leverage over energy flowing through and from the South China Sea.

Just next door, India faces a series of challenges as it pursues energy security. Mr. Tom Cutler argues that the United States has strong interests in an energy secure India, which has seen its demand for energy increase dramatically over the last several years. A variety of factors, including corruption as well as extensive domestic fuel subsidies, have prevented India from becoming more self-sufficient in its energy consumption, forcing it to look overseas for more of its growing needs. Given its geographic position at the heart of the east-west trade through the Indian Ocean, India stands to play a key role as South, Southeast, and East Asia continue to outpace other regions of the world in economic growth. For its part, the United States has sought greater energy cooperation with the Indian government, including in the sphere of civilian nuclear cooperation. As an emerging energy supplier and as a key partner of India, the United States is likely to forge even closer civil and military ties to enhance mutual energy security.

The cases of China and India exemplify the growing demand throughout the developing world. Ms. Deborah Gordon argues that the most dramatic increases in global energy demand in the coming decades will be in non-Organization for Economic Cooperation and Development (OECD) countries. In particular, China, India, Brazil, Indonesia, the Middle East, and Africa are the countries and regions that are expected to see the highest rates of energy demand growth. One of the most critical challenges here will be the fact that most of that demand in the developing world will be met with fossil fuels, exacerbating human-induced climate change and potentially intensifying the effects of natural disasters. Additionally, as fossil fuel production in the Western hemisphere expands exponentially, there will be corresponding increases in global fossil fuel movements—this trade may become increasingly vulnerable to terrorism, accidents, and damage from ever more intense natural disasters. At the same time, more traditional state-versus-state security competition over limited fossil fuel resources may become more pronounced among the developing countries.

Dr. Michael Klare amplifies some of these same points in arguing that the United States is likely to be further drawn into regional conflicts regarding energy resources, at least in the short term, as consumer countries search for fuel supplies. Indeed, despite the advances in technology that have led to the shale revolution and expanded use of renewables, Klare argues that conflict over energy is likely to recur so long as major consuming states, like the United States, India, and China, continue to rely on supplies derived from distant and unruly areas. The dramatic expansion of land-based energy infrastructure, the increasing magnitude of the global energy sea trade, the vast distances between producers and consumers, the development of new energy resources where national boundaries remain contested or unresolved, and the geographical complexity of international transit choke points all add up to increased demands on the U.S. military to safeguard American and allied energy security. As the United States relies less and less on foreign sources of energy though, it remains unclear whether the U.S. Congress—or the American public—will remain interested in underwriting the security of global energy supply lines.

Having examined changing patterns of consumption and the shifting locus of production, the volume ends with an assessment of some specific military issues and implications, especially in terms of operational energy security—the energy necessary to prepare for, deploy to, conduct, and redeploy from military operations.

The Honorable Katherine Hammack addresses the necessity of organizational culture change, as well as the need to adopt new technologies and capabilities, in her chapter on the progress the U.S. Army has made to date. Such changes are neither easy nor quick for an organization comprised of over 2 million soldiers, family members, and civilians, and which manages one billion square feet of building space and over 100,000 military homes on its bases. In order to mitigate future energy security challenges at home and abroad such as those outlined previously, the Army is focusing on turning its installations into platforms of stability, resiliency, and endurance, and on leveraging innovations that reduce fuel demand and resupply requirements in the field in order to increase mission effectiveness. Microgrids allow Army installations the ability to combine on-site energy generation and storage with the ability to manage local energy supply and demand. At the same time, the Army is working to integrate efficient vehicles, renewable energy, and backup generators into the energy management systems at contingency locations and forward operating bases.

Dr. Paul Roege provides some key context in pointing out that operational energy security emerged as a result of rapidly intensifying military technologies and public attention drawn by the longest historical American conflict. Although the average American Soldier is now far more effective than he was in World War II or the Korean War, he uses correspondingly more energy per capita. Trying to sustain the energy requirements in remote and often austere environments proved extraordinarily costly in blood and treasure. As a result, the U.S. Department of Defense (DoD) has tried to develop concepts that enable it to utilize energy in flexible ways in order to optimize mission effectiveness. One of the greatest challenges within DoD, though, remains changing existing energy-related paradigms held by individuals. In spite of this and other challenges, Roege maintains that, as DoD works to achieve progress, it can play the role of exemplar, helping to transform the American energy posture toward one of resilience, which will ultimately best strengthen U.S. security.

As the Army and the rest of DoD rely increasingly on computers and technology to manage and use energy, the risk to operational energy security posed by cyber attack also increases. In his chapter examining the intersection of cyber and energy security, Dr. Chris Bronk argues that the ever increasing use of computers in the energy industry, as well as the significant advances in computing technology that have enabled hydraulic fracturing to revolutionize the American energy sector, mean that energy security is more susceptible today to cyber attack than ever before. Bronk sees vulnerabilities for the U.S. military in at least three areas—cyber attack against the electrical grid upon which military facilities rely, hacking of the oil and gas supply system, and cyber attacks against major producers or suppliers that would result in significant supply disruptions or price increases. Some of these vulnerabilities are difficult to avoid, though, so Bronk posits that resiliency and recovery are the key mitigation strategies for DoD and Army energy systems that increasingly rely on unclassified information technology.

The North Atlantic Treaty Organization (NATO) may prove a useful venue for developing and sharing lessons learned on resiliency and recovery. To date, the Alliance has certainly raised awareness of energy issues affecting the security of member states, and it has clearly stated its interest in becoming engaged in energy security, including in the protection of critical infrastructure. However, Dr. John R. Deni argues that NATO has achieved little in terms of practical accomplishments—and this despite some significant energy related crises in Europe in 2006 and 2009. Where the Alliance has seen practical progress has been in terms of some key **operational** energy security initiatives, including the establishment of an Energy Security Center of Excellence in Vilnius, Lithuania. In spite of such limited successes to date, Deni argues that the United States can and should leverage NATO to strengthen operational energy security as well as broader energy security for itself and its allies.

Finally, Dr. Ronald Filadelfo examines the feasibility of strengthening military installation energy security through the use of small modular nuclear reactors (SMRs). Similar in some ways to Dr. Roege's argument earlier, Filadelfo argues that DoD could serve as a test bed for the fielding of SMRs. Cost effectiveness is critical in developing SMRs, and given the high first-of-a-kind expenses, some combination of Department of Energy, vendor, and direct congressional support would be necessary to make SMRs realistic for any particular U.S. military installation. If DoD could tap into other funding sources for the first-of-a-kind expenses, then Filadelfo argues that SMRs could be a cost effective source of electricity in about one-third of the states, where average prices of electricity per kilowatt hour exceed the cost of electricity produced by operating an SMR.

The energy security challenges facing DoD at the installation level, in the conduct of contingency operations, and beyond are significant. The chapters in this volume attempt to draw out some of the major trends occurring among producers and consumers of energy, and to assess some potentially significant implications for the U.S. military. Simply treating energy security as an "emerging" issue on the fringes of America's national security radar, or perhaps believing that the energy self-sufficiency created by the shale gas revolution will allow the United States to stop caring about events in the Persian Gulf, for example, is naïve. The new realities of energy security demand increased attention, objective analysis, and creative insights.

CHAPTER 2

RUSSIA AND ENERGY MARKETS

Theresa Sabonis-Helf

The views expressed in this chapter are those of the author and do not reflect the official policy or position of the National Defense University, the Department of Defense, or the U.S. Government. Many thanks to those who have been especially helpful in the development of this chapter, particularly National War College colleagues Dr. Lena Kovalova and Colonel Rob Timm, and Christian von Celsing, a graduate student at Georgetown University.

Energy is a centerpiece of Russian foreign policy, but it is also a very important Russian domestic issue as well. Understanding the sectors, and how they are managed within Russia, offers a clear sense of Russia's options—and limits—in using energy as a tool of "hard power." This chapter will examine the oil and gas sectors, and the regional and international relations that revolve around these sectors. Although Russia is trying to innovate within these sectors and trying to leverage its power in international relations, Russia's energy "power" is visibly in decline.

Russian domestic energy politics revolve around the level of control the state retains in various energy sectors. One goal of Vladimir Putin's administration has been to reconsolidate Russian state power, using the natural resources of Russia, with priority given to the needs and interests of the state, rather than the individual enrichment of elites. This was, in part, the topic of Putin's dissertation, and to a remarkable extent, Putin has succeeded in this goal, reclaiming the natural resource wealth of Russia from the oligarchs whose power in the 1990s was nearly unchecked. Putin's success in oil and gas, however, may be time limited. The government has not proven itself a good steward of the resources. Oil and gas each pose substantial challenges to governance in Russia, even as the Russian style of energy management poses challenges to the supply of gas and oil. In some ways, the challenges of the two sectors are similar. In other ways, however, they diverge significantly. Oil is a more important economic commodity to the Kremlin, while natural gas is the more important political commodity; but Russia is losing ground in both.

Russian international energy politics revolve around the tension between the interests and priorities of a large supplier and the interests of its transit states and markets. Tensions over Ukraine exacerbated some long evident trends in energy. For 2 decades, Russia skeptics in the European Union (EU) have been caught between two very different fears. One fear is that Russia will continue to play hardball politics with its energy resources, and develop more skill and savvy with experience. The other fear is that Russia will continue to get the economics of energy so wrong at home that in a medium-term future, the resources it has available to sell to Europe will decline. Although both fears have legitimate historical bases and although the battle for Ukraine has focused international attention on the political impact of Russia deliberately withholding energy, the choices currently being made seem to push Russia more toward the medium-term inability to produce for Europe than toward the ability to increasingly manipulate Europe. This chapter will begin with an examination of the two key energy export sectors (gas and oil). It will then review Russia's domestic energy challenges, its energy relations with Europe, its relations with its own neighborhood, and its emerging energy relationship with China.

RUSSIAN GAS SUPPLY

The state-run company, Gazprom, which currently produces 74 percent of Russia's total natural gas output,[1] by law has enjoyed a monopoly on Russian gas exports. Russia's primary gas market is Western Europe—an estimated 76 percent of Russian natural gas exports go to Western Europe, with Germany, Turkey, Italy, France, and the United Kingdom (UK) being the largest customers by volume.[2] Russian gas to Europe is supplied via pipeline, with Ukraine and Belarus serving as the key transit states. The newest Russian pipeline to Europe, Nord Stream, connects Russia directly to Germany via an undersea route through the North Sea.

Although statistically second to the United States in production and second to Iran in proven reserves (see Table 2-1), Russia is likely to continue to be the most important global player in natural gas markets for the foreseeable future: The United States remains a net importer of natural gas, while Russia has long exported in significant volumes. In addition, Russia's more favorable ratio of reserves-to-production (a measure of how long a nation could supply at its current rate without new discoveries or new technology) suggests that Russia should be able to continue to produce at its current rate for 50 years longer than can the United States.[3] Russia's advantage over Iran's greater proven reserves is that it already has substantial existing markets, infrastructure, and technology, while Iran remains under sanction and has production laws in place that would be discouraging to potential investors even if sanctions were lifted.[4]

Country	Reserves (trillion cubic meters or tcm)	Reserves (trillion cubic feet or tcf)	Percent of Total 2013 World Proven Reserves	Percent of Total 2013 World Production*
Iran	33.8 tcm	1192.9 tcf	18.2 percent	4.9 percent
Russia	31.3 tcm	1103.6 tcf	16.8 percent	17.9 percent
Qatar	24.7 tcm	871.5 tcf	13.3 percent	4.7 percent
Turkmenistan	17.5 tcm	617.3 tcf	9.4 percent	1.8 percent
USA	9.3 tcm	330 tcf	5 percent	20.6 percent
Saudi Arabia	8.2 tcm	290.8 tcf	4.4 percent	3.0 percent
UAE	6.1 tcm	215.1 tcf	3.3 percent	1.7 percent
Nigeria	5.1 tcm	179.4 tcf	2.7 percent	1.1 percent
Algeria	4.5 tcm	159.1 tcf	2.4 percent	2.3 percent
Australia	3.7 tcm	129.9 tcf	2.0 percent	1.3 percent
Uzbekistan	1.1 tcm	38.3 tcf	0.6 percent	1.6 percent

* excludes gas that is flared or reinjected.

Table 2-1. Natural Gas World Proven Reserves and Production 2013.[5]

In addition to its own natural gas, Russia has integrated the "near abroad" closely into its production system. In 2013,[6] Russia moved nearly 30 billion cubic meters (bcm) of gas from other post-Soviet states across its territory, including 9.9-bcm from Turkmenistan.[7] Turkmenistan, which ranks fourth in the world for proven reserves, continues to expand its export via new pipelines to China, but still exports substantial volumes through Russia (24 percent in 2013).[8]

Russia, although primarily an exporter of natural gas via pipelines to Europe, has expanded into liquefied natural gas (LNG) in recent years, exporting

14.2-bcm as LNG in 2013 (2 percent of its production that year), mostly to Japan.[9] The Sakhalin Energy LNG plant responsible for that export has been in operation since 2009 and serves the Asian market under long-term contracts.[10] LNG is an area of expected future innovation, as Russia has established a goal of doubling its share of global LNG trade by 2020. In support of this goal, the Duma adopted a December 2013 law allowing established companies that meet certain criteria to sell LNG to global markets, removing Gazprom's export monopoly. The criteria in the law favor Novatek (Russia's largest independent gas producer) and Rosneft (the state oil company).[11]

In spite of gains in LNG, Russia's overall gas trade has fluctuated. Trade was down in 2012 relative to 2011, due to lower European demand.[12] Demand rose again in 2013, but the gains were in pipeline deliveries (Europe) rather than LNG (Asia).[13] The temporary lower demand from Europe was linked to the global economic downturn and the high price, and recovered as European economies recovered. Because of the regional nature of the gas market (gas remains a regional rather than a global market because the price of transporting gas typically exceeds the cost of getting it out of the ground, and because most international gas trade is via pipeline), the shale gas-related price collapse in North America did not have an equal impact on European prices (at the end of 2013, the price for a million British thermal units (BTUs) was $3.71 in the United States, and $10.72 in Germany).[14] The Russian price remains high, governed by long-term contracts, and is only slowly de-linking from the price of oil. Because gas is more difficult to store than oil and pipelines cannot be rapidly replaced, Europe has been compelled to continue to pay high prices. LNG (because it is more flexible than pipelines) may eventually help reduce the price differences between regions, but the costs and timelines involved in a shift from pipelines to LNG are considerable. In economic terms, the World Bank maintains that pipelines are more economical than LNG up to distances of 3,500 kilometers (km).[15] The International Energy Agency expects differences in price across regions to narrow, but remain large through 2035.[16]

The relationship between the Russian state and the industry is stronger in natural gas than in any other sector. The Russian state remains the major shareholder in Gazprom, holding slightly over 50 percent of shares since September 2002.[17] By tradition, the Chairman of Gazprom is also a currently serving or former high-ranking member of the Government of the Russian Federation (prior to becoming Prime Minister, Dmitri Medvedev was simultaneously Chairman of Gazprom and First Deputy Head of the Government). In spite of the political emphasis on the importance of natural gas, the international revenue gas provides for Russia is actually less than what Russia receives from oil, a world market in which Russia is a less powerful player. The close relationship between the Kremlin and Gazprom will be tested in the coming years, as Gazprom loses its monopoly on exports, and the LNG innovators increase their market share.

RUSSIAN OIL SUPPLY

Shortly before its collapse, the Soviet Union was the largest oil producer in the world, extracting 12 million barrels of oil a day (bbls/day), 11 million of which were from Russia.[18] The oil industry in Russia has never quite recaptured this height. After a free-fall in the early post-Soviet years, production has recovered steadily since 1998, in every year since 2008, and in some quarters Russia has produced more oil per day than Saudi Arabia. The increase in production has slowed despite high prices, rising less than 0.2 million-bbls/day between 2011 and 2012, and again less than 0.2 million-bbls/day between 2012 and 2013, to a level of 10.5 million-bbls/day. [19] The United States replaced Russia as the world's second largest producer in 2012.

There is no single oil company comparable to Gazprom in the Russian market. Although the state retains a strong hold on the oil pipeline system (Transneft, owned by the state, transports 88 percent of all crude oil and 27 percent of oil products),[20] and has reasserted control over the sector in recent years, a range of domestic companies (many paired with multinational companies) produce Russia's oil. Russia exported approximately 7.2 million-bbls/day in 2012.[21] Because oil is more easily transported than gas, producers can readily diversify output: In addition to the pipeline system, exports via rail and sea (using 18 different ports) continue to increase.[22] As the number three producer of oil in the world, Russia unquestionably has some impact on the world oil market. However, the ease of transport, ease of storage, and the well-developed nature of the market which leads to a global price of oil (in contrast to the regional price of natural gas), make it more difficult for Russia to exert tight domestic control over the oil, or international political leverage with that oil.[23]

Oil, therefore, is politically less instrumental to Russia than natural gas, but it is economically more essential. A downward shift in oil prices would be more damaging to Russia than a shift in gas prices. Energy scholar Thane Gustafson offers two persuasive reasons for this: Oil yields more value per calorie than gas, and Russia exports three-quarters of its oil production, while only exporting one-third of its gas production.[24] World oil demand is expected to continue to grow significantly, which should keep prices trending slowly upwards even as new exporters enter the market. Mainstream forecasts suggest a price somewhere between $128 per barrel in 2012 dollars by 2035[25] and $163 per barrel by 2040.[26] This is good news for Russia, which cannot afford a low price. Russia is extremely sensitive to any drop in the price, due to some persistent domestic challenges.

THE DOMESTIC CHALLENGES IN OIL AND GAS

Cost of production in Russia is (in all but future Arctic locations) lower than Canada's oil sands production costs,[27] but remains much higher than the Middle East cost of production: $15-20 per barrel for Russia versus $4-6 for Saudi Arabia.[28] The cost of production is only one component of Russian concern about oil price. Other components include the extensive programs oil revenue is expected to fund; problems of Soviet legacy; and the need for recapitalization of the energy industry, which is made difficult by Russian policies that affect both domestic and international investors.

In 2012, the Russian government's overall tax revenues from oil amounted to about $70 per barrel.[29] This high level of revenue has been built into state budgeting expectations for the future. At a production cost of at least $15/barrel, the minimum price to meet cost and budget expectations has been $85 per barrel—and that is without profit or recapitalization. In the first quarter of 2013, the Kremlin's official budget projections for oil dropped to $93 (down from $119 in 2012).[30] In principle, the Russian government could cut back on the subsidies and supports it offers to the citizens, but in his 2012 campaign, President Putin promised more, not less, state largess.

Within the oil and gas industry, there are problems with Russia's unrealistic expectations. In essence, Russia has been enjoying high returns for little investment, and has not focused on maintaining the industry. Thane Gustafson has documented key anomalies that allowed Russia a decade of unusually high profit: infrastructure already in place, an overhang of discovered but unexploited fields,[31] and a rise in the price of oil that outpaced the rise in the price of materials after the 1998 crash.[32] Each enabled Russia to succeed dramatically in the short term without substantial investment. These trends, however, have created dangerous assumptions within Russia about the future. As Gustafson argues, "Russia is not running out of oil, but it is running out of cheap oil."[33]

Following in Soviet tradition, the current structure of investment in Russia remains focused on mature fields. Gustafson estimates that slowing the decline of mature oil fields currently takes up about $20 billion per year, about four-fifths of upstream capital spending in oil.[34] Little has been spent on new fields, even though the old ones are well-known to be past peak performance. When Russia does pursue the green fields, much of the new oil will cost more to produce, in addition to the costs of exploration, as most underdeveloped oil is further north. Arctic oil is expected to cost somewhere between $40 to $140 per barrel to develop (depending on which field and which expert you ask),[35] making commercial developments problematic, and putting state-supported development even further out of range.

The economic "legacy" problems inherent in natural gas are even harder to solve than those of oil, which is likely why the Duma began liberalizing LNG. Gazprom is believed to be facing a steep rise in production costs: The bulk of gas production comes from three super-giant fields, which have been in decline at a rate of 20-bcm/year for 10 years.[36] Arguably, Russia cannot afford even existing production. As late as 2008, Gazprom was arguing that they were actually losing money on every cubic meter of gas sold domestically. Gazprom is required by law to provide some 70 percent of its production to the Russian domestic market, which means that the company was trying to keep afloat and make investments for the future on less than 30 percent of its product.[37] Achieving cost recovery in gas was one of the prerequisites for the EU approving Russia's accession to the World Trade Organization (WTO), and from 2008 to 2013 (with a brief hiatus for the global economic downturn), Russian domestic prices rose incrementally. Upon joining the WTO in August 2012, Russia made a commitment that natural gas would operate "on the basis of normal commercial considerations based on recovery of costs and profit."[38] The Russians now argue that they have achieved cost recovery. However, the assumptions incorporated into the cost estimate are much disputed: Since Soviet-era facilities and pipelines are still in use, and carry no debt, it is tempting to make estimates for the domestic market purely based on the cost of getting gas out of the ground, discounting any capital cost involved in domestic transit. Russia's heavy reliance on gas makes reallocation of price especially difficult. Opening of the gas export market to companies willing to innovate in LNG is evidence of the Kremlin's concern about how to encourage the future of gas.

Across both sectors, it is clear that oil and gas are increasingly suffering from a lack of investment. The International Energy Agency, which seeks to ensure stability in energy markets through policies, has already expressed concern that some $11 billion/year is needed to help meet the projected growing demand for Russian energy, and although Gazprom promised in 2005 to increase investment to $10.8 billion/year, it appears to continually prioritize foreign acquisition and export infrastructure over needed upstream investments.[39] Even if Russian government policies become more welcoming to international investment, current shifts in global markets make it difficult for Russia to compete. Further, it is not clear that the Russian government will conduct a sustained effort to attract the needed investment. The Russian response to Ukraine related sanctions has been consistent with efforts to disengage, not re-engage, global markets. Even before Ukraine, Russia was uneven in its pursuit of international investment. According to the Organization for Economic Cooperation and Development's (OECD) Global Forum on international investment, windfall profits had allowed the Russian government to avoid seeking outside investment through 2008, but the state-controlled companies in oil and gas are not well-adapted to respond to growing demand or difficult production conditions.[40] The OECD report, written prior to the global economic crisis (and the further-expanded role for the state in Russian companies that resulted) noted the urgency of public sector reform, stating that, in spite of the perception that energy investors could tolerate low regulatory quality, "the lack of policy predictability, inefficient regulations and corruption-prone administration exert unquestionably a strong deterring effect."[41]

In addition to the problems of capitalization, Russia has a significant domestic consumption problem. The Russian government itself notes that it extends the largest energy subsidy in the world, which it estimated at $40 billion per year in 2005. Efficiency scholars estimate that Russia could reduce its primary energy use at home by one-third if it achieved efficiencies comparable to OECD states, but to date Russia has only managed annual reductions in energy intensity of about 3.4 percent per year since 1990.[42] Russian overall efficiencies could be dramatically improved, but the slow progress in energy reform could harm Russia's ability to export natural gas in the medium term. Even the energy system itself is strikingly inefficient. For example, due to the remoteness of oil facilities, tensions between the oil and the gas sectors, the domestic price of gas and government policies that make pipeline access difficult, Russia remains the largest flarer of natural gas in the world, flaring an estimated 37.4-bcm in 2011,[43] in spite of years of policies designed to reduce the practice. In addition, the unusually high levels of leakage from pipeline systems and fuel gas use in the transmission process further reduce the amount of Russian gas that makes it to world markets.[44] Well-known inefficiencies, the nontransparency of the sectors, the visible underinvestment and poor capitalization, and the problematic relations with neighboring states have all contributed to a worsening of energy relations between Russia and its most important market, Europe.

Dependence on gas and especially oil revenues has security implications for Russia. In 2012, oil and gas revenues accounted for 52 percent of federal revenues.[45] The evidence suggests, however, that military spending will not decrease when revenues fall. Russia is more likely to shift revenues away from other priorities, as it has done over the past several years. Russia ranks third globally on military spending, which has been increasing since 2009 even in spite of slowed economic growth. In 2013, the military budget comprised 4.1 percent of gross domestic product (GDP), a higher percentage than the United States for the first time in 10 years.[46] As the Ukraine crisis was unfolding in early April, the Russian Federal Treasury made the announcement that expenditure on national defense would increase by 18 percent in 2014, bringing the level to a 92.3 percent increase in nominal terms since 2010.[47] *Jane's Defence Weekly* estimates that over 20 percent of government spending goes to national defense, with another 16.5 percent toward "national security and law enforcement." Combined defense and security spending has risen from less than 25 percent of the total state budget in 2010 to 33 percent in 2014.[48]

RELATIONS WITH THE EU

European energy security concerns do not focus on oil, but rather on natural gas, for which the market is less flexible. Overall European dependence on Russian natural gas averages 34 percent,[49] but this dependence is not evenly spread, as Table 2-2 demonstrates. Both percentages of dependence and market size are each significant, so both are presented when available. Germany, for example, is only 39.9 percent reliant on Russian natural gas, but imports the largest volume of any state in the EU. But Russia is also dependent—Europe constitutes its largest markets for oil and gas exports.[50]

European Nation	Percent of Natural Gas Imported from Russia 2012	Total Volume of Natural Gas Consumed 2012*
Bulgaria	100 percent	2.7-bcm
Estonia	100 percent	N/A
Finland	100 percent	3.1-bcm
Latvia	100 percent	N/A
Lithuania	100 percent	3.3-bcm
Czech Republic	80.5 percent	8.2-bcm
Turkey	70.0 percent	46.3-bcm
Slovakia	63.3 percent	6.0-bcm
Slovenia	57.4 percent	N/A
Greece	54.8 percent	4.2-bcm
Poland	54.2 percent	16.6-bcm
Austria	52.2 percent	9.0-bcm
Hungary	49.5 percent	9.7-bcm
Belgium	43.2 percent	16.9-bcm
Germany	39.9 percent	75.2-bcm
Croatia	37.1 percent	N/A

*Those states whose volumes are not represented are very small markets.

Table 2-2. European Dependence on Russian Natural Gas, 2012.[51]

It is possible that Russo-European energy relations will be transformed by the Ukraine events of 2014. It is also possible that they will not be. The history of Russo-European energy relations has been often fraught over the decades, with Europe frequently revisiting the balance of risk and price that their relationship with Russia offers.

The history of European reliance on Russian gas dates to the Cold War. European states (over the strong objection of the Reagan administration) cooperated with the Soviet Union to complete the Trans-Siberian pipeline in 1984. The debate between the United States and Europe on this issue was, essentially: Is it more dangerous to rely on Middle Eastern oil for electricity, or to substitute gas imported from the Cold War adversary? Europe concluded that diversifying its portfolio of risk was essential, but the European allies planned that they would not import more than 30 percent of their supply from the Union of Soviet Socialist Republics (USSR). The USSR proved to be a reliable supplier throughout the Soviet period to full price paying European customers. The stability of Soviet supply, coupled with the advantages of using gas as a fuel,[52] led Europe to turn more and more toward gas in its supply mix. With the increase in demand over time, and the inclusion of the Eastern Bloc after the Soviet collapse, Europe found itself well over the notional 30 percent dependence rate.

Soviet energy behavior toward full paying European customers contrasted starkly with its treatment of Soviet bloc countries for which the subsidized gas in the Soviet era was very influenced by politics. Maintaining a customer base that was partially subsidized and part full price paying became increasingly difficult in the post-Soviet era. Tensions between Russia and transit states (especially Ukraine) after the fall of the USSR made it more difficult for Russia to serve its paying customers reliably. In March 2005, January 2006, January 2007, and December 2008, disputes between Russia and Ukraine over debt, gas prices, and gas storage led to brief temporary gas reductions in supply to the gas grid on which Europe relied.

When New Year's Eve negotiations on December 31, 2008, broke down and Russia cut back gas supply by Ukraine's share on three major pipelines, a major crisis resulted. Ukraine took its usual amount of gas, and 12 countries in Europe were left without power (temporarily), while six were affected by reductions in heating.[53] It took 21 days of negotiation to restore the gas supply fully, and by the time the issue was resolved, European-Russian energy relations were transformed.

Russian-EU tensions after December 2008 came to reflect an energy security dilemma in which European states sought to secure future supply by containing Gazprom's power and diversifying suppliers as much as possible. European measures, in turn, caused Russia to feel that its security of markets and security of transit were threatened. By the spring of 2009, the EU was actively seeking ways to use the Energy Charter Treaty (which had entered into force in April 1998) to compel more transparency in Russian energy behavior. Although Russia originally had signed the Energy Charter Treaty, President Medvedev announced in April 2009 that Russia would not ratify the Energy Charter and that Russia "does not consider itself to be bound by these decisions."[54] After Russia's departure from the Treaty, the EU proceeded with expanding regulations associated with the Energy Charter, including the Third Energy Package.

The Third Energy Package pushes EU countries to unbundle their energy sales, meaning that nations are encouraged to separate production, transit, and distribution of energy, in order to increase transparency in energy markets shared between the EU and Russia. The Third Energy Package was applied early to electricity but was not immediately enforced with respect to natural gas. The policies enshrined in the

Third Energy Package, however, gave member states political and legal tools with which to reduce Gazprom's dominance of their supply chains.[55] Lithuania, during its 2013 presidency of the EU, prioritized implementation in the gas sector. Russia argues that Lithuania and Latvia have taken on particularly stringent definitions of how to implement the requirement to unbundle, choosing the most aggressive approach and trying to force sale of Gazprom assets. In both states, Russia owns portions of the entire system. Gazprom advocates argue that Lithuania and Latvia's current approach amounts to nationalization, and is not in conformity with existing international obligations and bilateral agreements. This has led to a series of impasses in contracting. Gazprom has pushed for a 20-year exemption from the Third Energy Package, while some EU nations have pushed for a shorter period of 5 years. In the interim, Gazprom is seeking agreements on specific pipelines, particularly the Ostsee-Pipeline-Anbindungsleitung (OPAL) pipeline which is fed by Nord Stream.[56] Prior to the events in Ukraine, Russia was already organizing to dispute the Third Energy Package in the WTO. On April 30, 2014, the Russian Federation requested a consultation with the WTO regarding the Third Energy Package. A request for consultation is the method for formally initiating a dispute within the WTO. Russia has filed the complaint that the EU and its member states, through the Third Energy Package, are taking measures inconsistent with EU obligations under the WTO.[57] Under WTO rules, the EU and Russia have 2 months in which to consult, after which Russia may call arbiters to consider the lawsuit.[58]

Unbundling the gas sector would have both economic and political consequences for Russia, and Russia's resistance to this approach is felt keenly in the former Soviet region. According to Russian energy scholars, the final price of gas in the EU market is comprised of 34 percent taxes, 44 percent distribution, and only 22 percent to Gazprom.[59] Given this configuration, Gazprom recognizes that access to the final customer is very desirable and has made it a priority to increase its ownership of that end of the business—but such expansion is illegal under the Third Energy Package. Critics of Gazprom estimate that since 20-40 percent of its revenues are lost to corruption and inefficient practices, Gazprom is ill-suited to capture a larger share of the downstream market in Europe. [60]

Not all of Russian-European energy relations have soured. Ukraine's conflicts with Russia over energy in the previous decade became Europe's concern in part because of Ukraine's ability to "pass the pain" of energy disputes to Europe. The development of Nord Stream, an undersea natural gas pipeline connecting Russia directly to Germany through international waters was, in part, the Russian-European response. Nord Stream, the construction of which was begun in April 2010, is now a twin system with the transport capacity of 55-bcm/year.[61] Its ownership structure satisfied EU rules, and its construction diversified Russia's export options to Europe, and established Germany as a transit state. Russia proposes that a southern route would serve a similar purpose, and is strongly supporting South Stream, an undersea pipeline that would bypass Ukraine and Turkey by traversing under the Black Sea to Bulgaria and on through Serbia, Hungary and Slovenia to Austria. This pipeline is still in negotiation and unlikely to progress, due to the European Commission's call for the suspension of South Stream due to pressures associated with the 2014

Ukraine crisis, and concerns about the ways in which it would violate the Third Energy Package.

Alternate routes do not resolve the problem of dependence on Russia as a supplier, but as Europe continues to develop a pipeline system that has more interconnectors between European states, more dundancy, and more capacity to switch the direction of flow in an emergency, both security of supply and security of market are partially ensured. Radical changes in European gas markets—including making destination clauses illegal and gas pricing more dynamic—will also enhance European energy security in the medium term. This diversification may help ensure European security, but its impact on Russia's neighbors is less clear.

RUSSIAN ENERGY RELATIONS WITH THE FORMER USSR

Events in Ukraine cast into high relief some of the tensions between Russia's notion of energy security and that of the EU. They also shed light on Russia's idea of appropriate relations with the territory once called its "near abroad"—that is, the states that were formerly part of the USSR. Ukrainian accession to the Free Trade Agreement with the EU was strongly opposed by the Kremlin in part because it would make Ukraine subject to the Third Energy Package, it would provide cover for Ukraine to ensure that Gazprom's efforts to buy portions of its transit assets are thwarted, and in particular because it would prevent Gazprom from purchasing storage assets it has long pursued. From the Russian perspective, the infrastructure it inherited from the Soviet Union, and the Soviet transit infrastructure which it re-acquired as transit states traded debt for equity, are critical elements of state power and prosperity. Enforcement of the Third Energy Package is interpreted by the Kremlin as "expropriation," and is being fought as such. Ukrainian President Viktor Yanukovych's refusal to sign the Free Trade Agreement led to his ouster. President Petro Poroshenko, elected in May 2014, signed the Free Trade Agreement on June 27, 2014.[62] Ratification by the Ukrainian parliament is expected in spite of the Kremlin's objections. If Russia chose to eliminate its transit routes across Ukraine, it would also lose a very important market: Ukraine purchased 25.1-bcm of gas from Russia in 2013, making it Russia's second largest customer after Germany.[63]

Nord Stream does reduce Ukraine's leverage with Russia and with Europe, but does not take it away entirely. Russia continues to use existing infrastructure: In 2013, 82.3-bcm of gas flowed through Ukraine to Europe, 49 percent of the gas Europe imported from Russia.[64] Even if existing lines are used less, Ukraine will retain importance because of its underground natural gas storage facilities, which have a total capacity of about 30-bcm, and are critical for managing fluctuating demand.[65] Prior to the conflict in Eastern Ukraine, Ukraine had been trying to engage both EU and Russian investment in the storage. Since the conflict began, Ukraine has asked the EU to assist in monitoring its gas storage. Ukraine now participates in regular reporting of the storage levels, a measure that increases European confidence.[66] For its part, Russia is diversifying, pursuing construction of new, smaller storage facilities in Belarus.[67]

Tensions in Ukraine in 2013-14 helped speed the progress of at least one alternative pipeline. After years of hope and skepticism about the ambitious Nabucco pipeline, Azerbaijan invested in a more modest pipeline, the Southern Gas Corridor. This pipeline, currently under construction, will link Azerbaijan via Georgia to Turkey and on to Greece, Albania, and Italy. The pipeline is currently designed for less than 20-bcm/year, but regarded as politically important since it secures a new non-Russian supply and offers a possible future route to Europe for Iraqi gas. Progress on this pipeline also led to renewed negotiations between the EU and Turkmenistan regarding a possible Trans-Caspian pipeline. Meanwhile, Russia is pursuing agreements for development of South Stream, a 63-bcm/year pipeline that would connect Russia directly to Europe via Bulgaria under the Black Sea. The EU maintains that the pipeline will violate the Third Energy Package and should not be built, but Russia has succeeded in signing agreements with most of the transit states, and with Austria (the pipeline's final destination) in spite of European objections. Forward progress on the pipeline will most likely depend on the WTO ruling regarding the Third Energy Package.

While Ukraine and Belarus both serve as Russia's transit states, Russia is itself an importer and a transit state, purchasing gas from Kazakhstan, Uzbekistan, and Turkmenistan. Russia's reputation as a transit state is badly damaged. Turkmenistan was entirely reliant on Russian transit in the 1990s and 2000s, during which time Russia forced Turkmenistan to be a swing supplier of gas to Europe, limiting its access to the pipelines when demand was low. Following years of frustration, Turkmenistan signed a deal with China in 2007, and now operates the 1,833-km Central Asia-China pipeline connecting Turkmenistan to China via Uzbekistan and Kazakhstan.[68] Russia is no longer a transit state for the majority of Turkmen gas: In 2012, Turkmenistan exported 52 percent of its gas to China, 22 percent to Iran, and only 24 percent to Russia.[69] Kazakhstan and Uzbekistan, also formerly reliant entirely on Russia, are building their own export capacity in cooperation with China. China has contracted with both to better-connect their supply of natural gas to their urban centers, and in return both will begin exporting to China by the end of 2015.[70] Russia had two small victories in these events. One is that Kazakhstan and Uzbekistan intend to continue selling natural gas to Russia (about 20-bcm/year combined). The other is that new Central Asian gas is traveling East, rather than encroaching on Russia's European customer base.

Russia has strengthened its energy relationship with Belarus through the purchase of 50 percent of the shares of the Beltransgaz network,[71] and through construction of new gas storage. In all other post-Soviet states that export oil and gas, Russia has either lost ground, or must now contend with other competitors. In spite of recent victories in Ukraine, overall trends suggest a decline in Russian control of energy resources in its near abroad, largely due to a failure of Russia to capitalize or to act in good faith. In an era of low prices, Russia was able to acquire natural gas from Central Asia at lower risk and more cheaply than investing in further development of its own territory, and it did so without substantial investment. In an era of higher prices and Chinese interest, however, the Central Asian states found new markets and pursued new options.

RUSSIA'S "NEW FRONTIER" WITH CHINA

While Europe seeks new supply, Russia has begun work on seeking new demand. In addition to the liberalization of laws governing LNG development, Russia also, in the midst of the Ukraine crisis in May 2014, signed a long-awaited agreement with China regarding the construction of a new pipeline. The $400 billion deal is based on a pipeline proposed to supply 38-bcm per year.[72] This level of supply represents about 20 percent of Russia's gas volume to Europe.

The new deal does not represent a wholesale shift away from Europe. Rather, it is evidence of Russia rationally developing some flexibility in terms of its market. China's reluctance to pay high prices for its gas, coupled with the long delivery chains involved, suggest that Russia will capture less profit for exporting toward the East than toward the West. Russia's choice to keep the pricing agreement secret reinforces the industry's assumption that China was successful in defending its preferences in the negotiations.

CONCLUSION

Energy, and in particular natural gas, may have served as useful tools of statecraft for Russia in past years. As markets shift, however, Russia's energy dependence may come to represent vulnerability. Although the crisis in Ukraine in 2014 was not solely about energy, a significant role was played by natural gas and its politics. In Europe's eagerness to include Ukraine in European business practices and increase transparency of supply, and in Russia's willingness to subsidize insurgency on its border, all the players had an energy angle. The energy lessons drawn from the conflict by both sides are similar: Russia will seek new markets and more redundancy, and Europe will seek new suppliers and more redundancy. There may be some cold winters for Ukraine and parts of Europe in the interim, but in the end, Russia's ability to use energy as a tool of statecraft will be sorely limited by its need to use energy as a source of revenue.

The trend of states dependent on Russia for supply or transit choosing to diversify is pervasive. As Central Asia sought to limit Russian influence on its energy, Russia remained focused on the Western market, only to discover that Europe would also develop interest in other options, if the price remained high enough (and especially in a climate of high political uncertainty). High domestic dependence on subsidized gas and on oil revenues has made it difficult for Russia to think in the long term, to the detriment of both the industries and the state. Even as the economic returns of oil and gas remain high, Russia's political returns are declining, and the inability to capitalize for the future commits Russia to a path of dependence more than its customers or international suppliers.

ENDNOTES - CHAPTER 2

1. U.S. Energy Information Administration (EIA), "Russia Analysis Brief," revised March 12, 2014 and accessed July 14, 2014, available from *www.eia.gov/countries/cab.cfm?fips=RS* (henceforth "EIA Russia Analysis Brief").

2. *Ibid*.

3. According to the *BP Statistical Review of World Energy*, proven reserves of natural gas in the Former USSR declined measurably from 2011 to 2012. Even so, the former Soviet Union (FSU) reserves-to-production ratio now stands at 71 years, in stark contrast to North America, where the reserves-to-production ratio is

below 20 years. See *BP Statistical Review of World Energy June 2013*, tables on reserves-to-production ratios, p. 21.

4. Mehdi Hosseini, an advisor to the Iranian Oil Minister, stated to the press that Iran would reveal details in March 2014 of an effort to attract $100 billion in investment over the next 3 years, offering new forms of contracts to international companies. See Nijmeh Bozorgmehr, "Iran tries to lure back western oil groups," *Financial Times*, October 28, 2013. No such tenders were offered in March 2014.

5. Data from *BP Statistical Review of World Energy June 2014*, British Petroleum, tables on Natural Gas Proven Reserves (at end of 2013) and Natural Gas Production (at end of 2013) in trillion cubic meters and trillion cubic feet, p. 20.

6. EIA Russia Analysis Brief.

7. *BP Statistical Review of World Energy June 2014*, "Trade Movements 2013 by Pipeline," table, p. 28.

8. *Ibid*.

9. *BP Statistical Review of World Energy June 2014*, "Trade Movement 2013-Liquefied Natural Gas," table, p. 28; and Natural Gas Production table, p. 22.

10. EIA Russia Analysis Brief.

11. Kathrin Hille, "Russia Paves Way for Limited Liberalization of LNG Exports," *Financial Times,* November 22, 2013.

12. *BP Statistical Review of World Energy June 2012*, "Gas trade in 2011 and 2012," table, p. 29.

13. *Ibid*.

14. Based on the U.S. Henry Hub price compared to the Average German Import price. See *BP Statistical Review of World Energy June 2014*, "Natural Gas Prices" charts and tables, p. 27.

15. Venkataraman Krishnaswamy, "Potential and Prospects for Regional Energy Trade in the South Asia Region," Document 41582, Washington, DC: World Bank, Sustainable Development Department, South Asia Region, June 2007, p. 17.

16. International Energy Agency, "World Energy Outlook [WEO] 2013 Executive Summary," Paris, France: OECD/IEA, 2013, based on the WEO's central scenario for projections to 2035, p. 2 (henceforth "IEA-WEO 2013").

17. For details, see Theresa Sabonis-Helf, "Power and Influence: Russian Energy Behavior in Central Asia," *Competition and Change*, Vol. 11, No. 2, June 2007, pp. 199-219.

18. See Ed Chow, "Russian Pipelines: Back to the Future?" *Georgetown Journal of International Affairs*, Winter/Spring 2004, pp. 27-33.

19. Data from Energy Information Administration, "Overview Data for Russia, 'Russia Total Oil Production (1992-2013)'," Washington, DC: U.S. Department of Energy, accessed July 14, 2014, available from *www.eia.gov/countries/country-data.cfm?fips=RS#pet*.

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21. *Ibid*.

22. *Ibid*.

23. See Adam Stulberg, *Well-Oiled Diplomacy: Strategic Manipulation and Russia's Energy Statecraft in Eurasia*, Albany, NY: State University of New York Press, 2007, for an excellent discussion of Russia's variable leverage across energy sectors.

24. See Thane Gustafson, *Wheel of Fortune: The Battle for Oil and Power in Russia*, Cambridge, MA: Belknap Press/Harvard University Press, 2012, p. 3.

25. World Energy Outlook (WEO) projections suggest that China, India and the Middle East will drive global energy use one-third higher by 2035. This is the basis for their price projections. See IEA-WEO 2013, pp. 1, 3.

26. *International Energy Outlook 2013*, July 2013, DOE/EIA-0484, Washington, DC: U.S. Energy Information Administration, 2013, p. 2.

27. U.S. Energy Information Administration, "Canada Analysis Brief," estimates break-even prices for new *in situ* projects are $40-70 per barrel, while new surface mining projects are $80-100. See Canada Analysis Brief, last revised December 10, 2012, accessed January 2014, available from *www.eia.gov/countries/analysisbriefs/Canada/canada.pdf*.

28. Saudi Arabian crude oil is the cheapest in the world to extract. Estimate for Saudi Arabian cost from "Factbox: Oil Production Cost Estimates by Country," *Reuters*, July 28, 2009, accessed January 2, 2014, available from *www.reuters.com/article/2009/07/28/oil-cost-factbox-idUSLS12407420090728*. The Saudi estimate includes capital expenditure and operating costs. The Russian estimate is based on conversations with Cambridge Energy Research Associates.

29. Based on conversations with Cambridge Energy Research Associates.

30. See "The Past, Present and Future of Russian Energy Strategy," *Stratfor Geopolitical Weekly*, February 12, 2013.

31. Gustafson attributes this to exploration being independently funded and conducted by the Ministry of Geology in Soviet times. Over-exploitation of existing fields allowed Russia to come out of the Soviet period with a long list of undeveloped, known fields, but that surplus was exhausted by the end of the 2000s. See Gustafson, *Wheel of Fortune*, p. 197.

32. *Ibid*.

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34. Gustafson, *Wheel of Fortune*, p. 459.

35. Based on conversations with Cambridge Energy Research Associates.

36. "Optimising Russian Natural Gas: Reform and Climate Policy," (in Support of the G8 Plan of Action), OECD-IEA, Washington, DC: International Energy Agency, 2006, p. 15.

37. As late as 2005, the domestic price for gas remained between 36 percent and 46 percent of regional price. For a detailed discussion of Gazprom and pricing, see T. Sabonis-Helf, "Power to the Producers," Chap. 6 in Brenda Shaffer and Taleh Ziyadov, eds., *Beyond the Resource Curse*, Philadelphia, PA: University of Pennsylvania Press, 2012, particularly pp. 187-190.

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CHAPTER 3

THE ARAB UPRISINGS AND MIDDLE EAST AND NORTH AFRICA ENERGY PRODUCERS: HEAVY COSTS AND EPHEMERAL BENEFITS

John Calabrese

The hydrocarbon resources of the Middle East and North Africa (MENA) region play a vital role in the global energy market.[1] The oil and gas sector is also of central importance to the economies of MENA countries themselves, whether or not they are major producer-exporters.

While it is too early to say how the social and political forces unleashed by the Arab Spring will ultimately resolve themselves, the uprisings that began in December 2010 have already profoundly affected the countries in which they have occurred and have reverberated throughout the region. This chapter examines the effects of the Arab Spring on five Middle East producers:

1. Egypt, where the euphoria accompanying the initial stage of the revolution gave way to deep disillusionment and an acute economic crisis;
2. Libya, where government authority has disintegrated, and crude oil production has plunged;
3. Syria, where the scramble for control of oil in the context of protracted conflict has become both a symptom and a cause of the country's fragmentation;
4. Iraq, where instability elsewhere in the region has helped fuel the resurgence of the oil industry, while at the same time contributing indirectly to heightened sectarian tension and worsening violence; and

5. Saudi Arabia, which has profited financially from sustained high oil prices but at the cost of greater dependence on government spending, as well as increased friction with some of its neighbors and with the United States.

EGYPT—REVOLUTION DERAILED

Although Egypt is not a major oil or gas exporter, oil, and increasingly gas, production has been of critical importance in helping meet the country's growing domestic energy demand and in generating valuable export earnings. The impact of the political upheaval in Egypt on production and consumption has been mixed. Oil and gas fields were not attacked during the uprising in January and February 2011 that toppled President Hosni Mubarak, as most of Egypt's production is offshore. However, key energy transportation arteries—the North Sinai gas pipeline, the SUMED oil pipeline, and the Suez Canal—have either been attacked or threatened.

At the first signs of widespread unrest, the Egyptian military deployed along the 320 kilometer (km) SUMED oil pipeline that runs from the Ain Sukhna terminal on the Gulf of Suez to offshore Alexandria. As a result, the pipeline was spared any damage. However, reports that a plan to attack a container ship transiting the Suez Canal was foiled this past September (2013) have raised concerns that these arteries are being targeted. In response, the Egyptian military again has tightened security along the pipeline and the Suez Canal.[2]

Unlike the SUMED pipeline and Suez Canal, the North Sinai gas pipeline has suffered over a dozen attacks, which interrupted exports to Jordan and Israel in 2011[3] and subsequently halted the flow of supplies for nearly a year. Though the pipeline reopened in March 2013, attacks resumed just a few months later amid a new wave of violence in the Sinai Peninsula following the ousting of Mohamed Morsi's government in July.[4] Ansar Bayt al-Maqdis, a group believed to be comprised mostly of local Bedouins, had claimed responsibility for previous attacks on the pipeline,[5] though not for this one. In fact, there are a number of militant groups now operating in the Sinai. Consequently, it is difficult to determine which, if not all of them is responsible for the wave of attacks. It is also difficult to assess whether such violence can be contained, much less quelled.

The resumption of attacks on the North Sinai pipeline, coupled with the diversion of gas destined for export to local markets in order to bridge the energy deficit, have caused Egypt's exports to once again decline sharply.[6] The attacks have also interrupted the flow of gas to the national Egyptian Electricity Holding Company (EEHC), forcing its gas-fired power plants to switch to heavy oil for energy generation in the interim.

Additionally, Egypt faces other complications. For instance, natural gas output and prospects for expanded production have declined. In recent years, despite having significant natural gas reserves and promising new discoveries, Egypt has been struggling to boost production in order to fulfill export commitments and meet soaring local consumption needs. As it happens, gas shortages have been as much a cause as a consequence of the political upheaval in Egypt.[7]

To cope with these shortages, Egypt has been forced to import gas for the first time. Short-term relief was provided in the form of gas swap deals with

Qatar[8] whereby Egypt was able to allocate the Qatari liquefied natural gas (LNG) cargoes it received to foreign partners, freeing up more of its own gas for the domestic market. Doha agreed in May 2013 (before the Morsi government was ousted) to donate five cargoes of LNG, and initial talks were held for Egypt to buy at least 13 more.[9] Egypt has also sought to diversify its gas supply sources with spot imports of LNG—a costly option. It is unclear whether these stop-gap measures will be sufficient or even sustainable over the longer term.

The fiscal situation has worsened in Egypt as well. Due to the fact that Egypt is a net importer of oil products, it incurs fiscal losses from buying at international prices and selling domestically at a discounted rate.[10] The Arab Spring uprisings, by having contributed to high prices, have put additional strain on Egypt's fiscal situation.

Moreover, electricity blackouts have persisted. Intermittent transportation fuel supply shortages and electricity outages (especially in the peak summer season) ignited popular frustration with the Morsi government. Even though Morsi was deposed, chronic power outages have persisted.[11] Although Saudi Arabia has announced plans to export electricity to Egypt in order to ease shortages, this project, if implemented, is estimated to take another 3 years.[12]

As a result of these and related domestic economic challenges, the planned reduction of energy subsidies has been delayed. Between 1999 and 2009, Egypt's fuel subsidies increased ten-fold. According to interim Prime Minister Hazem El-Beblawi, fuel subsidies currently consume about 25 percent of the state budget.[13] Egypt has been discussing for years the phasing-out of fuel and electricity subsidies to private consumers and industry. In fact, prior to the uprising, the government had planned to slow the rapid increase in energy consumption by gradually reducing subsidies. Given the public anger over high prices, it is highly unlikely that reforming energy prices will be a major priority for the new leaders in Cairo.

Efforts to reschedule foreign debt and to attract foreign investment in the energy sector have been stymied. Prior to the Arab Spring, Egypt had been struggling to break out of the cycle of overdue payments and delayed or canceled investments. Egypt's indebtedness to foreign oil companies such as BP, Eni, and Edison is estimated to be as much as $6 billion.[14] The political upheaval has slowed efforts to renegotiate these debts.

The Egyptian government had also been trying to attract foreign investments to increase exploration and production as well as to expand refining capacity. But securing these investments requires a stable economic and political environment and improved internal security. In light of the political upheaval in Egypt, foreign companies have been reassessing their commitments.[15] Apache, a foreign oil producer operating in Egypt, recently reduced its footprint in the country, selling a 33 percent minority stake in its Egyptian assets to China's Sinopec Group.[16] Shortly thereafter, Chevron announced the sale of its network of gasoline and fuel stations in the country.

LIBYA—IMPLOSION

Libya, which holds 3.4 percent of the world's proven oil reserves,[17] produces high-quality low-sulfur oil which is relatively easy and cheap to supply to the nearby European market.[18] Oil is the mainstay of the national economy. According to the International Monetary Fund (IMF), oil export revenues account for about 95 percent of the country's currency earnings and more than 70 percent of Libya's gross domestic product (GDP).[19] Since mid-2013, the interim government, which has failed to revive the moribund economy, has been struggling to hold together the country in the face of intractable strikes at oil fields, refineries, and export terminals, as well as growing intra-militia violence and jihadist attacks in the east.

Of Libya's six main terminals, at least two of them, Es Sider and Marsa el Brega, were heavily damaged in 2011 during the civil war.[20] Production stoppages resulting from the conflict were severe. Although Libyan oil production recovered rapidly,[21] the country's oil industry is currently in crisis. Between May and October 2013, oil production and exports slumped by 70 percent.[22] Striking workers, angry about government corruption and low wages, have seized facilities. In fact, strikes in July 2013 closed all of the country's oil terminals except Zawiya.[23] There have also been instances in which army units have seized the very oil fields they were charged with protecting.[24]

Oil infrastructure has been subject to attacks as well. Exports from Mellitah and Zawiya dried up in late-August 2013 when the pipeline linking them to the main producing fields in western Libya was attacked and closed.[25] In late-September 2013, the Zintan tribal militia reopened a critical pipeline between the El-Sharara and El-Feel oil fields in the western part of the country. But there has been no indication of a similar breakthrough in the east, where a welter of well-armed groups—ranging from the Libya Shield Force and Islamist elements drawn from anti-Gaddhafi forces to the Zintan tribal militia (secular Bedouins from the desert interior)—are vying for control and where two-thirds of the nation's oil production is concentrated.[26]

Providing a glimmer of hope, acting Prime Minister Abdullah Al-Thinni announced in July 2014 that the government had reached agreement with brigade commander Ibrahim Jafran to reopen the Ras Lanuf and Es Sider oil terminals in eastern Libya. However, damage to the facilities sustained during the year-long blockade and persistent political disputes and disruptions suggest that the oil crisis has not yet ended.[27]

Insecurity has resulted in the scaling back of foreign involvement in the Libyan energy sector. The current climate of insecurity makes the mobilization of foreign investment in the oil sector unlikely, a problem compounded by the lack of a long-term strategy for its development.[28] OMV, an Austrian oil company that is a major producer in Libya, announced that it was suspending production. BP, which re-entered the country in 2007, has continually postponed offshore drilling. Mediterranean International, an oil service company that withdrew from Libya during the fighting in 2011, has not yet returned.[29] Exxon Mobil said it was cutting back its staff and operations in the country because of the security situation.[30] Although Libyan officials had planned to hold an auction for exploratory rights this year, the bidding has been postponed indefinitely (that is, until such time as a permanent government is in place and new draft oil laws are crafted).[31] Even then, it is unclear whether the security situation will substantially improve and thus provide the reassurance needed to attract foreign investors.

Libya is saddled with payment of risk premiums and thus with especially high levels of public expenditures. Reported as far back as December 2012, Libya is paying significant risk premiums on its imports of staple foods, which in the case of wheat accounts for 75 percent of its needs. As a result, Libya is burdened by a higher level of public expenditures than the country can sustain over the longer term. According to the IMF, "Although Libya can afford elevated levels of current expenditures in a transitional period, the increase in wages and subsidies is eroding fiscal buffers and undermining prospects for fiscal sustainability."[32]

Political upheaval has delayed policy reform. Energy prices are heavily subsidized in Libya, as elsewhere in the region. The IMF has estimated that the low price of fuel and electricity cost Libya 12 percent of its GDP in 2012. The political upheaval in Libya, however, has delayed subsidy reform.[33]

SYRIA—ANARCHIC STRUGGLE

Oil, along with agriculture and tourism, has been the pillar of the Syrian economy. Although Syria's oil production has fallen steadily since its 1990s peak, prior to the conflict, proceeds from oil exports had constituted the country's main source of hard currency and accounted for about a third of its export revenue. On the eve of the conflict, with Syrian oil production continuing to decline due to geological depletion, Damascus was making preparations to start auctioning exploration rights for development of offshore oil reserves and marketing the country as a potential regional oil transit hub.

The combination of international sanctions and the damage to energy infrastructure by armed groups has resulted in a reduction in the government's capacity to produce and refine oil. The sanctions have also led to a shortage in diesel and fuel gas for home use and to a sharp increase in the prices of oil derivatives. Until recently, rebel groups for the most part had refrained from launching attacks on the country's energy infrastructure.[34] Consequently, the government has managed to keep a limited supply of oil flowing to the country's main refineries for domestic consumption. As the conflict has dragged on, however, reports suggest an increased frequency in the number of attacks on electricity and energy infrastructure, with conflicting accounts of who is responsible for them.[35]

The Syrian population has experienced great hardship. Attacks on oil pipelines and infrastructure have caused shortages for Syrians throughout the uprising. People wait for hours in lines to fill their vehicles' gas tanks, and hours of electricity cuts every day are common because of the difficulty of supplying power stations with fuel. The coping strategies devised to obtain fuel, particularly the use of small-scale wildcat refineries employing primitive techniques, have led to a number of injuries and deaths as well as long-term health hazards due to soil and water contamination.

Parties to the conflict are vying for control of oil. Most of Syria's oil fields are situated in the eastern or northeastern part of the country—specifically in Hassakeh, Deir al-Zour, and Raqqa provinces. Oil supplies transported from fields to refineries and from there to consumers must traverse multiple battle lines.

The proliferation of rebel groups and the fragmentation of the country are reflected in the competition for control of oil. Internal supply routes are hindered by hostilities between Kurdish and Arab factions.[36] However, a number of oil wells have been looted, and smuggling of diesel fuel along the Syrian-Turkish border has surged.[37] It has also been reported that some rebel forces, relying on intermediaries trusted by both sides, have allowed oil to flow to government-operated refineries in order to serve the communities in areas they control. In Deir al-Zour, for example, the Free Syrian Army accepted an arrangement whereby gas is shipped to the Syrian government, which distributes it throughout the country and pays the salaries of gas plant employees.[38]

Rebel infighting and numerous localized conflicts have made the situation murky. Initially, Jabhat al-Nusra, having wrested control of territory from Sunni tribes, reportedly had controlled most oil wells in Deir al-Zour province and had also seized control of other fields from Kurdish groups in Hassakeh governorate.[39] Over the past 6 months, however, the conflict has mutated, with months-long battles resulting in the Islamic State of Iraq and al-Sham (ISIS) making huge inroads into the northern and eastern provinces and gaining control of oil fields with which to support their operations. By July 2014, ISIS, which now calls itself The Islamic State, had seized the majority of the oil fields in Raqqa and Deir Ezzor provinces.[40] Clearly, all sides regard oil, and have been using it, as a vital strategic resource in waging war.

Localized clashes over oil[41] are also part of the battle for hearts and minds. The Islamic State, Jabhat al-Nusra and other jihadist groups, for example, have reportedly used money generated by oil sales to provide services to the communities in areas they have captured, such as Raqqa city. It is possible the European Union's (EU) easing of sanctions in April 2013 could have, or has already had, the perverse effect of further fueling the struggle among rebel groups for control of oil.

When the EU prohibited member states from importing oil from Syria in mid-November 2011, it stopped short of imposing a ban on investment by European companies in the Syrian energy sector.[42] However, companies such as Shell, Total, and Gulfsands Petroleum, nonetheless declared *force majeure* and pulled out of their contracts with the state-owned Syrian Petroleum Company.

Efforts to capitalize on Syria's location to make the country an energy transit corridor have been delayed indefinitely. Prior to the outbreak of conflict, Damascus had been pitching the idea of a "four seas strategy," which would connect the Persian Gulf and the Black, Caspian, and Mediterranean seas via pipelines and other infrastructure through Syria. To be sure, this was a grandiose idea. Yet, it is not far-fetched to contemplate Syria serving as a conduit for crude oil and natural gas supplies from Iraqi fields.[43] In fact, a tripartite agreement was signed between Iran, Iraq, and Syria in May 2011, which aims to transport Iranian gas through Iraq to Syria. However, ventures even this limited in scope are on hold for the foreseeable future.

IRAQ—PRECARIOUS REVIVAL

According to the *BP World Energy Statistical Review*, Iraq holds 9 percent of global proven oil reserves. Yet, as important as Iraq's role and potential are to the global energy market, oil export income is vital to Iraq's economic recovery and future prosperity. Oil's crucial importance to the Iraqi economy is illustrated by the fact that in 2012 crude oil export earnings accounted for more than 90 percent of government revenue.[44]

Ten years after the U.S.-led invasion swept Saddam Hussein from power, the Iraqi oil sector has experienced a revival. The huge contracts signed in 2009 with some of the world's largest firms (Malaysia Petronas, Russia Lukoil, and Royal Dutch Shell) have borne fruit. Iraq is now the Organization of Petroleum Exporting Countries' (OPEC) second largest exporter after Saudi Arabia. According to the *Integrated National Energy Strategy* (INES) unveiled in June 2013, Iraq plans to invest $620 billion in the oil sector over the next 2 decades in an effort to boost living standards and employment levels.[45] Given Iraq's abundant energy assets and recent success in exploiting them, the country is in a far better position than Egypt, Libya, or Syria.

Yet, the fact that there is no agreed legal framework to guide investment in the oil and gas sector casts doubt as to whether Iraq's oil revival can be sustained and its ambitious plans realized.[46] The relatively peaceful protests that erupted in Fallujah and other towns and cities in Iraq in December 2012 seemed at the time to echo the uprisings that had toppled other regimes in the region. However, far from heralding an "Iraq Spring," they occurred alongside a persistent insurgency that has taken the lives of hundreds of Iraqis and has shown no signs of abating.

Damage to Infrastructure and Disruption to Production.

The political upheaval in the region, if anything, benefited Iraq and the global energy market, as increasing production helped to replace some lost Libyan barrels. According to OPEC, Iraqi oil production reached 3.2 million barrels per day at the end of 2012.[47] However, the revival of Iraq's oil industry slowed in 2013, as infrastructure and security problems have kept production below targets. Repeated attacks and leaks from aging Iraqi pipelines have disrupted northern export flows.[48]

Long-running disputes over oil revenues have further complicated the situation. A wide-ranging energy partnership between Turkey and the Kurdistan Regional Government (KRG) includes plans to construct a gas pipeline from Kurdistan's fields that will bypass Iraq's federal pipeline network—a development that is sure to intensify the struggle between Baghdad and the KRG. In another illustration of the battle for control of the country's oil wealth, the Governor of predominantly Sunni-populated Ninevah Province was granted authority by local councils to sign deals with foreign firms independently of Baghdad.[49]

The conflict in Syria has had the most immediate, deleterious spillover effects on Iraq. In some ways, the border region between Iraq and Syria has become a single battlefield. ISIS has, in fact, framed the conflict in Syria exactly that way. The incidence of cross-border violence has increased. What had been a conduit for arms, al-Qaeda fighters and Iraqi refugees in the aftermath of the U.S.-led invasion of Iraq in 2003, is now a corridor for smugglers, insurgents, and displaced Syrians.

The conflict in Syria has also undermined Iraq's security by contributing, if only indirectly, to rising sectarian tension and violence. The successes and resilience of the Syrian rebels have reinforced Sunni Iraqis' perception of their own marginalization and perhaps given them the confidence to challenge what they believe to be systematic discrimination and intimidation. It may also have fed the belief that if a Sunni-led government were to come to power in Damascus, their own position would be strengthened. Conversely, the conflict in Syria stoked fears among some Iraqi political leaders, especially Prime Minister Nuri al-Maliki, that the insurgency in Syria helped revitalize, materially and ideologically, Sunni militants in Iraq based in Anbar province.[50] Such fears provided a justification, or a pretext, for repression.

Since early 2014, the deteriorating domestic political situation in Iraq, coupled with the spillover effects of the Syrian conflict, have resulted in an explosion of violence. In fact, as discussed earlier, the war in Syria and the insurgency in Iraq have become tightly intertwined—with ISIS opportunistically feeding off and fueling the ideological and sectarian tensions, and the scramble for oil emerging as part of the broader transnational conflict. Indeed, oil has played a prominent role in, and has underscored the transnational character of the conflict. Not only have the proceeds from the smuggling of oil become a key revenue stream for ISIS, but they have been garnered by tankers carrying oil from ISIS-controlled territory in Syria to middlemen in Iraqi Kurdistan.[51]

Specifically with respect to Iraq, the worsening security situation has jeopardized the recovery and expansion of the oil sector, if not its very survival as a unitary state. Although the insurgency has not erased the gains that Iraq has made in reviving the energy sector, it has imposed significant costs. Attacks on the Kirkuk-Ceyhan pipeline have resulted in estimated monthly losses of $1.5 billion, thereby increasing the budget deficit.[52] In July 2014, Kurdish Peshmerga forces took control of two oil fields near Kirkuk—a move defended by the KRG as a measure aimed at protecting vital infrastructure from terrorists, but one which is bound to affect adversely relations with Baghdad.[53] A month after Iraq's largest oil refinery (Baiji) had been besieged by militants and shut down, the battle for control of the facility was still being fought.

The fact that most of Iraq's major oil fields are located in the south has made them difficult to target and, therefore, their output has been largely unaffected. Baghdad has taken precautions so as to ensure that production is not disrupted.[54] Nevertheless, the escalating violence has delayed the much anticipated modernization of these fields and the development of other upstream projects.

SAUDI ARABIA—BUYING TIME

As the world's largest oil producer and exporter, Saudi Arabia plays an enormously important role in the global energy market. Oil—accounting for 80 percent of Saudi budget revenues, 45 percent of GDP, and 90 percent of export earnings—is the lifeblood not only of the House of Saud and the Kingdom's economy, but also of the country's power and influence within and beyond the MENA region.

Saudi Arabia has thus far managed to avoid the major political upheaval and violence that has convulsed Egypt, Libya, and, most tragically, Syria. In fact, Saudi Arabia has reaped a windfall, capitalizing on the high oil prices which regional instability has helped to sustain. Record oil revenues have enabled the Saudi leadership to buy social acquiescence. According to OPEC, Saudi Arabia—filling the gap caused by the loss of Libyan supplies and offsetting the drop in Iranian oil exports due to sanctions—has increased its oil output to about 10.2 million barrels per day, a rise of over 10 percent since the beginning of 2013 and the highest level since 1980.[55] Besides boosting Riyadh's hard currency reserves to more than $500 billion, record oil receipts have helped to provide the wherewithal for a $130 billion spending program that includes raising civil servants' salaries and increasing the number of public sector jobs.[56] Oil revenues have also enabled Saudi Arabia to raise its 2013 expenditure target by almost a fifth in an effort to move ahead with plans to expand non-oil industries.[57]

Windfall oil receipts have also enhanced Saudi Arabia's ability to pursue aggressively its regional strategic goals. Saudi Arabia has sought to advance its strategic goals by employing aid and oil as diplomatic tools in an effort to sustain its regional allies. Saudi Arabia has shown unwavering support for the interim government in Egypt and an apparent commitment to prevent at all costs the Muslim Brotherhood's return to power. Saudi Arabia has joined the United Arab Emirates (UAE) and Kuwait in providing a financial lifeline to Cairo, pledging $5 billion in aid to shore up Egypt's faltering economy, including $2 billion worth of oil products (i.e., diesel, fuel, and gasoline shipments).[58] Riyadh has made large-scale financial commitments to Bahrain, Oman, Jordan, Yemen, and Morocco as well.

Nevertheless, Saudi Arabia faces challenges on all fronts, most notably its fierce rivalry with Iran. To the north, neighboring Bahrain is a divided country with a disaffected Shia majority. To the south, Yemen's new leadership is struggling to cope with Houthi rebels, al-Qaeda-linked Islamists, high unemployment, and a stagnant economy. In Syria, unrelenting violence has already exacerbated region-wide sectarian tensions and raised the risk of further destabilization.

Indeed, the post-Arab Spring MENA region has become a fractured and competitive regional environment marked by shifting alliances. Saudi Arabia has sought to maneuver its way through these turbulent circumstances by leading, however reluctantly at first, a counter-revolution against the forces that initially swept some of its key regional allies from power and threatened the rest. This has involved positioning itself as protector of all Sunni Muslims, casting popular uprisings as having been chaos-inducing or counterproductive, and in a practical sense, investing in the post-Morsi Egyptian government and banking on the Syrian opposition.

Saudi Arabia's objectives in Syria appear to be to contain the unrest, break the alliance with Iran, oust Assad, and check Hezbollah. Riyadh has pursued these objectives by arming Syrian rebel groups (including furnishing support for the Free Syrian Army through Jordan)[59] and, more recently, by reportedly trying to consolidate local Salafist rebel groups in an effort to thwart the expansion of al-Qaeda's influence.[60] Yet, by seizing the opportunity to detach Syria from Iran, Saudi Arabia has run the risk of transforming the country into a proxy battleground.

The sectarian dimension of regional power politics has intensified, as has intra-Gulf rivalry and U.S.-Saudi friction. The Arab uprisings, coupled with Riyadh's assertive regional posture in response to them, have exposed and sharpened the policy divergences between Saudi Arabia and some of its neighbors, and have badly strained relations with Washington.[61] Though Saudi Arabia and Turkey are united against the Assad regime, Riyadh has allegedly been supporting Salafi-leaning rebel groups, while Ankara, in collaboration with Qatar, has been backing Free Syrian Army brigades close to the Muslim Brotherhood. These differences are also apparent in the case of Egypt, with Saudi Arabia, Kuwait, and the UAE opposing the Morsi government, endorsing its removal and stepping in to shore up its successor, and Turkey and Qatar having been staunch supporters of the Brotherhood-dominated government in Cairo.

CONCLUSIONS

The time when the major powers were determined and seemed capable of decisively shaping, or at least containing, developments in the MENA region is over. Today, contending local and regional actors are driving events in a region marked by many moving parts.

Looking at the direct and indirect losses sustained by three countries which, 4 years after the Arab Spring protests began are still experiencing political turmoil and/or conflict—Egypt, Libya, and Syria—and two countries which appear to have benefited from the region-wide upheaval—Iraq and Saudi Arabia—several things are clear: First, the effects of the Arab Spring on the MENA region's energy sector vary greatly by country. Second, there are no clear "winners" and "losers," nor are all of the setbacks and bottlenecks directly attributable to the Arab Spring. Third, on balance, the Arab Spring's effects on MENA producers have not substantially jeopardized U.S. energy security—at least not yet.

The disruptions to oil/gas production—wherever they have occurred and whatever their causes—have undermined the ability of producers to meet export commitments and fulfill rapidly rising domestic consumption requirements; worsened their fiscal situations by depressing export earnings and increasing domestic public expenditures; impeded their ability to maintain and/or expand production capacity; further delayed fuel subsidy reforms; and spurred intra-regional energy realignments.

At the same time, the Arab Spring uprisings have been a major factor sustaining high oil prices. This has, in turn, fueled GDP growth in Saudi Arabia, the rest of the countries that comprise the Gulf Cooperation Council (GCC) and Iraq. This financial windfall has enabled Saudi Arabia, in particular, not just to contain domestic political pressure but to conduct a much more assertive regional foreign policy—sustaining Sunni allies and supporting proxies. However, a number of risks and costs offset such gains, including the spillover effects of the conflict in Syria, the question of whether/for how long such high levels of expenditure can be sustained, the strain placed on intra-regional relationships and the possibility of "blowback."

Shale technology and renewable energy provide the United States with the opportunity to further reduce its reliance on imported oil. However, even before the Arab Spring and the shale revolution, the United States had not been dependent on the Gulf for the physical supply of oil. Rather, it depended—then, now, and in the future—on the Gulf for price stability. A strong U.S. commitment to Gulf security will remain essential to oil market stability for the foreseeable future. Neither the Arab Spring nor the promise of "energy independence" appears to have eroded Washington's willingness to fulfill that commitment or the GCC countries' need for it.

The United States was spared the worst case of a post-Arab Spring "price shock," partly as the result of its own soaring production, coupled with the record-high production levels achieved by Saudi Arabia, Kuwait, the UAE, and Qatar. These same supply-side factors afforded the United States the strategic flexibility needed to push for the tightening of sanctions on Iran.

Nevertheless, there are a number of "over the horizon" risks and uncertainties, including the possible spread of unrest to/within the GCC sub-region, whether Iraq can overcome the political and other challenges that imperil the resurgence of its energy sector, when and under what circumstances Iranian supplies fully return to the market, and the policy choices that China and other major Asian energy consumers adopt in order to ensure that their needs are met.

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CHAPTER 4

GAME CHANGER?
THE ENERGY REVOLUTION AND AMERICAN POLICIES TOWARD AFRICA

Ian Taylor

Since the end of the Cold War, American policies toward Africa have been grounded on two main goals: to advance global economic integration under conditions of neo-liberalism, and to counter perceived threats to American security interests. In 1997, then-Assistant Secretary of State for African Affairs Susan Rice spelled out this twin-track approach by asserting that the United States had:

> two clear policy goals: a) integrating Africa into the global economy through promotion of democracy, economic growth and development, and conflict resolution; and b) combating transnational security threats, including terrorism, crime, narcotics, weapons proliferation, environmental degradation, and disease.[1]

Even with the securitization of many government policies under the George W. Bush administration, and in the context of a post-September 11, 2001 (9/11) world, Washington's approach toward Africa was altered little. Indeed, a renewed focus on the continent post-9/11 by Washington meant, in fact, a continuation of well-established policies that pre-dated the Bush government's tenure.[2]

It is in policy domains deemed to be particularly apposite to American national interests where Africa has enjoyed a resurgence of attention from Washington.[3] As one commentator noted, post-9/11, "Africa has assumed a new, strategic place in U.S. foreign policy and in the definition of vital U.S. national interests."[4] This may be linked to two related factors: oil and potential terrorist threats. Consequently, with regard to counterterrorism, military training and policing, American interests and involvement have multiplied post-9/11, with the U.S. Africa Command (AFRICOM) being but one example of this new redefinition of the strategic place Africa occupies in American policy-making calculations. Yet, referring back to Susan Rice's comments in 1997, it is apparent that Washington's assessments of the main challenges to American-defined interests that Africa presents has remained, at least up till now, largely unchanged. However, a new development, the "energy revolution" of shale gas and tight oil, means that a reappraisal of Washington's approach to Africa is now urgent.

AFRICA'S OIL AND THE UNITED STATES

The overwhelming dependency of the U.S. economy on oil is well known. In the 2006 State of the Union address, Bush famously asserted that "America [was] addicted to oil, which is often imported from unstable parts of the world." The inherent security threat this posed to American interests was intrinsic to the President's demand that the United States "replace more than 75 percent of our oil imports from the Middle East by 2025 . . . and make our dependence on Middle Eastern oil a thing of the past."[5] Apart from the potentiality of new energy technologies to help break this dependency, locating alternative sources of oil supplies other than those found in the Persian Gulf were central to Bush's message. Africa fits neatly into this energy-security nexus, and indeeed has been, "central in its efforts to reduce [American] dependency" on oil from the Middle East.[6]

Early on in the post-9/11 environment, Assistant Secretary of State for Africa Walter Kansteiner had asserted in mid-2002 that, "African oil is of strategic national interest to us," and this reality would only "increase and become more important as we go forward."[7] Later that year, a *New York Times* article stated that, "Africa, the neglected stepchild of American diplomacy, is rising in strategic importance to Washington policy makers, and one word sums up the reason—oil."[8] Yet, such pronouncements were not simply a counter-reaction to the Arab-originated attacks on 9/11. Reducing a dependency on oil from the Middle East was viewed as vital to American national interests prior to the calamitous events of 9/11. For instance, in May 2001, the National Energy Policy Development Group, chaired by Vice President Richard Cheney, characterized America's reliance on imported oil as a major national security issue, stating that the "concentration of world oil production in any one region of the world," was a "challenge" and that the American economy's reliance on Middle Eastern oil fostered "a condition of increased dependency on foreign powers that do not always have America's interests at heart."[9] In this sense, 9/11 merely propelled and speeded up policy calculations that had been made **before** the attacks.

How and why Africa fits into the previous calculations was directly related to contemporary estimates that West Africa would supply 25 percent of imported oil to the United States by 2015 (up from 14 percent in 2000).[10] As a result, "there [was] a greater recognition that Africa matters to the United States as an important and growing source of non-Gulf oil."[11] The growing abundance of oil supplies in the Gulf of Guinea is congruent with American policies to diversify oil supplies. Yet, this provided a challenge to American policies, given that West Africa was only in the initial stages of an:

> extended oil boom that [would] significantly enhance the global position of Nigeria and Angola and bring greater attention to emergent, unstable producers' such as Chad, Equatorial Guinea, and São Tomé and Príncipe.[12]

Trying to promote stability and governance in such states would not be easy.

As noted earlier, the Cheney Report issued its finalized findings in May 2001, fully 4 months **before** 9/11. It can therefore be asserted that, although 9/11 intensified American efforts to diversify supplies and consequently place even stronger weight on sourcing African oil, it was not 9/11 specifically that generated a change in American energy diplomacy. Rather, 9/11 and the clamor to further lessen dependence on oil from the Persian Gulf merely provided another, if particularly compelling, reason why Africa's energy fields should be accorded a greater priority in Washington's policy considerations and why American oil companies were particularly encouraged to explore opportunities there.

Clearly, in today's globalized world economy, oil provides the foundation for commerce and industry, the means for transportation, and provides the ability to wage war. It is **the** prize to capture.[13] In recent times, there was a growing international interest in Africa as a source for such a vital resource. So much so, that there was talk of a "scramble for Africa's oil," redolent of the 19th century's Scramble for Africa.[14] It is important to remember that, though this unprecedented attention was relatively new, the presence of oil in Africa was not; oil extraction on the continent began in the 1950s, while exploration was started much earlier.[15] Yet, Africa emerged as a hugely important source of oil in the global economy. This was largely due to new discoveries—"in the years between 2005 and 2010, 20 percent of the world's new production capacity [was] expected to come from Africa."[16]

These and other factors resulted in major oil corporations from around the world increasingly focusing their attention toward diversifying oil supplies and looking toward sub-Saharan Africa. An identifiable configuration emerged whereby American oil corporations largely controlled the oil fields of those economies that had recently discovered oil reserves, such as Equatorial Guinea and São Tomé and Príncipe, while British and American oil interests dominated Nigeria and French companies dominated in Gabon and Congo-Brazzaville. Chinese corporations dominated the oil sector in Sudan. Meanwhile, actors from Brazil, India, Japan, Malaysia, South Korea, and other locations were aggressively competing and seeking access across the continent.

In a report from the mid-2000s, the U.S. Department of Energy estimated that the combined oil output by all African producers was projected to rise by 91 percent between 2002 and 2025 (from 8.6 to 16.4 million barrels per day).[17] Thus, within oil circles, there was growing excitement about the, "alluring global source of energy in Africa."[18] Indeed, as the only region in which oil production was actually rising, Africa was identified as the "final frontier" in the quest for global oil supplies.[19]

The burgeoning oil fields in sub-Saharan Africa, particularly in the Gulf of Guinea, became of major geo-strategic importance to the oil-dependent industrialized economies. In fact, it could be stated that the United States did not just buy oil from Africa, but, "in many ways it [was] **dependent** on African oil."[20] As Assistant Secretary of State for Africa Walter Kansteiner noted, "African oil is critical to us, and it will increase and become more important as we go forward."[21] Thus African oil became a "matter of US national strategic interest," granting the Gulf of Guinea, "major strategic relevance in global energy politics."[22] To the American Ambassador to Chad's surprise, "for the first time, the two concepts—'Africa' and 'U.S. national security'—[were] used in the same sentences in Pentagon documents."[23]

Concomitantly, Africa emerged as a major site for competition between various oil corporations from diverse nations. In the mid-2000s, three of the world's largest oil corporations (Shell, Total, and Chevron) targeted 15 percent, 30 percent, and 35 percent respectively, of their global exploration and production budgets on Africa.[24] Meanwhile, it was estimated that Sub-Saharan economies would gather over $200 billion in oil revenue income over a 10-year period.

THE NATURE OF THE SCRAMBLE

At the global level, there was mounting anxiety that future oil supplies would not meet global demand, particularly within a wider context where emergent economies such as Brazil, China, and India were rapidly increasing oil consumption to feed their growing economies. The gap between global supply and demand was predicted to be met as early as 2025, according to some analyses.[25] Although the actual quantity of African oil reserves was low in comparison to those found in the Middle East, in a context that was marked by deep anxiety over future supplies, Africa's reserves (roughly 9 percent of the world's total) were deemed extremely significant.[26]

Another characteristic of the "scramble" was that while it was not solely a race between Chinese and American corporations, the dynamics **were** heavily influenced by the roles and activities of actors from these two states.[27] Policymakers in both nations had identified African oil as vital to their national interest, albeit for different motives. It was apparent that policy analysts in Beijing saw the broader global political milieu as being intrinsically linked to Chinese energy security and felt that in the current environment China was vulnerable until and unless it could diversify its oil sourcing and secure greater access to the world's oil supplies.[28] Between 2002 and 2025, it was estimated that Chinese energy consumption would rise by 153 percent and China became the second largest consumer of oil globally, after the United States.[29] In order to fuel such a growing demand, Chinese oil corporations entered into the competition for African oil. In the mid-2000s, 85 percent of Chinese African oil imports came from the oil-rich states of Angola, Sudan, Equatorial Guinea, the Democratic Republic of the Congo, and Nigeria.[30]

From the American perspective, the, "war on terrorism and preparations for war against Iraq . . . enormously increased the strategic value of West African oil reserves."[31] The high level of interest from such major importers certainly raised the level of competition over Africa's oil. While corporations headquartered in other states—Britain, Brazil, France, India, and Malaysia, for example—were playing important roles in the ongoing scramble and equally striving to build up their oil portfolios in Africa, it was the ostensible Sino-American competition for oil on the continent that grabbed the most headlines: "There [was] little doubt that the interest in Africa's oil and gas resources . . . spurred a rivalry between international actors in Africa, notably the American and Chinese governments."[32]

Apart from the objective amount of new oil discoveries being revealed in Africa on a regular basis, there were a number of factors that made the continent particularly attractive to oil corporations **and** to non-African political policymakers. Technically, what has made African oil of particular interest to the oil industry is the quality of African crude oil, known as "sweet" crude, which is comparatively unproblematic to refine and lessens the costs involved in the refining process. Most of Africa's crude oil is high quality and has a light, low sulfur grade. This is highly valued thanks to its high gasoline content and relatively cheap processing outlay—particularly attractive to corporations headquartered in the West, where environmental regulations make it problematic to refine heavier crude without running up relatively high expenditures. In a profit-driven industry, African oil makes commercial sense.

The second factor in Africa's attractiveness to the global oil industry was the geographic nature of the continent—entirely enclosed by water, Africa's location reduces transportation costs and time necessary to ship supplies to the prime global markets, with well-developed sealanes readymade for facilitating haulage. The Gulf of Guinea in particular benefits from a favorable geographical position from the perspective of oil companies as it consists of a large maritime area lacking in shipping chokepoints, i.e., narrow transport routes, such as those found in the Persian Gulf, that are vulnerable to blockade and flashpoints for trouble.

Third, Africa provided a **relatively** favorable environment vis-à-vis contractual agreements. In an environment where local technical expertise and the capital investment required to extract the oil are often lacking, foreign oil companies enter into production sharing agreements. Under a production sharing agreement, the contractor (that is, the foreign oil company) carries the whole cost and risk of exploration, and is rewarded only if exploration is successful. If there is a commercial discovery, the contractor regains its expended costs through the allocation of oil, what is known in the trade as "Cost Oil." Production for royalties is also recovered, after which the rest of any production, "Profit Oil," is shared as per the agreement. In Nigeria, for example, oil companies pay a flat 50 percent tax on petroleum profits, and the installations continue to be assets of the government during the contract.[33] Production sharing agreements are attractive to foreign oil corporations as they create conditions where lucrative profits can be made in exchange for relatively low upfront costs. Furthermore, such agreements are far more attractive than having to work with state owned oil companies in joint ventures, where the local national oil corporation invariably has a monopoly, including in the distribution of petroleum.

A fourth plus point for Africa in the eyes of foreign oil companies was that, with the exceptions of Angola and Nigeria, sub-Saharan African oil-producing countries were not members of the Organization of Petroleum Exporting Countries (OPEC). OPEC membership places stringent measures on member states regarding output as a means to maintain an artificially high oil price. This is why, "both the United States and oil companies operating in Nigeria have been pressuring the Nigerian government to pull out of OPEC to avoid production quotas imposed by the organization."[34] Equally, this is why the emergence of major sources of oil from non-OPEC states was seen by strategists in London and Washington as positive since, with the increase in non-OPEC oil states, which may produce and export at maximum output, it weakened OPEC's ability to keep the price of oil unnaturally high.

Another attraction for corporations investing in African oil was the fact that most of the oil reserves were offshore. The development of new technology within the oil industry opened up deep water and ultra-deep water reserves (5,000 to 10,000 feet) throughout the Gulf of Guinea, making them commercially feasible. Offshore locations obviously lessen the possibility that violence, civil strife, and other crises may interrupt production.[35] This was hugely desirable from the standpoint of the corporations, given the ongoing onshore situation in the Niger Delta, where oil companies must deal with large-scale illegal bunkering, kidnapping, and violence that has created a situation where:

> A presidential committee report says Nigeria lost at least $28 billion to oil theft and sabotage in the first 9 months of 2008. Some 1,000 lives were lost within the same period. Bombings of oil pipelines and kidnappings of oil workers by armed gangs in the creeks of the Niger Delta, home to Africa's biggest oil and gas industry, have cut Nigeria's crude oil output sharply over the past 3 years.[36]

Offshore locations also of course avoid the "two-speed problem," that is, pipelines and offshore platforms can be built much more quickly than competent states. Clearly, offshore fields, often far from the political instability and conflict found onshore, could be more easily insulated from the endemic turmoil that characterizes many African states.[37] Related to this **relative** safety (from the perspective of the oil companies), Africa was increasingly viewed more favorably than the Middle East, where anti-American sentiment is high, and where the perennial problem of Palestine generates perpetual tensions.

The previous factors illustrate why Africa emerged as a prime site of global interest in terms of oil exploration and production, including for American policymakers. However, new developments in energy technology and extraction may radically reshape such a scenario.

THE "ENERGY REVOLUTION"

In the past few years, a radical change in the forecasts for growth in American oil production and oil reserves has taken place. This has sprung from light tight oil (LTO). LTO includes both crude oil and condensate in all tight formations, including shale basins. Currently, the oil industry is considering LTO's potential and its likely implications for global oil supply and demand. This is important, given the fact that over the past decade, as noted earlier, the demand from non-OECD countries such as China and India expanded at an unparalleled rate and compelled these countries to seek new oil sources, Africa included. This was at the root of the so-called (and possibly short-lived) new scramble for Africa. Recently, however, this has begun to change as oil companies have started to develop unconventional hydrocarbons, successfully bringing to the market several large and under-exploited oil and natural gas liquid resources. American shale/tight oil, Canadian tar sands, Venezuela's extra-heavy oil, and Brazil's pre-salt oil are the main examples. This has meant that the fear of a decline in oil supplies (the "peak oil" thesis), which would then prompt concerns about energy shortages and propel oil prices upwards, possibly leading to "oil wars" has been quietly shelved. There is now little doubt that unconventional resources through the "energy revolution" will satisfy global demand. Instead, the debate now revolves around the speed and price at which these resources can be extracted.

The energy revolution derives from technological innovations in horizontal drilling and hydraulic fracturing (or "fracking"). The U.S. Department of Energy forecasts U.S. production of crude and other liquid hydrocarbons will average around 11.4 million barrels per day (bpd) by 2014, which would place the United States just below Saudi Arabia's expected output for 2013 of 11.6 million-bpd. Several forecasts put American production at between 13-15 million-bpd by 2020, with the International Energy Agency (IEA) suggesting that the United States may supplant Saudi Arabia as the world's largest producer. It should be said at this juncture that Saudi oil is cheaper to tap than tight oil, and LTO needs a price above $70 per barrel to be profitable (break-even prices of most tight oil are in the range of $40- $60 per barrel). However, the recent turnaround in the United States' crude oil production is extraordinary and will have major implications for Africa (and the world). As the United States meets more of its current and future demand for oil from indigenous supplies, imports from traditional suppliers will inevitably fall (see Table 4-1). This has already started to happen in dramatic fashion.

	2010	2011	2012
Algeria	186,019	130,723	88,487
Angola	143,512	126,259	85,335
Cameroon	19,728	13,921	12,356
Chad	11,312	18,473	11,004
Congo-B	26,276	19,275	11,341
DRC	3,225	3,999	137
Eq. Guinea	21,063	8,500	15,100
Gabon	17,022	12,557	15,886
Ghana	215	3,832	313
Ivory Coast	17,022	12,557	15,886
Liberia	-	20	1
Libya	25,595	5,542	22,281
Nigeria	373,297	298,732	161,558

Source: U.S. Energy Information Administration, *International Energy Outlook 2013*, DIE/EIA-0484, July 2013.

Table 4-1. U.S. Imports of Total Crude Oil and Products from Africa, 2010-2012 (in thousands of barrels).

In its *Medium-Term Oil Market Report* for 2013, the IEA asserted that LTO and other aspects of the energy revolution will act as a "supply shock" to the global oil market, that will be, "as transformative to the [energy] market over the next five years as was the rise of Chinese demand in the last 15 years."[38] Exports of Nigerian oil to the United States almost halved between 2011 and 2012. In the late-2000s, Nigeria was regularly exporting around one million barrels a day of crude to the United States, but by the end of 2012, that number was just 405,000 barrels a day. Nigeria has experienced difficulties in finding alternative destinations for its crude, and it has had to cut prices. Indeed, at the start of 2013, weak demand forced Nigeria to sell some cargoes of its oil below the official selling price. This would see Nigeria lose $380,000 on a typical cargo.[39]

Such a scenario is obviously very serious for Nigeria. Addressing the Nigeria Economist's Group Summit in May 2013, Minister of Petroleum Resources Diezani Alison-Madueke gave a rather pessimistic outlook for the future. In her speech, Alison-Madueke asserted that:

> U.S. dependence on oil imports is expected to continue declining over the next 10 years reaching a share of about 43 percent of total oil consumption by 2020 from 67 percent in 2005. . . . Between 2007 and 2011, U.S. shale gas share of total gas supply increased from 8 percent to 32 percent; consequently pipeline and LNG import share of total gas supply declined from 16 percent and 3 percent in 2007 to 12 percent and 1 percent respectively. As a result of shale gas production, it is projected that United States will become a net exporter of natural gas in the year 2020. This is already evident in the decline of Nigeria's LNG exports to the United States from 12 percent in 2007 to 1 percent in 2011."[40]

Consequently, "unprecedented growth in U.S. gas reserves inevitably **eliminates** the United States as a destination for Nigerian gas."[41] In addition, the growth in gas reserves helps re-establish the United States as a major producer of industries such as petrochemicals and fertilizer, in effect slashing the market options for such products from Nigeria.

As a result of such developments, Edward Morse, the head of commodities research at Citigroup Global Markets, has predicted that, "sometime before mid-2014, the United States and Canada will stop importing crude from West Africa altogether."[42] Indeed, the Philadelphia Refinery and the Trainer Refinery (both in Pennsylvania) are likely to no longer import sweet crude from Nigeria once the Keystone Pipeline System transporting oil sands from Alberta, Canada, and crude oil from the northern United States becomes operational. This is, it should be noted, ignoring the fact that Texan oil production will, by late-2014, surpass the 2.7 million-bpd mark, and push Texas' production above that of Nigeria (2.524 million-bpd), Venezuela (2.489 million-bpd), and Algeria (1.875 million-bpd).[43]

IMPLICATIONS FOR U.S. POLICY

According to Soares de Oliveira, "the catapulting of the Gulf of Guinea from strategic neglect to geopolitical stardom in the last few years is illustrative of how space is easily re-conceptualized by capital and politics."[44] With the upsurge of interest in oil by industrialized and emerging economies, there was the very real possibility that African elites would chose to ignore blandishments about the necessity to practice good government (however defined). As one analysis remarked on Angola, but which is equally applicable to all oil-rich states in sub-Saharan Africa:

> Interest in engaging with the transparency rhetoric may already have peaked amidst all-time high oil prices and a new business partner, China, which has essentially replaced conditionality-ridden OECD donors and Bretton Woods institutions as the source of credit for Angola's 'reconstruction,' and is unruffled by fashionable Western good governance agendas.[45]

While one should by no means overestimate how serious the international financial institutions have been in promoting good governance, the sort of dynamics unleashed by the resurgence of interest in Africa cannot be a good thing in such circumstances.

Kleptocratic and authoritarian trends historically have been tolerated by external players, the United States included. The political make-up of the external actor makes very little concrete difference in engagement with oil-rich African spaces and the need for oil accelerated a long-existent trend of forgetting the rhetoric about good governance in favor of naked geopolitics.[46] As Condoleezza Rice admitted, "nothing has really taken me aback more as secretary of state than the way that the politics of energy [are]—I will use the word 'warping'—diplomacy around the world."[47]

Of prime concern was that this new interest in African oil would reify in Africa what one analysis has termed the phenomena of a successful failed state.[48] These entities would, by any normal measure of a state's capabilities and performance, be considered as failed, in that there are chronic leadership standards and poor governance, weak and undiversified economies, fragile institutions, and low levels of human development. Yet while being marginalized by the rest of the world, oil-rich states are inherently engaged with it. While possessing the attributes of a failed/failing state, there persists a paradoxical sustainability where the presence of oil maintains the interest and attention of the international community that upholds relationships with such states, granting them (or rather, their elites) legitimacy.[49] This "legitimacy" not only can serve to play out in domestic terms, but also at the global level. In such circumstances, when a state's success was determined by its international legitimacy, recognized sovereignty and the ability to interact at the global level (rather than how it serves its citizenries), then the presence of oil granted success to some fundamentally dysfunctional African states. Angola, Equatorial Guinea, Nigeria, and Sudan all spring to mind at this juncture.

Will this change if the United States no longer needs African oil? It is probably unlikely to make a major difference, although freeing Washington from reliance on oil from some of the more odious regimes has to be a good thing per se. But it is unlikely that U.S. security concerns in Africa vis-à-vis energy supplies will totally decline. Other issues will likely develop which will require continued attention. The new U.S. oil glut and resulting suppressed demand for African oil could cause a fall in prices to $70-$90 per barrel by 2020 from current levels of $90-$120 per barrel. In fragile African states that depend highly upon oil revenue, a price collapse could engender far-reaching economic instability. Nigeria, for instance, already plagued by Boko Haram and continuous tensions in the Niger Delta, could be seriously affected. Similarly Chad, already vulnerable to the spread of al-Qaeda in the Sahel is exposed. So, while energy security will be less of a reason for a U.S. military presence, broader U.S. interests will remain. While there has been a game change in U.S. sourcing of oil from Africa, a development that has not yet played its course, strategic interests in Africa dictate that Washington remain engaged with the continent.

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CHAPTER 5

THE IMPACT OF POLITICAL INSTABILITY ON THE DEVELOPMENT OF LATIN AMERICAN ENERGY SUPPLIES

David R. Mares

Latin America was once a major energy provider to world markets and has the potential to become a major exporter of oil and natural gas in the next decade. Latin American energy resources could help diversify world energy markets away from the turbulent Middle East, contribute to world economic growth by stabilizing and lowering international energy prices, and help mitigate climate change by supporting the turn to cleaner natural gas. The impact of Latin American energy supplies on the United States is indirect—via global energy markets and Western Hemisphere geopolitics.

But translating that international potential into reality requires significant investments in exploration and production, the development of efficient and effective energy markets at home, and a significantly improved distribution of rents associated with hydrocarbon production within Latin American societies, not just between Latin American governments and public and private international oil and gas companies. These are significant challenges, and of the four major Latin American energy producers (Venezuela, Mexico, Argentina, and Brazil), only in Brazil do they appear likely to be successfully addressed, although even there the challenges are significant. Fortunately, on the other hand, guerrilla insurgencies and criminal organizations are not a major challenge for developing Latin American supply.

This chapter has four parts. The first presents the region's potential in conventional and unconventional oil and gas, and renewables. The second examines the competing demands between energy security at home and exports. The third assesses the four major challenges (investment, human capital, environment, and property rights [spanning contracts, communities, and cultures]) that must be addressed if developing those resources is to be successful. The fourth turns to the source of political instability around the oil and gas sector—the distribution of the wealth generated by these resources. The conclusion notes that these challenges are not unique to Latin America, but that the region historically has had a difficult time successfully addressing them because of its underdeveloped but participatory political systems.

POTENTIAL

Latin America's share of total world petroleum proven reserves was 12.9 percent in 2000 and increased to 20.4 percent in 2011[1]—of course, these figures cannot reflect the impact of technological change that could add significant new reserves in the region, and particularly as shale oil potential is explored.[2] Recent discussions[3] of world energy markets enthusiastically have forecast a shift in the geopolitical center of energy back to the Western Hemisphere as early as the 2020s, and Latin America is an important part of that forecast. The hemisphere had dominated oil markets up to World War II after which cheap, plentiful, and high quality Middle Eastern oil became the epicenter of the geopolitics of energy. Though oil (including tar sands in Canada, heavy oil in Venezuela, pre-salt oil in Brazil, and shale oil in the United States) continues to lead the discussion, the share of natural gas in total energy is projected to equal that of oil by 2030, at 28 percent.[4]

Venezuela's proven oil reserves of 296.5 billion barrels places it first in the world (17.9 percent of global reserves), and it has been among the top three exporters to the United States for decades. Mexico was among the top producers in the world and is the second most important source of U.S. oil imports. Brazil's recent discoveries in the pre-salt layer allowed it to significantly increase production, from 4.8 billion barrels in 1991 to 15.1 billion barrels in 2011, surpassing Mexico's 11.4 billion barrels that same year.[5] But in order to meet the projections of increasing production, Latin American energy policies will need to provide incentives for exploration and production. For instance, Mexico's proven reserves fell from 50.9 billion barrels in 1991 to 18.8 in 2001 and 11.4 in 2011, but it has a significant unexplored potential in the Gulf of Mexico. BP puts Venezuela's 2011 production 12 percent below that of 2001, and Venezuela's proven reserves indicate that there are no geological reasons for the decline. (See Tables 5-1 and 5-2.)

	1991	2001	2010	2011	Share of Global Total
Mexico	50.9	18.8	11.7	11.4	0.7%
Argentina	1.7	2.9	2.5	2.5	0.2%
Brazil	4.8	8.5	14.2	15.1	0.9%
Colombia	1.9	1.8	1.9	2.0	0.1%
Ecuador	1.5	4.6	6.2	6.2	0.4%
Peru	0.8	1.0	1.2	1.2	0.1%
Venezuela	62.6	77.7	296.5	296.5	17.9%

Source: *BP Statistical Review*, June 2012, p. 6.

Table 5-1. Proven Reserves (Billion barrels at end of Year).

	2004	2005	2006	2007	2008	2009	2010	2011	Share of Global Total
Mexico	3,830	3,766	3,689	3,479	3,165	2,978	2,958	2,938	3.6%
Argentina	754	725	716	699	682	676	652	607	0.8%
Brazil	1,542	1,716	1,809	1,833	1,899	2,029	2,137	2,193	2.9%
Colombia	551	554	559	561	616	685	801	930	1.2%
Ecuador	535	541	545	520	514	495	495	509	0.7%
Peru	94	111	116	114	120	145	157	153	0.2%
Venezuela	2,817	3,003	2,940	2,960	2,985	2,914	2,775	2,720	3.5%
Total									12.9%

Source: *BP Statistical Review*, June 2012, p. 8.

Table 5-2. Production (Thousand barrels daily, 2011).

Latin America also has potential to become an important producer and supplier to the world market of natural gas. Latin America appears to be rich in shale gas, according to a study commissioned by the U.S. Energy Information Administration (EIA).[6] The dark colors in Figure 5-1 are preliminary indicators of the location of major basins with shale gas potential that were examined in the study. One can see the unique situation of the Western Hemisphere (though most of the basins in the world have not yet been explored), and within Latin America of Argentina, Mexico, Brazil, and Paraguay.

Figure 5-1. Location Indicators of Major Basins with Shale Gas Potential.

Table 5-3 presents a deeper cut into Latin America's natural gas potential with figures on proven conventional natural gas reserves and the estimated technically recoverable[7] shale gas, organized by major countries. Venezuela, with 179 trillion cubic feet (tcf) of proven conventional gas, ranks second in the Western Hemisphere to the United States and eighth in the world. No other Latin American country holds major reserves of conventional gas. When we turn to shale gas, the picture is dramatically different. Column four in the Table shows Argentina with 774-tcf of technically recoverable gas from its shale deposits, far outdistancing Venezuela and second among potential shale gas reserves in the EIA study (now that U.S. reserves have been re-evaluated significantly downward). Mexico also dwarfs Venezuela and ranks third in the EIA study, with 681-tcf of technically recoverable gas. Brazil also has the potential to become a major player in gas in addition to its likely weight in oil markets once the pre-salt fields begin producing; its technically recoverable shale gas reserves are estimated at 226-tcf. Paraguay, with minimal internal demand, could also produce significant quantities of shale gas and generate significant exports. In short, Latin America has the potential to be floating in a vast supply of natural gas.

Country	Conventional	Potential Shale	Technically Recoverable Shale
Mexico	12	2,366	681
Colombia	4	78	19
Venezuela	178.9	42	11
Bolivia	26.5	192	48
Brazil	12.9	906	226
Paraguay	--	249	62
Uruguay	--	83	21
Argentina	13.4	2,732	774
Chile	3.5	287	64

Source: Jeremy Martin and Vanessa Orco, "Shale Gas en America Latina" (Shale Gas in Latin America"), available from *energiaadebate.com/shale-gas-en-america-latina/*.

Table 5-3. Natural Gas Potential in Latin America (tcf, 2011).

Until significant exploration is undertaken, however, it remains unknown how much shale gas exists and is potentially recoverable under current economic and technological conditions. Even in the United States, where shale gas exploration and production have been underway for several years, estimates of reserves have been revised downward dramatically. In 2012, the EIA's estimate of shale gas reserves was cut from 827-tcf to 482-tcf, and in the prolific Marcellus Shale basin, the EIA revised the estimated reserves downward by 66 percent, from 410-tcf to 141-tcf.[8]

The pace of exploration in Latin America, as well as subsequent production and development of the infrastructure needed to deliver the gas to the market, will be influenced significantly by each country's politics and its public policies on the domestic energy market, the environment, and indigenous rights. The experience of the past decade suggests that the conditions needed for the shale gas revolution to take off in Latin America will vary by country.

Latin America is a major user of hydropower, with 65 percent of all electricity in the region generated in this fashion. The largest users in the region are Brazil, Chile, and Colombia, but in terms of percentage of total domestic electricity production, Brazil is the second largest producer in the world (83.8 percent) and Venezuela is third (72.8 percent). Brazil has the world's second largest hydropower complex in the world (Itaipú on the border with Paraguay) and is building the third largest (Bello Monte in the Amazon), as well as a number of others. But large dams have been stymied in Chile and are the targets of environmentalists and indigenous peoples throughout the region, so their future contribution to power generation is uncertain. A significant failure here will put more pressure on domestic consumption of natural gas for electricity.

Biofuels is the other major renewable—including traditional sources such as firewood and grass and modern industrialized forms including sugarcane and other soures of ethanol—and accounted for 62 percent of renewable energy in 2006.[9] The former are not environmentally favorable or sustainable, and their use is declining, though still important. Industrialized biofuels have grown in importance but generate controversy regarding both their contribution to greenhouse gasses and their impact on food production.

The region is well-endowed with sustainable and more environmentally favorable renewable energy sources. Solar, wind, and wave potential exist, but technology for commercial use lags for the latter and government policies to promote all of them are in their infancy. Some countries provide credit subsidies and reserve grid capacity for solar or wind sources. For 2011, total primary energy consumption in Central and South America was 642.5 million tons of oil (MTOE) equivalent, but only 11.3-MTOE was generated by renewables excluding hydropower. Mexico was the worst performer, with 173.7-MTOE total primary energy consumed, and only 1.8-MTOE of that from non-hydro renewables.[10]

THE CHALLENGE OF ENERGY SECURITY

Both producing and consuming countries are concerned with "energy security." The basic goal of energy security is to minimize the adjustment costs that a reduction in volume or an increase in price has on the national economy. Those adjustment costs are not simply economic, but also include social dislocations as jobs, consumption, and investment are impacted, as well as the political fallout that follows a major social and economic adjustment process. The means of achieving energy security also vary. Market forces such as price incentives lead previously unexploited resources to become productive or consumers to reduce demand. In contrast, government regulation of national energy markets include subsidies to stimulate domestic supplies, price controls to reduce inflationary pressures, and trade restrictions to increase domestic supply. In either case, the pursuit of energy security implies a subordination of other policy goals to mitigating the impact of rising prices for energy.

The United States has export controls on oil and gas to ensure domestic supplies at politically acceptable prices. Even in today's era of low natural gas prices, gas export permits are only available to countries with which the United States has Free Trade Agreements. Given the underdeveloped natural gas markets in Latin American producing countries except Argentina, it seems reasonable to expect domestic political pressure to limit exports (as we have seen in both Peru and Bolivia) until the domestic market is developed and supplied at politically acceptable prices. The concept of "politically acceptable prices" is addressed below, but it is worth noting here that energy security also requires efficient **use** of oil and gas, as well as an effective national production strategy. But in many Latin American countries, corruption, political payoffs, and investment restrictions make it difficult to develop an effective and efficient national power grid or gas pipeline system, thus undermining energy security. Where state-owned enterprises (SOEs) have privileged roles in the energy sector, the governments that starve their SOEs of financial and human capital (such as Venezuela and Mexico) contribute to the problem of developing efficient and effective domestic energy markets.

THE CHALLENGES FOR PRODUCTION

Production requires financial capital, human resources, and "property rights," which essentially means the stability of contracts between the government and both investors and local communities. Investors focus on the impact of the government on the market conditions expected when the contracts were negotiated and the legal sanctity of signed contracts. Communities look to their rights as citizens and often as legally protected distinct indigenous cultures to expect that the government will adhere to its social contract with them in a democratic context. This section will address investors, and the next will turn to the politics of the social contract.

Empirically, one can divide Latin America's eight major oil and gas producers into two groups. The group that allows market incentives to play an important role includes Peru, Colombia, and Brazil. Another group consisting of Argentina, Bolivia, Ecuador, and Venezuela has an extremely heavy government hand in the sector but does not exclude the private sector or other countries' SOEs. Mexico has just reformed its constitution to break its SOEs' monopolies, but until legislation is implemented, it is difficult to know into which camp it will fall.

Peru has the most market-oriented energy sector. It has auctioned off a significant portion of its oil and gas blocks, permits up to 100 percent private operation in a block, and has an independent regulator that does not favor the national oil company (NOC), Petroperu. As a result, output of Peruvian oil and gas liquids reached a 24-year high in November 2012. Although there has been concern about supplying the domestic market, the government's response has been to promote more exploration and production rather than limit exports. Indigenous groups in the Amazon and environmentalists oppose these plans, but the Peruvian courts have found no legal reason to stop exploration in the largest producing area, Camisea. Colombia has a minor resource base but investor-friendly policies. Oil production in 2013 was expected to increase 16.5 percent to 1.1 million barrels per day (bpd), continuing a steady rise since 2007.

Gas reserves in Venezuela and Argentina remain underdeveloped because of the lack of incentives for investors and the significant deterioration of Venezuela's NOC, PDVSA, resulting from government policies that redistribute earnings away from sectoral needs and into opaque expenditures and social programs. But both economies are reeling—Venezuela's currency was devalued by 32 percent in 2013, and inflation that year reached 50 percent in Venezuela and 27 percent in Argentina—so expectations are that the governments will need to find ways to increase production. Ecuador has moderate reserves, but its decision to turn all oil contracts into service contracts (which decouples investors from the oil produced) provides a significant disincentive to investors.

Mexico's 2008 energy reform created service contracts to permit private and foreign firms to enhance Pemex's oil recovery in older wells. But there were few takers, and they did not make a significant impact on reserves or production levels. The constitutional reforms at the end of 2013 have not yet been implemented, so we cannot know if the government will adopt policies to encourage the investment and human capital necessary to explore and develop its resources. Brazil is encountering significant difficulty attracting investors to its pre-salt fields under the terms that require its NOC Petrobras to operate the field and require an important level of local content throughout the operations. In 2013, the government auctioned the first field but only received one bid. Petrobras, meanwhile, is selling international assets and bringing human capital back to Brazil in an insufficient attempt to help bring these vast resources into production.

THE CHALLENGE OF SPREADING THE WEALTH AT HOME

Latin American governments face the same challenges as governments everywhere natural resources are abundant: There are many priorities, and trade-offs need to be made among them. The specific way in which these trade-offs are addressed in Latin America is affected by three factors: subsoil resources belong to the nation (this is true for all countries in the world except the United States and some parts of Canada); governments historically have had a poor record of living up to their contract obligations to investors (thus most investors in the region want more profit up front); and the region has the most unequal distribution of wealth in the world (thus citizens are skeptical about government contracts with investors).

The commodity boom of the past decade in general, not just in hydrocarbons, has benefited governments financially. Some nationalists believe this is the best means to judge whether a country benefits from its natural resource wealth. But the major issue for natural resource production when one is dealing with democracies is the distribution of wealth within the country. Unfortunately, corruption and inefficiencies in government services abound, leading to a waste of resources. Citizens who do not receive benefits from natural resource production either believe investors are getting too high a share of the profits or rebel at the ballot box or in the streets against their government; either way, investors will find the country to be a risky site for business and either demand higher returns or go elsewhere.

To use its hydrocarbon resources effectively for national development, therefore, Latin America needs to bring its political systems into the 21st century. Democracy in the developing world today means much more than the right to vote; it requires transparency in government behavior, accountability of elected officials, and citizen empowerment. Only by developing these elements of their democracies can governments convince citizens that the social contract is operative, a contract in which citizens support government policy and governments use their legal power and the nation's wealth for the benefit of national (not elite- or sector-specific) development.

CONCLUSION: THE POLITICS OF ENERGY

Hydrocarbon energy resources will remain important sources of energy for decades to come, and the role of cleaner-burning natural gas will increase as coal and oil succumb to environmental pressures for lower emissions. This developing energy scenario can be extremely favorable for Latin America and the world. The region is potentially rich in unconventional oil and shale gas resources, as well as renewables. These resources can fuel domestic growth because of their abundance and their ability to have a significant impact on poverty by boosting power generation and employment and by making national economies more cost competitive. The world will also benefit as the significance of oil resources in the volatile Middle East declines leading to a restructuring of the geopolitics of energy. (U.S. and Canadian production of conventional and nonconventional oil and gas also contribute substantially to this shift.)

The development of Latin America's potential, however, faces significant challenges, and it is not clear that the region will address them successfully. To varying degrees, the politics of hydrocarbon production is problematic in the major Latin American countries. Though Latin America is quite diverse, and some smaller producers (Colombia and Peru) have policies that encourage exploration and production, conditions in the big four countries (Venezuela, Brazil, Argentina, and Mexico) raise significant obstacles to achieving the levels of production that would usher in this new regional and global context. The essential challenge for Latin America to meet its hydrocarbon potential is crafting stable domestic political coalitions that see the benefit of providing incentives for foreign investors to bring the requisite capital, skill, and technology to the region. Historically, Latin American democracies do not have a stellar record in providing such incentives when they perceive that they have an asset that others desire. Unless resource nationalism can be made compatible with providing incentives for significant foreign participation, it may be far too early to start trumpeting a bonanza for Latin America and a shift in the geopolitical center of energy toward the Western Hemisphere.

ENDNOTES - CHAPTER 5

1. *BP Statistical Reviews*, 2000 and 2012, pp. 4 and 6, respectively.

2. Leonardo Maugeri, "Oil: Never Cry Wolf—Why the Petroleum Age is Far from Over," *Science*, May 2004.

3. Cf., Daniel Yergin, "Oil's New World Order," *The Washington Post,* October 28, 2011; Amy Meyers Jaffe, "The Americas, Not the Middle East, Will Be the World Capital of Energy," *Foreign Policy*, September-October 2011.

4. *BP Energy Outlook 2030*, London, United Kingdom, January 2011, p. 18, available from *www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/2030_energy_outlook_booklet.pdf*.

5. *BP Statistical Review of World Energy*, June 2012, p. 6.

6. Vello Kuuskraa, *et al.*, *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States*, Arlington, VA: Advanced Resources International, Inc. April 2011.

7. According to the Energy Information Agency (EIA),

> The estimates of technically recoverable shale gas resources for the 32 countries outside of the United States represents a moderately conservative 'risked' resource for the basins reviewed. These estimates are uncertain given the relatively sparse data that currently exist and the approach the consultant has employed would likely result in a higher estimate once better information is available. The methodology is outlined below and described in more detail within the attached report, and is not directly comparable to more detailed resource assessments that result in a probabilistic range of the technically recoverable resource.

World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, April 5, 2011, available from *www.eia.gov/analysis/studies/worldshalegas/*.

8. *AEO2012 Early Release Overview*, Washington, DC: US Energy Information Administration, available from *www.eia.gov/forecasts/aeo/er/pdf/0383er(2012).pdf*.

9. *Energy Balances of Non-OECD Countries*, Paris, France: International Energy Agency, 2006, Online Data cited by Federico Barraga Salazar, "Renewable Energy Policies in Latin America: The Role of the State," MA Thesis, The Diplomatic Academy of Vienna, University of Vienna, June 2008.

10. *BP Statistical Review of World Energy June 2012,* p. 41, available from *bp.com/statisticalreview*.

CHAPTER 6

THE SHALE REVOLUTION AND THE NEW GEOPOLITICS OF ENERGY

Robert A. Manning

Still in its early stages, the shale revolution has already had a profound multidimensional impact, redrawing the U.S. and global energy landscape and beginning to reshape global geopolitics. Shale holds promise to enhance substantially U.S. global economic competitiveness and U.S. foreign policy leverage. But it is worth recalling just how recent a phenomenon it is. It should also be kept in mind the continued questions about environmental impact that may limit or even undermine the future of shale gas and tight oil.

In 2008, the shale boom was in its infancy. Most forecasters failed to anticipate its stunning rise. Still more remarkable is the fact that, despite its impact already, only a fraction of its potential in both the United States and worldwide, has been realized. Yet, after the information technology revolution over the last 2 decades, shale may be the most transformational technological change so far in the 21st century. This chapter argues that shale gas and tight oil have:

- begun to radically shift global energy markets and redraw the global energy map, 40 years after the Arab oil embargo;
- dramatically shifted the outlook for U.S. energy security and our national strategic calculus;
- altered global geopolitics, as the Western Hemisphere—especially Canada, the United States, Mexico, and Brazil—has the potential to become the new center of gravity of oil and gas

production, as David Mares points out in part in Chapter 5 of this volume;

- turned the debate on the future of oil on its head—the debate about whether we have reached "peak oil" is over, and now the issue is whether we are approaching "peak demand";
- strengthened the U.S. economy, positioning the United States for a resurgence as industry is relocating to take advantage of cheap gas prices; and,
- potentially repositioned the United States vis-à-vis the Middle East and Asia.

For many years, the notion that we have reached "peak oil"—that recoverable oil reserves had reached their maximum point and would begin a terminal decline—was a central issue of debate among geologists and oil analysts. But developments over the past couple of decades have exposed a major flaw in the argument: Geologists failed to factor in technology. This has been demonstrable as the technology for fracking and also for ever deeper offshore-sea drilling has become widely deployed. Indeed, the world supply of proven oil reserves has increased from 683 billion barrels in 1980 to 1.69 trillion barrels by 2012, largely the result of technology innovation in deep sea oil drilling and the shale revolution.[1] This despite a 16 million barrel per day (m/bd) increase in production over that period to the current 89-m/bd level.

Now, some analysts contend that we are reaching "peak demand," possibly by the end of this decade, as a Citigroup analysis has argued.[2] Projections for future global oil demand by 2030 range from 92-m/bd to 110-m/bd or higher. In the developed countries of the Organization for Economic Cooperation and

Development (OECD), particularly the United States and Europe, demand has been declining, a trend that is projected to continue. More stringent Corporate Average Fuel Economy (CAFE) standards, mandated to increase to 54.5 miles per gallon by 2025 and the growing electrification of transport (for example, plug-in hybrid and electric vehicles) lead to some projections of a 4-6-m/bd decline in U.S. oil consumption by 2030. Such a scenario could impact prices as well as carbon dioxide (CO2) emissions and the U.S. trade deficit.

One important caveat must be pointed out: There are continuing legitimate environmental concerns—methane flaring, methane leaks, and water pollution—that could undermine the shale revolution, and severely limit its further development. This has constrained the development of major shale gas deposits in New York, Colorado, and California, all of which have yet to approve fracking. Such concerns have also restrained numerous countries around the globe from developing their respective shale reserves. However, recent studies suggest that environmental concerns are manageable if best practices are widely adopted as norms by energy companies.[3] One problem is a conflicting welter of differing state regulatory policies, which continue to evolve.

Moreover, in the long term, the principal energy challenge remains the environmental imperative to move decisively toward a more resilient post-petroleum-centered energy system. Gas should still be viewed as a critical bridging technology—though the bridge appears longer than previously thought. Low-cost U.S. gas is not only triggering a shift from coal to gas for electricity production, it is also changing the economics of nuclear power as well as that of solar and wind energy. All appear less cost-competitive in the near-term, even as costs for solar and wind continue to fall.

This long-term challenge is made more poignant when one considers the demand growth for energy services as the global middle class grows to as many as 4 billion of the 8 billion people estimated to be on this planet by 2030. The International Energy Agency (IEA) projects global energy demand to increase by 35-46 percent from 2010-35.[4] The overwhelming majority of that increased demand will come from outside OECD countries, principally from China, India, and the rest of developing Asia and Latin America. Whether the emerging middle class in China, India, and Southeast Asia are driving electric cars and getting electricity from sources other than coal will, to a large degree, determine the extent of global climate change.

THE SHALE REVOLUTION: U.S. ENERGY RENAISSANCE

The combination of computer-aided horizontal drilling and hydraulic fracturing (known as "fracking") technology has boosted enormously both U.S. production and reserves of tight oil and gas. The United States has already become the world's largest producer of oil and gas hydrocarbons, is projected to surpass Saudi Arabia as the world's top oil producer by 2017, and is likely to become a net exporter by 2030.[5] Oil production is now 7.32-m/bd, the highest since 1994 and is projected to reach 8-m/bd in 2014.[6] Natural gas production is 72 billion cubic feet per day (b/cfd), 40 percent of which is from shale.

There are currently ample natural gas reserves to meet current U.S. demand for the next century. While the shale gas phenomenon, like the internet, is now taken for granted, the rapidity of its increase, since roughly 2008, is a useful reminder of both how protracted is the process of commercializing technology and how swiftly innovation can transform reality when it achieves a sort of commercial critical mass.

Though shale gas and tight oil production ramped up from roughly 2007-08, the technology had existed for nearly a century. It was the combined public/private partnership of government-funded research and development (R&D) from the 1970s and creative wildcatting entrepreneurs aided by tax credits and oil prices in the $85-$100 per barrel range that developed commercially viable hydraulic fracturing, directional drilling, and other gas recovery technologies that scaled up the technology and took off.[7]

Moreover, estimates of recoverable shale gas and shale/tight oil are continuing to be revised upwards: The EIA has increased its estimate of recoverable shale gas reserves from 6.2 trillion cubic feet (tcf) in 2011 to 7.3-tcf in 2013, and revised its estimate of recoverable tight oil by 1,000 percent, from 32 to 345 billion barrels.[8] It is also important to note that shale technology is not static: It continues to improve, with recent developments cutting required amounts of water in half, improving knowledge of shale composition, and increasing the production of shale gas and tight oil.[9] Some analysts suggest that the amount of recoverable reserves may be substantially larger by an order of magnitude.

The net effect of the shale revolution is that the center of gravity of world energy markets is shifting from the Persian Gulf to the Western Hemisphere (specifically, the United States, Canada, Mexico, and Brazil). This shift has already reduced U.S. dependency on oil imports from 60 percent in 2005 to 39 percent in 2013, with prospects for U.S. self-sufficiency on the horizon.[10] The bulk of U.S. imports are from the Western Hemisphere, only about 10 percent from the Persian Gulf. Moreover, North America—the United States, Canada, and Mexico—is an increasingly integrated market. Mexico's recent landmark energy reform legislation is likely to increase dramatically its offshore oil and gas potential as well as its shale gas reserves if effectively implemented.[11]

Indeed, by the end of the decade, investments in the Gulf of Mexico, off the coasts of West and East Africa, in Central Asia, and in the waters of East Asia will likely see non-OPEC (Organization of Petroleum Exporting Countries) production attain new levels and dilute OPEC's ability to dictate prices. Despite moves toward self-sufficiency, it is a mistake, and certainly an overstatement, to talk of U.S. energy independence. It is and will remain a global market for oil, with disruption anywhere impacting prices everywhere. But steadily declining U.S. oil and gas imports will enhance U.S. freedom of action. Another issue this trend raises is the future of the Strategic Petroleum Reserve (SPR). If the United States is less reliant on imports and less vulnerable to disruptions, the role of the SPR may change: It may become useful as a tool to set a ceiling for prices. In any case, the role of the SPR merits a serious policy review.

In fact, if OPEC has leverage in the future, it is likely to be mainly with Asian consumers. The long-term trend is for a growing Middle East-Asia-Pacific nexus with some 70 percent of Middle East exports going to Asian consumers, principally China, India, and Southeast Asia, and some 75 percent of Asian oil imports coming from the Middle East. One potential concern is that America's Asian allies and partners may be pressured in regard to their support for U.S. Middle East policies.

STRATEGIC IMPLICATIONS OF SHALE GAS

The strategic implications of the shale revolution begin at home and strengthen the case for U.S. resilience, bolstering the U.S. economy and the environment in important ways. The falling price of U.S. natural gas to roughly $4-b/cf has led to a shift from coal-fired to gas-fired power plants. Prior to the shale boom, coal accounted for 50 percent of U.S. electricity, but plants have increasingly shifted to gas, with coal dropping to roughly 39 percent of U.S. electricity production and gas growing to 32 percent.

This has added a new dimension to U.S. economic competitiveness and to U.S. comprehensive national power, reinforcing the U.S. capacity for global leadership. Energy-intensive industries such as chemical, petrochemical, cement, and steel have resulted in a new "in-sourcing" trend. American firms are relocating industry back into the United States, and many European firms are also opening new plants in the United States, catalyzing a revival of U.S. industry (in Europe average gas prices are about $10-b/cf, and in Japan $16-b/cf).[12] For example, BASF, the German chemical firm, has earmarked $1 billion a year to 2017 to invest in factories in the United States.[13] A Citibank analysis estimated that increased gas and oil production could add 2-3 percent to U.S. gross domestic product (GDP) by 2020.[14]

An additional and unexpected benefit has been that of a drop in U.S. greenhouse gas emissions. The shift from coal to shale combined with the economic slowdown has led to a 12 percent drop in emissions since 2007, a 20-year low, achieving roughly 70 percent of Kyoto treaty goals, even though Washington has not ratified the treaty.[15] The possibility of converting transport, particularly trucking and car fleets to natural gas from oil, something already beginning to occur, could further accelerate this trend.

GEOPOLITICAL RISKS AND BENEFITS

Globally, the shale revolution is beginning to put the United States in a position to challenge OPEC's control of oil markets. As mentioned earlier, the SPR could become an instrument of leverage on global oil prices. More generally, the shale revolution is enhancing Washington's freedom of action and policy choices in the world. The shale revolution already has had a broad foreign policy impact. It is doubtful whether it would have been possible to impose oil export sanctions on Iran without oil prices skyrocketing and destabilizing a fragile global economy absent the surge in U.S. oil production. More broadly, oil production disruptions from the Arab Awakening would almost certainly have driven prices significantly higher, were it not for the boom in U.S. oil production.

Importantly, the shale gas boom has also freed up liquefied natural gas (LNG) that the United States was projected to import from markets in Europe and Asia. This has increased gas options for the European Union (EU), reducing Russian leverage and Moscow's ability to use energy as an instrument of foreign policy. It has also provided Asian LNG importers with increased available supply.

But the most intriguing potential benefits likely to unfold over the coming decade will flow from the real possibility of the United States becoming a major LNG exporter and building global LNG markets. At present, LNG only accounts for about 16 percent of internationally traded gas. The majority of gas exports is via pipelines, most under fixed, long-term contracts. There are 22 LNG terminals in the United States, which were built to receive imports and are in the process of being re-engineered to convert to LNG exports. The U.S. Department of Energy (DOE) has approved licenses for four of them to date, with some 15 pending. This prospect of LNG exports is now being debated in Congress. For some 20 countries with which the United States has a free trade agreement (FTA), such as Korea, LNG exports are necessarily included. Other key trading partners, like Japan, must get DOE approval. Given the magnitude of shale gas reserves, concerns about the impact of exports on the domestic price of gas are overblown. A 2012 study done for DOE concluded that gas exports would have only a modest impact on prices.[16]

Energy exports would strongly reinforce the U.S. position in Asia. Presently, Japan, South Korea, and Taiwan are major gas importers, and China is also becoming a major importer. Strategically, gas exports would bolster the U.S. "rebalance" in Asia. Energy security in Asia is widely viewed as a priority strategic issue. The U.S. ability to bolster the energy security of Asian allies and partners would reinforce perceptions of U.S. reliability and presence as an Asia-Pacific power. Since Australia, a close U.S. treaty ally, is another major source of Asian gas exports, the combination of U.S. and Australian gas as underpinning East Asian energy security would be an important new strategic reality. Moreover, China currently imports roughly 30 percent of its natural gas, and demand projections suggest China may import 50 percent of its gas by 2025. U.S. gas exports to China would add a dimension of economic and strategic interdependence to the Sino-American relationship.

The diffusion of fracking technology globally to areas such as China, Australia, Central Europe, and Latin America over the coming decade may further transform the energy landscape and significantly reduce C02 emissions. China, for example, depends on coal for roughly 70 percent of its electricity. This has been the case for the past quarter-century despite massive investments in renewable energy technologies. Yet, China holds larger recoverable shale gas reserves than the United States, though difficult geology and water resource factors may limit its development. Further suggesting the notion of North and South America as the new center of gravity of hydrocarbons, Argentina, Mexico, and Brazil, all possess substantial recoverable shale gas resources, and Venezuela possesses large-scale tar sands.[17]

For Europe, LNG exports and (over the longer term) shale gas production could reduce its dependence on Russia. Poland and Ukraine have significant shale deposits and have signed exploration contracts with major U.S. firms to develop them. If Ukraine can produce shale gas, it could free Kiev from Russian pressure and facilitate its integration with the EU. However, the potential of Ukrainian or Polish shale gas production will likely not be clear before the end of this decade. Beyond Central Europe, the United Kingdom (UK) is the only European nation that has thus far made a policy choice to develop shale gas.

An intriguing question is how the shale revolution will impact Russia's future. Moscow's ability to use its energy resources as an instrument of coercive diplomacy will almost certainly begin to decline. The larger question is in regard to Russia itself. With an economy still heavily dependent on oil and gas resources—30 percent of its GDP, 70 percent of its exports, and 50 percent of its growth since 2000—shale gas could impact Russia in different ways. Already, though oil is in the $100-brl range, Russian economists forecast only 1.2 percent growth over the next several years. One scenario is shale leading to increasing pressure on Moscow to reform, diversify and modernize its economy to become less dependent on energy resources. Another possibility is that Russia, which has substantial shale resources of its own, becomes more of a petro-state, developing its shale resources (if it can create incentives for U.S. firms with state of the art technology to invest) and using its large conventional gas resources to move away from "pipeline politics" toward building its own LNG markets. Russian firms are building two large LNG facilities in the Russian Far East aimed at exporting to Asian markets.

GEOPOLITICAL CHALLENGES

For major gas exporters Qatar and Iran as well as Russia, U.S. shale gas may also complicate or diminish prospects for further development. In the case of Iran, the U.S. shale revolution will complicate its efforts to develop its large gas reserves.[18] To date, close U.S.-Saudi relations and a sense of antagonism has precluded cooperation between Russia and OPEC oil and gas producers. A weakening of the U.S.-Saudi bond resulting from increased U.S. energy self-sufficiency and divergent interests in the on-going Sunni-Shia conflict in the Islamic world could create a different set of circumstances. However, Russian support for Bashar al-Assad in Syria puts Moscow on the other side, as the Saudis and Gulf Cooperation Council (GCC) states have backed the Syrian opposition, suggesting a Russian-GCC energy coalition remains a distant prospect.

Coming at a historic juncture when the U.S. public is weary after a decade of, at best, inconclusive wars in Iraq and Afghanistan and as the Barack Obama administration has refocused U.S. strategic priorities on the Asia-Pacific, the shale revolution may presage a rethinking of the U.S. role in the Middle East. The U.S. role as security guarantor in the Persian Gulf and guardian of the vital shipping lanes from the Strait of Hormuz to the Straits of Malacca has shaped the region's strategic landscape for more than half a century.

This U.S. role has meant other major oil consumers have been largely free-riding on the U.S. provided public good of stability and sea lane security. This is especially true of China, which is in the midst of building a blue water maritime capacity. One key question is whether the combination of redefined U.S. interests, the reality of a growing Middle East-Asian energy nexus, and new or enhanced naval capabilities of China, India, Japan, the Republic of Korea, and other actors results in burden-sharing in regard to the security of sealanes. A key policy question is whether the United States and China can cooperate in the Middle East or whether a more assertive China will become a new source of tension. Another factor that could reduce the U.S. role in the Middle East is a potential rapprochement with Iran, although that still remains problematic. In any case, China is likely to play a larger role in the Middle East, as it already has in Central Asia.

One new phenomenon in this regard is the unprecedented maritime cooperation in the Horn of Africa among all the countries mentioned earlier in response to the threat of piracy. In peacetime, piracy and terrorism are the principal threats to the security of energy flows in the Gulf. Whether the antipiracy cooperation in the Horn of Africa is an anomaly or a precedent remains to be seen. But more maritime security cooperation is something to be seriously explored.

CONCLUSION

There are clearly more questions than answers in regard to the strategic consequences of the shale revolution. While much attention has been focused on the economic and environmental impact of the revolution, comparatively little thought has been given to the national security consequences. The U.S. energy situation has been transformed with ramifications rippling across the American economy. The shale revolution opens up a range of new choices for U.S. foreign policy. Certainly, the growing move toward self-sufficiency gives the U.S. more flexibility in its foreign policy choices.

The new energy realities the United States has created could lead American foreign policy in different directions. One path is more isolationist, pulling back from current global responsibilities and focusing inward on American renewal. But the increase in U.S. national power could also lead to a more interventionist international posture. The current national mood, as reflected in a number of opinion polls is, if not isolationist, certainly one for more cautious engagement.[19]

It is difficult not to conclude that support for greater U.S. involvement in a Middle East enmeshed in what will be generations-long turmoil in its quest for modernity is greatly diminished. This may be reflected in the Obama administration's cautious approach to the unfolding events in Egypt, its reticence to intervene in Syria, and its approach toward Iraq's civil strife.

It will likely lead to a process of situation-specific trial and error as Washington adapts to the new realities shaped by the shale revolution. It will require discerning where newfound American leverage can usefully be applied, and where the limits of U.S. influence lie. But over the coming decade, as indicated earlier, the shale revolution is likely to impact U.S. relations with Russia and also to reinforce the U.S. "rebalance" in the Asia-Pacific. Over time, the shale revolution may well be viewed as an inflection point for where the "post-Cold War" era became something else, one that could well be marked by an American resurgence.

ENDNOTES - CHAPTER 6

1. *BP Statistical Review of World Energy*, 2013.

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CHAPTER 7

THE SECURITY RISKS AND REWARDS OF RENEWABLE ENERGIES: IMPLICATIONS FOR THE UNITED STATES

Karen Smith Stegen

INTRODUCTION

During the days following the first U.S. bombing raids on Iraq in 1991, protestors gathered outside the Standard Oil Building in downtown Chicago, IL—known as the Amoco Building—and chanted, "Hell no, we won't go, we won't fight for Amoco!"[1] Considering that Amoco was not operating in either Iraq or Kuwait in 1991, one might conclude that the protestors were misinformed. However, the protest was not against Amoco per se, but against the notion of the United States fighting a war to protect U.S. oil interests. This *raison d'être* for the war was specified in Vice President Dick Cheney's statements to the Senate Armed Services Committee on September 11, 1990, when he expressed concern about the deleterious effect of the Iraq invasion of Kuwait on energy security, specifically, the risk of Saddam Hussein dictating "the future of worldwide energy policy" and having "a stranglehold on our economy."[2]

As exemplified by Cheney's statements—and by the many other military and political activities the United States pursues to protect global energy markets—the reliance of the United States and other importing countries on foreign sources of energy renders the importers vulnerable to economic disruption and shapes their foreign policy aims and options.[3] How can this link be decoupled? Some observers might advocate greater hydrocarbon independence; but, as this chapter argues, a more lasting and efficacious solution is offered by replacing hydrocarbon sources of energy with renewable energies.

Beyond outlining the security benefits of renewable energies, this chapter also delineates some of the associated security risks—under the guiding principle that policymakers and security specialists can only prepare for and ameliorate the potential risks of renewable energies if they are aware of them. Special emphasis will be placed on the question of rare earth elements (REEs), owing to their criticality for many renewable energy technologies. The chapter begins by detailing the security risks posed by heavy dependence on foreign sources of energy and how renewable energies militate against those risks. In the next sections, the potential risks of various forms of renewable energies are presented, organized according to how they are deployed, either in the transportation or power generation sector. The chapter concludes by reviewing recent U.S. Government activities vis-à-vis REEs and proposes several policy initiatives.

THE SECURITY RISKS OF OIL AND GAS DEPENDENCE AND THE REWARDS OF RENEWABLE ENERGIES

Reliance on foreign sources of energy indirectly and directly affects geopolitical configurations of power and the foreign policy options of individual states. First, oil revenues empower producer countries and facilitate their ability to adopt policies inimical to consumer state interests. For example, energy revenues facilitated Iran's ability to pursue its nuclear program and have bolstered the Russian government's increasingly authoritarian tilt. Second, oil dependence weakens strategic partnerships and collaborative efforts as states may be reluctant to challenge producing states upon which they are heavily reliant. Third, protecting energy interests may result in a disproportional build-up of military capabilities. As observed in a Council on Foreign Relations (CFR) independent task force report chaired by John Deutsch, James R. Schlesinger, and David G. Victor, "U.S. strategic interests in reliable oil supplies from the Persian Gulf are not proportional with the percent of oil consumption that is imported by the United States from that region."[4] The implications are that either defense spending could be reduced, or the military could use those funds elsewhere; in other words, protecting sea lanes and other forms of military engagement on behalf of energy may carry opportunity costs. Fourth, energy dependence may make states vulnerable to "energy weapon" manipulation by producer states.[5] Fifth, oil revenues may have a destabilizing effect on producer countries, by encouraging rent-seeking and thereby undermining good governance in fragile states, such as Nigeria.[6]

In addition to constraining and shaping foreign policy, oil dependence also increases "stranglehold on our economy" risks. Moreover, such risks arise not only from the degree or quantity of U.S. oil dependence, but from our concern about the global importance of oil. In 1990, for example, oil from Iraq comprised only 3 percent of U.S. consumption, and imports from Kuwait even less, only 0.47 percent.[7] However, U.S. energy interests are not just about protecting direct U.S. supplies, but also about stabilizing global energy supplies and reducing the risk of oil volatility. For this reason, the United States has encouraged and supported the flow of global oil, even when that oil is not exported to the United States. Examples include U.S. support for Russia or the Caspian states as oil producers. Economists have found that oil volatility is more economically damaging than high oil prices because price volatility creates uncertainty,[8] which in turn invites a vicious circle dynamic: Investors curtail investment, consumers reduce consumption, and economic signals point downwards. Because oil prices are set on the international market, U.S. oil prices are not immune to the deleterious effects of global events and price fluctuations.

In sum, the more dependent a state is on oil, the more it exposes itself to economic and political constraints. One of the main security rewards of renewable energies is decoupling this link, which would give the United States greater leeway in its international affairs. Other potential rewards, for the United States and other countries, include diversifying the energy mix, easing water shortage tensions through desalination (for example, with concentrated solar power technologies), and increasing regional independence (which strengthens prospects for democratization).[9] The security rewards of renewable energies are manifold—for the United States as well as for other countries around the world—and far outweigh the risks. However, risks do exist. Policymakers should be both aware of these risks and proactive about addressing them. The risks vary according to the technologies and the energy sector under discussion.

Transportation Risks.

For the transportation sector, there are three primary methods for deploying renewable energies: (1) replacing gasoline or diesel with biofuels; and replacing combustion motors with electric motors, powered either by (2) hydrogen fuel cells or (3) rechargeable batteries. Each of these presents its own unique portfolio of risks.

Biofuels.

For domestically sourced biofuels, the disruption risks include those of any other crops (for example, detrimental weather and reliance on water, arable land, fertilizers, and pesticides). In a number of countries, protests have emerged against biofuel plantations. Biofuel producers must also compete for crops against other industries, such as food, clothing, or chemicals. Second generation biofuels are made either from nonfood plants or are the residual byproducts of crops cultivated primarily for nonenergy uses (such as food, energy, and chemicals). Thus, an additional risk for second generation biofuels is reliance on sufficient demand for the primary crop. Adding biofuels to a country's energy mix reduces economic exposure to oil volatility, but, unlike most renewable energy sources, biofuels are potentially subject to price variations: Unlike the wind, crops are not free.

Imported biofuels are vulnerable to the same problems as for domestically sourced biofuels, but pose additional risks—namely, risks either the same or similar to those posed by imported hydrocarbons. In short, what are the reliability considerations associated with the supplier? For long-term contracts, the supplier must manage its crops/forests in such a way that it can reliably deliver biofuels per pre-established delivery schedules. Additional factors include: Where is the supplier located? Is it an area prone to weather events? How long are the delivery routes? How stable is the supplier's political regime?[10]

Fuel Cells.

For years, fuel-cell vehicles have been off-and-on promoted as the solution for sustainable transportation, but each hype has ended in disappointment. However, several manufacturers recently displayed fuel-cell cars at international automobile shows, and Toyota projects it will have volume production of a fuel-cell car by the end of 2015. Other manufacturers, such as General Motors, have also announced the near-term introduction of fuel-cell vehicles. What makes this recent round of fuel-cell excitement more plausible is that recent technological advancements have led to reduced vehicle cost, greater efficiency, and increased driving range.[11] Even if fuel cell vehicles become more competitive, other challenges remain, such as resolving hydrogen storage issues and developing the infrastructure for supplying hydrogen (for example, in the United States only 10 supply stations are currently available). Once resolved, however, neither storage nor infrastructure would pose a risk in terms of energy security. The primary "risk" confronting low-temperature fuel cells—which are used in vehicles—stems from the need for a catalyst. At the moment, platinum is the catalyst of choice; but, it is also one of the rarest metals on earth and correspondingly expensive.

In 2012, platinum was mined in South Africa (128,000 kilograms [kg]), Russia (26,000-kg), Zimbabwe (11,500-kg), Canada (6,500-kg) and the United States (3,700-kg) with other countries producing the remaining 3,160-kg. Global sales of platinum in 2012 were 250,000-kg, with the United States consuming 167,000-kg (37 percent more than 2011), 40 percent of which went to the automobile industry, primarily for diesel catalytic converters. The difference between the mining and consumption figures is the amount of platinum gained through recycling, which accounts for a significant portion of supply each year. In 2012, for example, 35,100-kg were recovered globally from catalytic converters.[12] Global demand for platinum outstripped supply in 2012 and 2013, and 2014 is expected to be another deficit year.[13] Meanwhile, supplies from two of the three top producers, South Africa and Zimbabwe, are considered potentially unstable because of socio-economic and political risks.[14] The bright side for the United States is that, according to an expert on platinum at the U.S. Geological Survey (USGS), future prospects for domestic mining are promising.[15]

The United States currently has two operating platinum mines, the Stillwater and East Boulder mines, both located in Montana and owned by the same company, Stillwater Mining Co. (SMC). SMC is planning three production increases, scheduled to take effect by 2015, 2016, and 2017. Moreover, the Duluth Complex in Minnesota, home to the Twin Metals project and owned by Duluth Metals Limited (DML), has potential to become a major source of platinum; the most recent estimates of Twin Metals' platinum-group metals (PGMs) deposits indicate they are among the largest outside of South Africa, with indicated resources of platinum at 174,000-kg. In January 2014, DML reported that it hopes to achieve a pre-feasibility study and technical report by mid-year 2014, but provided no dates for when commercial mining might begin.[16]

According to a top hydrogen scientist, three options exist for reducing the risk of potential platinum shortages or disruptions: (1) using less platinum for the same purpose; (2) finding substitutes; or (3) switching to high temperature fuel cells.[17] At the moment, progress has primarily been made with regard to the first two risk reductions. In recent years, for example, the quantity of PGMs used in fuel cells has decreased dramatically.[18] Researchers are also working on developing substitutes. Platinum is considered an ideal catalyst because it can mediate any kind of reaction. Because a hydrogen-powered fuel cell has only one reaction, however, an all-purpose catalyst is unnecessary and research is being conducted on possible replacements. High temperature fuel cells might do away with the need for a catalyst at all, but these are currently only used for stationary applications. If they were to be used for transportation, then concerns regarding safety and public acceptance of vehicles running with motor temperatures of 800 Celsius/1,470 Fahrenheit would have to be addressed.[19]

Electric Batteries.

The third primary method is replacing combustion motors with electric motors. The main risks associated with electric vehicles are the same as those for many of the renewable energies used for electric power generation and will be covered in the next section.

Power Generation and Battery-Electric Transportation.

The primary supply risk associated with many renewable energy technologies, regardless of whether they are used for power generation, heating, lighting, or transportation, is reliance on materials that either currently or potentially face availability challenges.[20] To establish which materials are "critical" or "near critical" for renewable energy technologies, the U.S. Department of Energy (DOE) assesses two dimensions: (1) the importance of a material to renewable energy, and (2) the supply risks.[21] The most recent assessment was conducted in late-2011 and, for both the short- (0-5 years) and medium-term (5-15 years) periods, DOE's analysis indicated that the same five materials are critical: **dysprosium**, used in permanent magnets for wind turbines and in electric vehicle motors; **neodymium**, used in permanent magnets for wind turbines and electric vehicle motors, but also used in electric vehicle batteries; and **europium**, **yttrium**, and **terbium**, which are used in lighting applications. All five of these critical materials are considered REEs, which are sometimes also referred to as rare earth metals (REMs).

Rare Earths and Supply Risks.

REEs comprise 17 metals, the 15 chemical elements with the atomic numbers 57 through 71, known as the lanthanoides, plus two additional metals with similar properties that are often found with the lanthanoides. Rare earths are actually not "rare," but are found throughout the earth's crust. However, a deposit must contain a sufficiently high density of rare earths for extraction to be economically feasible. The term "rare" refers to the difficulties in isolating the individual elements; rare earths are not found in pure form, but are chemically bound to the host rock. Separating the rare earths into their individual streams is a costly, complex, and difficult set of processes—and potentially environmentally damaging. Indeed, many rare earths and the radioactive elements thorium and uranium are found together, and most rare earth mining, processing, and separating produces radioactive waste.

Rare earths are categorized as light or heavy; the light REEs (LREEs) are more easily processed and separated, and the most critical of these for renewable energy applications are neodymium and europium. The heavy RREs (HREEs) are more difficult to separate and are less common, found in only about one to two percent of all known deposits.[22] Of the heavy rare earths, the most critical for renewable energies are dysprosium, yttrium and terbium. One of the primary uses of rare earths is in permanent magnets. Rare earth magnets can withstand high temperatures, are resistant to demagnetization, and are lighter and smaller than other types of magnets, which facilitates miniaturization and reduces costs by reducing the amount of other components.[23] In addition to permanent magnets, rare earths are used in many other applications in the "aerospace, automotive, electronics, medical and military" sectors.[24]

Many countries have abundant reserves of rare earths, including the United States; however, as indicated in Table 7-1, only a handful of countries have mining operations. Even fewer countries have processing and/or separating capacities, and only China has a complete "mine-to-magnet" supply chain.

	2011 Production	2012 Production	Reserves
United States	--	7,000	13,000,000
Australia	2,200	4,000	1,600,000
Brazil	250	300	36,000
China	105,000	95,000	55,000,000
India	2,800	2,800	3,100,000
Malaysia	280	350	30,000
Other Countries	NA	NA	41,000,000
World Total (rounded)	111,000	110,000	110,000,000

Table 7-1. World Mine Production and Reserves, in metric tons of rare-earth oxide content, USGS, Mineral Commodity Summaries, January 2013.

Each rare earth deposit is unique, and the extraction process must be "custom built" to match the specific mineralogical characteristics of the deposit. Developing rare earths mines is thus technologically challenging, time consuming, and costly. It takes roughly 12 to 13 years to develop an underground mine from the initial exploration to actual production.[25] As Table 7-1 indicates, China produces most of the world's rare earths; even more important, however, is China's dominance in processing and separation, in particular for the more valuable heavy rare earths. There is reportedly only one full spectrum processing facility outside of China that **could** isolate dysprosium, Rhodia's La Rochelle plant in France (Rhodia is a subsidiary of the Solvay Group). The Rhodia plant is supposedly being reactivated and, if it was operational, could process 9,000 tons per annum (t/a) of rare earths, some of which would be heavy rare earths. But

9,000-t/a of rare earths would be insufficient to supply global demand.[26]

Mining, mineral processing (beneficiation and leaching), and separating are only part of the supply chain for permanent magnets. After the rare earths are separated, the next steps include refining the elements into metals; making the metals into alloys; and using the alloys to produce permanent magnets.[27] While companies conducting these activities exist outside of China, they rely on China for supplies. Thus, a complete, China-independent supply chain does not exist—and will take many years to create.

To achieve "safety and certainty in oil," Winston Churchill famously said, the answer lies "in variety and variety alone."[28] This axiom still holds true; not just for oil (and gas), but for any critical commodity, such as rare earths. Thus, the rare earth supply problem is not just that China's reliability has come into question in recent years, but that the United States – and other countries – are so reliant on a sole supplier.

China as Supplier.

In 1984, the Mountain Pass rare earth mine in California was the world's largest REE mine and produced 60 percent of global output. However, as China's production increased, prices fell, and the Mountain Pass mine eventually closed. Global dominance in the rare earth market shifted to China, which now produces more than 95 percent of the world's rare earths[29] and 80 percent of its permanent magnets.[30] For many years, China was considered a reliable REE supplier, but more recently problems have emerged, ranging from severe catastrophic damage from lax regulation to rogue production and smuggling to soaring domestic demand. For these reasons, among others, in 2009 the Chinese government began reducing its export quotas, causing a worldwide shockwave and skyrocketing prices. Prices have since stabilized, but have not returned to pre-crisis levels.

The issues enumerated previously could be interpreted as justifiable reasons for China to exert control over its exports. However, Chinese officials have also admitted that the export quotas were implemented in order to attract end-use industries to relocate their manufacturing to China to bypass the export quotas. In 2010, the global rare earth industry was estimated to be worth $1.3 billion, but the industries using rare earths were valued at **$4.8 trillion**.[31]

In September 2010, concerns about China's reliability as a supplier were exacerbated when China halted rare earth deliveries to Japan to exert political pressure in a dispute.[32] The reactions of importing countries to the quota reductions (and the political manipulation) fall into two categories: (1) filing World Trade Organization (WTO) complaints—in 2011, the United States, Japan, and the European Union (EU) filed a complaint—and (2) pursuing alternatives, including joint activities. In the fall of 2010, the United States, the EU, and Japan held a series of joint "Trilateral Conference on Critical Materials" workshops to discuss how to overcome potential shortages.[33] The conclusions were that non-China mining would be the quickest fix, and that research should be undertaken to find substitutes for REEs.

COPING WITH REE SHORTAGES AND SUPPLY CHAIN CONSTRAINTS

At least six approaches exist for addressing rare earth and supply chain constraints: (1) new mining outside of China; (2) capturing REEs from factory residue and consumer end-user products (recycling); (3) finding substitutes; (4) reducing the REE content; (5) stockpiling; and (6) establishing supply chains independent of China. As the DOE's analysis indicates, five REEs are considered "critical" for the next 15 years. Due to space constraints, only the material considered the most critical, *dysprosium*, will be used in specific examples.

New Mining.

In the few years since China's reliability became questionable, a global search for new sources of rare earths has been underway. Mining companies have sprung up and announcements of new finds, ranging from deposits in the seabed of Japan[34] to deposits located 150-km north of Pyongyang, North Korea,[35] seem to occur on a quarterly or even monthly basis. As rare earth mining has become a "hot" investment topic, some of these announcements should be taken with a grain of salt. Scientists have been aware of Japan's seabed deposits, for example, for decades. Moreover, discovery of deposits does not mean that the ore contains sufficient quality or quantity to be considered economically feasible. Even if the ore is promising, approximately 12 to 13 years is required to construct an underground mine. Open pit mines require less time, but pose greater environmental challenges.[36]

Mining Overseas and Offshore.

The quickest way to produce rare earths is to re-open closed mines. Thus, just as the Mountain Pass mine was re-opened, the Mount Weld mine in Australia was re-opened. However, its output was stockpiled for several years, until 2013,[37] when its sister processing and separating facility in Malaysia received a temporary processing license. The plant in Malaysia has encountered numerous problems, ranging from public opposition to the radioactive waste[38] to the death of an engineer in a work accident.

In terms of potential future sources, exploration and development assessments are underway in numerous countries, including Australia, Brazil, Canada, China, Finland, Greenland, India, Kyrgyzstan, Madagascar, Malawi, Mozambique, South Africa, Sweden, Tanzania, Turkey, and Vietnam.[39] Another potential source of rare earths is seabed mining,[40] but this is decades away from becoming a supply source.

Mining in the United States.

The United States has several sources, existing and potential, of both light and heavy rare earths. At the moment, the Mountain Pass mine in California (owned by Molycorp) is the only mine producing REEs. Molycorp re-opened the mine in 2012 and has built a new separation plant.[41] Mountain Pass has a current capacity of 15,000-million tons/annum (mt/a) with a target capacity of around 20,000-mt/a. According to a rare earths expert based in Washington, DC, although Mountain Pass reports its current capacity as 15,000 tons, no one external to the company knows their actual production; but, by interpreting the data

Molycorp does release, the expert estimated that in 2013 Molycorp's actual production was approximately 5,000-mt.[42]

Molycorp's main production will be four of the light rare earths—cerium, lanthanum, praseodymium, and neodymium—in addition to smaller amounts of samarium (LREE), gadolinium (LREE), europium (LREE), yttrium (a non-REE associated with the REEs), terbium (HREE), and dysprosium (HREE).[43] A 2013 report from the Congressional Research Service also indicates Molycorp will produce erbium (HREE).[44]

Although the Mountain Pass facility has the capacity to separate LREEs, it cannot separate HREEs, which Molycorp has been presumably stockpiling until it attains separation capacity.[45] Molycorp, however, recently purchased a company with HREE separation technologies, but as the company's CEO concedes, its HREE production occurs in China. The CEO further elaborated that the company would like to open a processing plant outside of China, potentially in the United States: "The location(s) for this processing will naturally follow growth in manufacturing demand, but my hope is that it can be located in the U.S."[46] Molycorp has announced it will eventually produce 7-t/a of dysprosium, which is exactly the amount needed to supply the U.S. military's demand for permanent magnets (the U.S. military needs 160-t/a of permanent magnets, which requires 7-t/a of dysprosium).[47] The implication is that other sources of demand for dysprosium, such as clean energy applications, cannot be supplied from Mountain Pass.

In addition to Mountain Pass, there are about 100 other sites in the United States in which rare earth mineralization has been found. However, the presence of REEs is far removed from a commercially feasible deposit. For example, in the late-2000s, the Great Western Minerals Group conducted extensive exploration and drilling at the Deep Sands site in Utah and concluded that the deposit was not economically feasible.[48] One should approach the seemingly high number of "100" with caution and be wary of claims that sites are "promising." As Great Western Minerals Group found, deeper analysis may lead to disappointment. With these caveats in mind, we turn to the handful of projects in the United States that geologists and investors consider among the most promising: Bokan Mountain, Alaska; Pea Ridge, Missouri; and Bear Lodge, Wyoming.

The Bokan Mountain site is rich in rare earths including heavy rare earths and dysprosium. Construction of the mine is expected to start in 2014, and production is projected to begin in 2017. Bokan Mountain could produce 120-t/a of rare earths; however, the dysprosium is found in hard rocks, from which there has been no production anywhere in the world up to now.[49] A second potential source of rare earths, including dysprosium, is from the closed Pea Ridge iron mine. The third location is Bear Lodge, which preliminary investigation indicates could have equivalent or greater resources than Mountain Pass.[50] In late-2013, new drilling found areas with high concentrations of heavy rare earths, including dysprosium.[51] Other sites in the United States that are under exploration include the Powderhorn, Iron Hill and Wet Mountains properties in Colorado; the Thor REE Project Area in Nevada; and the Elk Creek Project in Nebraska.

As Molycorp has stated, a drop in global prices—caused, for example, by "predatory pricing behavior" by "competitors, primarily various Chinese producers"—could "materially adversely affect our profitability."[52] Presumably, lower global prices would be disastrous for the completion or survival of the Mountain Pass mine, and this would hold most likely true for the other rare earth mines, both in the United States and abroad. Could China cause a dramatic drop in prices? Some consider it unlikely as China's own prices are rising due to higher environmental, social, and labor costs as well as higher internal consumption.[53] Whereas China used to consume 60 percent of its REE production, it now consumes more than 80 percent.[54] However, according to Dr. Michael Bau, a geologist specializing in rare earths, China has extensive stockpiles and could flood the market for a few years before it risked jeopardizing domestic demand. If prices dropped it would, as Molycorp warned, render non-Chinese mining uncompetitive and thereby encourage shifting of more of the $4.8 trillion rare earth-related manufacturing to China.[55]

In sum, concerns about Chinese supply of rare earths have stimulated exploration of other resources around the world and the re-opening of a few mines. However, optimism should be tempered, for several reasons. First, the time it takes from initial exploration of a site to the opening of an underground mine is 12 to 13 years.[56] Second, even if the mines in Australia and the United States begin extracting dysprosium in the near-term, the DOE estimates that their output would only increase supply by 10 percent, whereas demand is expected to rise substantially beyond 10 percent.[57] Third, where are rare earths from the new mines supposed to go? Processing is still a problem, as is finding metal and alloy makers:

> Therefore, even the HREE producers coming on stream in the next 2 years will have little choice but to

> sell their products to Chinese or Japanese rare-earth metal and alloy producers. There is no other location for them to go.[58]

Thus, in addition to new mining, other approaches must be pursued to address potential shortages.

Recycling.

In addition to finding new geological sources of REEs, recycling is the other method for generating additional supplies of raw materials. As the platinum discussion indicated, recycling valuable materials can contribute significantly to compensating for mining shortfalls. However, recycling rare earths is far more complicated than recycling platinum, as rare earths are, "deeply embedded into other products," which means that, "physical extraction often yields a small return on substantial effort."[59] Moreover, as rare earths are chemically alike, a similar separation challenge emerges for recycling as for the initial post-mining processing.

Although there is not yet a "standard method of recycling rare earths,"[60] research is producing incremental improvements that may lead to efficient recovery processes. In 2012, for example, DOE's Ames Laboratory announced it had found a new way to isolate rare earths from magnets. But where can vast quantities of reclaimable rare earths be found? The best candidates are the large permanent magnets used in wind turbines; for example, a GE turbine uses 200-kg of neodymium and 40-kg of dysprosium per megawatt.[61] A major drawback is that this scale of rare earths is used in the more recent generations of wind turbines, which will not be ready for recycling for many years.

In sum, despite DOE's success and breakthroughs in other laboratories, recycling is not yet considered a commercially viable alternative for **substantially** increasing rare earth stocks.

Stockpiling.

Although it is not a method for producing new supplies of rare earths, stockpiling has gained traction as a method for at least ensuring supplies in emergencies. In recent years, the U.S. Department of Defense (DoD) as well as the EU have begun stockpiling. As it is only useful for short-term shortages and cannot provide a continuous source of raw materials, stockpiling should not be considered a favored approach for addressing longer-term shortages.

Substitution.

The search for substitutes and alternatives is relatively new; for decades the focus in magnet research was on improving the efficiency of permanent magnets rather than developing new magnets. Also, rare earth magnets offer certain ideal characteristics and comparable substitutes have not been found. As DOE reports, "Magnet research has not achieved a **commercially** significant breakthrough innovation in high-energy permanent magnets since the advent of neodymium-iron-boron [permanent magnets] in the early 1980s." For example, terbium is, "the only known substitute," for dysprosium in permanent magnets, but it is, "even rarer and historically more expensive."[62]

Reducing Content.

To address shortages, one of the favored options is developing alternative technologies that reduce the content of critical materials or eliminate the need for them altogether. Manufacturers are seeking alternative technologies, but so are government entities, such as DOE and Japan's Ministry of International Trade and Industry.[63] As opposed to substitution research, new developments in reduction and elimination are announced on what seems like a relatively frequent basis. For example, Toyota has announced the development of a motor for hybrid cars that does not require dysprosium or neodymium and General Motors has announced it has reduced the quantity of dysprosium needed for the Chevy Volt.[64] Mitsubishi Electric Corp has also announced the creation of a dysprosium-free electric vehicle motor, but "concedes that the new motor is less efficient than conventional ones during acceleration but performs comparably after reaching what it calls stable speed."[65]

In sum, despite the research that has been invested into finding substitutes or reducing or eliminating critical materials, none of these options offer a commercially viable alternative that will be available on a mass scale in the foreseeable future. As one industry report indicates:

> While every effort should be expended to find new and better materials and machine designs, this is a lengthy process. Invention defies mandated timelines. The process of discovery, scale-up and commercialization can easily consume 5 to 10 years.[66]

Considering the need for rare earths in many of the advanced technologies upon which the U.S. economy depends and the lack of readily available alternatives, supply diversification will require exploiting non-Chinese deposits of rare earths—whether from the United States or other reliable suppliers. However, as has been argued, developing new sources of rare earths is only part of the solution. In addition to non-Chinese rare earths, non-Chinese permanent magnet supply chains must also be developed.

Supply Chain Development.

At the moment, the United States lacks the ability to produce sufficient permanent magnets to supply domestic consumption, a situation which the U.S. Magnetic Materials Association (USMMA) has described as a "silent crisis." But this was not true 2 decades ago. Until the 1960s, permanent magnets were a combination of iron, cobalt, and nickel. In the 1960s, U.S. researchers developed the first rare earth magnets. At its apex in the late-1980s and early-1990s, 6,000 people were employed in the U.S. permanent magnet industry; that number is now 600. Of the $8 billion global magnet industry, the United States has a tiny portion[67] and a handful of companies. In mid-2013, the USMMA released a comprehensive, but not exhaustive, list of the key players in the global rare earth supply chain from rare earth oxides, representing mining, to magnets. For the "oxides" category, only one U.S. company appears—Molycorp. Under the category "Metals, Alloys and Powders," two U.S. firms are listed—Great Western Technologies Inc./Less Common Metals and Molycorp's recent acquisition, Magnetic Material & Alloys. Under magnet manufacturers, only four U.S. firms are indicated—for samarium cobalt magnets, Electron Energy Corporation and Arnold Magnetic

Technologies; and for NdFeB magnets, Hitachi Metals and Thomas and Skinner.[68]

Several recent reports and commentaries, by the USMMA and other concerned experts as well as by U.S. Government agencies, have drawn attention to the fact that even if rare earths are mined in the United States, China still plays an integral role in the production of permanent magnets used here. The crisis may no longer be as silent, but it is still a crisis. The questions are: Should the United States develop its own supply chain? Should this supply chain be completely domestic/North American, or can non-North American companies be involved? What should be the role of government versus the role of the private sector in developing a strong U.S. supply chain?

China does not have vertically integrated "mine-to-magnet" companies, but it has had decades in which numerous companies comprising the different facets of the supply chain have become established. How can the United States compete with such a head start? Some western companies, such as Molycorp and Great Western Minerals, are acquiring companies in an attempt to create vertical integration. Although the wisdom of such an approach has been questioned,[69] this might be one of the few ways of quickly creating non-Chinese supply chains.

U.S. Government Activities.

In addition to filing WTO complaints and convening the Trilateral Conference, the U.S. Government has slowly begun to turn its attention to the risk of rare earth shortages. The Department of the Interior and DoD intensified their engagement; the White House Office of Science and Technology Policy established an Interagency Working Group on Critical and Strategic Minerals Supply Chains; and DOE established the Critical Materials Institute (CMI), which is DOE's fifth Energy Innovation Hub.[70] The CMI is spearheaded by the Ames Laboratory and integrates experts from academia, national laboratories, and the private sector, and will focus on a range of topics "from mining to separations, alloy formulations, component and systems development, and materials recycling."[71]

Policymakers in the U.S. Congress have also become active, and since 2009, 18 bills have been introduced. However, aside from the rare earth elements mentioned in the annual National Defense Authorization Acts, which are not counted among the 18, no other bills regarding REEs have been signed into law. In the 113th Congress, the following bills were introduced:

1. H.R. 761, the National Strategic and Critical Minerals Production Act of 2013, focuses on mine development, streamlining of permitting, and environmental protection. Last action: referred to Senate Committee and referred to Committee on Energy and Natural Resources, September 19, 2013.[72]
2. H.R. 981, the Resource Assessment of Rare Earths (RARE) Act of 2013. Requires the Department of the Interior (DOI) and the U.S. Geological Survey (USGS) to report on REE resources, future global supply, and on the REE "supply chain and associated processes and products, including mining, processing, separation, metal production, alloy production, and manufacturing of products sold to end users."[73] On May 15, 2013, the House Subcommittee on Energy and Mineral Resources approved the bill and sent it back to the House.

3. H.R. 1063, National Strategic and Critical Minerals Policy Act of 2013. Similar to H.R. 981, the Secretary of the Interior is required to conduct a Global Mineral Assessment of current and future mineral demand, including an analysis of the "critical minerals supply chain and associated processes and products…." The USGS is tasked to coordinate this assessment "with the heads of foreign geologic surveys when possible."[74] The last action on H.R. 1063 was March 12, 2013, when it was referred to the House Committee on Natural Resources.

4. H.R. 1022, Securing Energy Critical Elements and American Jobs Act of 2013. Provides support for "new or significantly improved technologies" for the various components of the supply chain, including (1) separation; (2) "The preparation of rare earth materials in oxide, metal, alloy, or other forms needed for national security, economic well-being, or industrial production purposes"; and (3) the application of REEs in the production of magnets, batteries and other end-use products. In March 2013, this bill was referred to the House Subcommittee on Energy.[75]

5. H.R. 1960, National Defense Authorization Act for FY2014. Focus on military access to critical materials, including rare earth substitutes. This bill was passed by the House in June 2013 and received in the Senate in July 2013.[76]

6. S. 1600, Critical Minerals Policy Act of 2013. Perhaps more than any other piece of legislation, this Act is directly concerned with "critical mineral manufacturing," which includes many of the steps identified elsewhere in this chapter as the manufacturing weaknesses of the United States, specifically, the Act refers to "the production, processing, refining, alloying, separation, concentration, magnetic sintering, melting or beneficiation of critical minerals within the United

States."[77] In October 2013, this bill was introduced and referred to the Committee on Energy and Natural Resources.

Prior to 2013, the bills primarily dealt with promoting mining and exploration and conducting assessments. As the short descriptions of the 2013 bills indicate, the focus is not just on exploration and mining, but also on improving the U.S. supply chain. This indicates that the silent crisis is indeed becoming less silent.

CONCLUSION

The main objective of this chapter was to delineate the risks and rewards of renewable energies. The chapter began by explaining how replacing hydrocarbon sources of energy with renewables could help grant the United States greater freedom of movement in international affairs. From a security perspective, this is the prime reward of renewable energies. The security risks arise from potential supply disruptions, ranging from the political instability of foreign suppliers (biofuels and platinum for fuel-cell vehicles) to inclement weather (biofuels) to foreign monopolies of critical material supply chains (rare earths and permanent magnets).

Because of the importance of rare earths and rare earth permanent magnets to a wide variety of applications, such as lighting, solar panels, wind turbines, electric vehicle motors and batteries, an additional objective of this chapter was to clarify several misconceptions that have contributed to widespread muddled thinking by the media, policymakers, and analysts about the "rare earth problem."

First, not all rare earths are the same: Some, such as dysprosium, are more valuable and difficult to produce, than others. Thus, when one speaks of changes in demand for rare earths, one should be very careful about **which** rare earths one is speaking. Second, despite the focus on finding new deposits of rare earths, new sources would solve neither short- nor medium-term shortages; the time required from initial exploration to production of an underground mine is roughly 12 to 13 years. Third, research into recycling, substitution, and content reduction is still in its infancy and, thus far, no silver bullets have been found. Fourth, as long as one country, China, possesses the only complete "mine-to-magnet" supply chain—processing, separating, metal making, alloy making, and magnet manufacturing—rare earths mined elsewhere must be imported into China before they can be used. Fifth, in addition to not having a complete supply chain, the United States lacks adequate infrastructure, intellectual capital, and technological know-how.[78]

By misunderstanding the nature of the problem, the extent of our reliance on one supplier and the lack of alternatives, one risks either ignoring the problem or chasing the wrong solutions. A January 2014 article in *The Wall Street Journal* titled "How the Great Rare-Earth Metals Crisis Vanished"[79] exemplifies the former. The author seems to think the problem is not a lack of diversification and reliance on one supplier, but the potential for China to use rare earths as strategic pressure. Even more troubling, however, are the author's assertions that demand is declining and that new exploration combined with new developments in recycling and content reduction have resolved the crisis. As this chapter demonstrated, it is important to know which rare earths are in greater demand or are more critical and to be aware of the time factor. Exploration, recycling, and content reduction might **eventually** help diversification, but when? Most likely not within the short- (0-5 years) to medium-term (5-15 years) time periods of criticality identified by DOE.

As this chapter outlined, U.S. policymakers and government departments have become more active on the rare earths front—perhaps they are awakening to the extent of U.S. vulnerability and the complexity of the issue. However, the measures pursued seem too meager and none of the proposed legislation, aside from the annual National Defense Authorization Acts, has heretofore been signed into law. Clearly, legislation supporting the U.S. rare earth industry needs stronger advocacy. Exploration and mining needs to be supported – but so do the industries in the rest of the permanent magnet supply chain. Furthermore, the country's intellectual capital needs to be improved. In short, the United States needs to educate and train a new generation of scientists, engineers, and technicians, who could be encouraged through measures such as scholarships and rewards.

The U.S prosperity has, in large part, been built on its technological prowess. Without realizing it, however, the United States has become heavily reliant on one country, China, for materials that are critical for many advanced technologies in a wide variety of industries. Now that China's supply situation has changed, the United States must also change. In addition to mitigating risks, the United States could accrue additional benefits. If the United States could offer more of the rare earth value chain, then it might be able to attract some of the rare earth-related manufacturing, valued at $4.8 trillion, which China seems to be targeting by restricting rare earth exports. If the United States does not act, it loses this opportunity. Moreover, the crisis might not just be silent, but also disastrous.

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CHAPTER 8

THE EVOLVING GLOBAL NUCLEAR INDUSTRY LANDSCAPE AND THE STATUS OF THE U.S. NUCLEAR INDUSTRY

Jane Nakano

Only a decade ago, the nuclear industry in the United States was buoyant about what appeared to be the imminent onset of a nuclear renaissance in the country and around the world. As recently as 2009, one industry estimate suggested that the world would build 180 nuclear power reactors by 2020—a significant increase over the approximately 40 reactors that had been built between 1999 and 2009.[1] However, a combination of the availability of low priced natural gas, the weak energy demand due to the economic slowdown, and the fierce competition in the post-Fukushima global nuclear marketplace have dampened commercial prospects for the U.S. nuclear industry. The state of the industry may also render some national security implications for the U.S. Government.

OVERVIEW OF THE GLOBAL NUCLEAR POWER CAPACITY

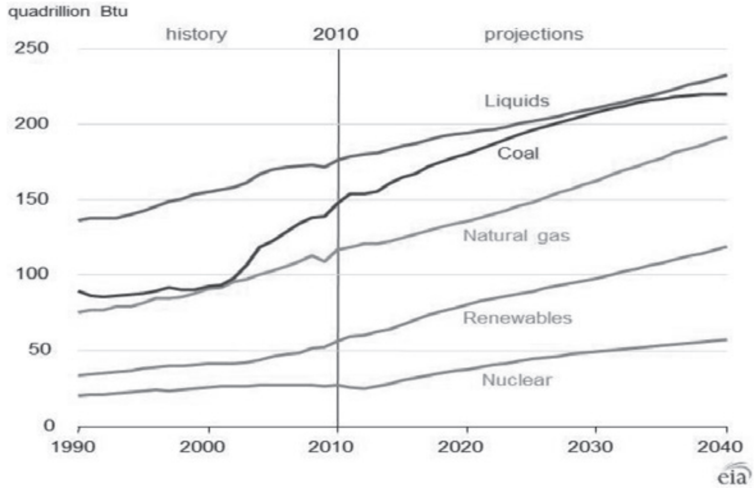
Today, there are roughly 440 nuclear power generating reactors around the world, providing 370 gigawatts (GWe)—equivalent to 14 percent of the world's electricity supply. According to the forecast by the International Atomic Energy Agency (IAEA), the forecast future share of nuclear power in the total power generation has been declining since before the 2011 Fukushima accident (Figure 8-1), where the earthquake-triggered massive tsunami incapacitated the power supply and led to core melt-downs in three of the four operational reactors at the Fukushima Daiichi Nuclear power station.

Publication Year	2030		2050	
	Low	High	Low	High
2005	418-GW (8.0%)	640-GW (8.9%)	n/a	n/a
2010	546-GW (8.5%)	803-GW (10.4%)	590-GW (5.0%)	1,415-GW (11.9%)
2012	456-GW (4.7%)	740-GW (6.2%)	469-GW (2.3%)	1,137-GW (5.7%)
2013	435-GW (4.5%)	722-GW (6.2%)	440-GW (2.2%)	1,113-GW (5.6%)

Source: IAEA data as organized by the author.

Figure 8-1. IAEA Forecast for Nuclear Generation Capacity Growth (in gigawatts) through 2030 and 2050 and their Shares (in percentage) of Total Electricity Generation.

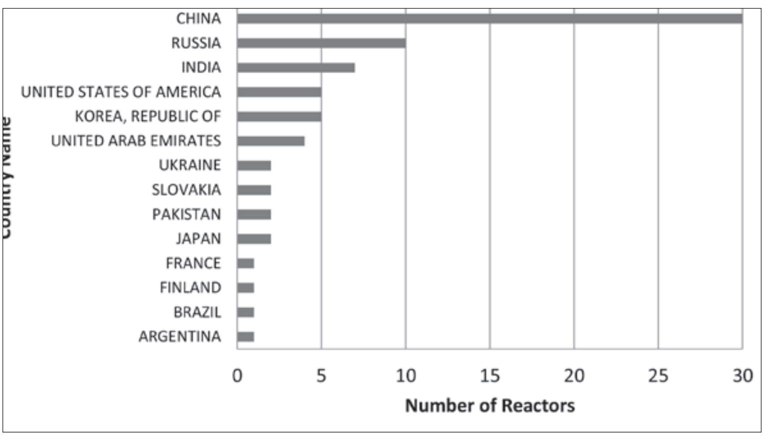
Although the same IAEA forecast indicates that the Fukushima accident has put downward pressure on the pace of forecast generation capacity growth—that is, the capacity growth in 2030 has been revised from 546-GWe in the 2010 forecast to 435-GWe in the 2013 forecast,[2] the 2013 forecast level is still clearly higher than the generation capacity today. In fact, nuclear energy is still projected to be one of the fastest-growing sources in the global primary energy consumption mix between 2010 and 2040 (Figure 8-2).[3]



Source: U.S. Energy Information Agency, Washington, DC.

Figure 8-2. World Energy Consumption by Fuel Type, 1990-2040.

Much of the capacity growth in the coming decades will come from developing economies, especially those experiencing rising energy consumption driven by economic and population growth as well as modernization and/or urbanization trends. In fact, developing countries will lead the total global energy consumption growth in the coming decades. For example, the energy consumption by countries that are *not* part of the Organization of Economic Cooperation and Development (OECD) will grow at 90 percent through 2040; in contrast, the energy consumption by OECD countries is at 17 percent and the global average is at 56 percent.[4] Not surprisingly, most current reactor construction and planned expansions in the near future are occurring in non-OECD countries, especially in non-OECD Asia and Eastern Europe. For example, 40 percent of the approximately 60 nuclear reactor construction projects are in China today, followed by Russia and India (Figure 8-3). Both China and Russia have ambitious plans for the expansion of their nuclear power programs. For example, China plans to expand its installed capacity to 58-GWe by 2020, up from 13-GWe today. As for Russia, where 10 reactors are currently under construction, the country plans to increase the nuclear power generation capacity by 50 percent by 2020, bringing the share of nuclear energy in the total electricity supply to between 23 and 25 percent.[5] Meanwhile, uncertainty is on the horizon for the South Korean nuclear power program. In the wake of a scandal that involved falsification of safety certificates for nuclear reactor parts, which led to the indictment of over 100 people in October 2013, the Korean government revised down the targeted share of nuclear power in the country's power generation capacity mix, from 41 percent to 29 percent by 2035.[6]



Source: World Nuclear Association data as organized by the author.

Figure 8-3. Global Nuclear Reactor Construction.

Nuclear energy may remain viable even in Western Europe, but mainly through the extension of operational life for existing nuclear reactors. For example, in 2012, Hungary's nuclear regulatory agency approved a 20-year extension of reactor lifespan.[7] Also, French state-controlled utility EDF is lobbying for the regulatory approval to extend the lifespan of its reactors beyond 40 years.[8] Additionally, in Belgium, which in the aftermath of the Fukushima nuclear accident decided to begin phasing out nuclear power, the government is reportedly considering extending the lifespan for one of its reactors in efforts to mitigate potential power supply shortage.[9]

As for Japan, the Fukushima nuclear accident has drawn scrutiny to the state of its nuclear power sector governance, including the soundness of the country's regulatory system generally, and the crisis management capability of the central government. This has led all of the nuclear reactors in the nation to remain offline as of December 2013, as local government leaders have not allowed plants shut for routine maintenance to reopen for business. The Basic Energy Plan, issued by the Japanese government in April 2014,[10] recognized the importance of nuclear energy in the national energy mix, but its pre-Fukushima vision to rely on nuclear energy for roughly half of the total power generation by 2030 has become anything but realistic.

THE STATE OF THE U.S. NUCLEAR INDUSTRY

Euphoria surrounding the coming onset of the nuclear renaissance has since been significantly toned down in the United States. There have been, however, some positive developments for the U.S. nuclear sector in the recent years. First, in February 2012, the U.S. Nuclear Regulatory Commission (NRC) issued the first combined construction and operation license since the major regulatory reorganization several decades ago following the Three Mile Island nuclear accident in 1979. The license issuance for the construction of two Westinghouse AP-1000 reactors at the Vogtle site in Georgia was quickly followed by the licensing for two more AP-1000 reactors at the V.C. Summer site in South Carolina. Combined with the Watts Bar 2 in Tennessee, the nation now has five nuclear reactors under construction. The four AP-1000 reactors—each expected to cost between $5 billion and $7 billion[11]—are scheduled for completion between 2016 and 2019. All of the stakeholders in the nation's civilian nuclear energy program—ranging from policymakers, reactor component manufactures, and environmental organizations—are carefully watching whether the projects will be completed on schedule and under budget. The Vogtle and V.C. Summer projects will indeed serve as a litmus test for the viability of the U.S. nuclear industry in the coming decades.

Second, the Obama White House support for the development and deployment of small modular nuclear reactors (SMRs) remains intact despite the Fukushima nuclear accident. SMRs refer to a category of nuclear reactors whose power generation capacity is generally smaller than 300 megawatts (MWe), but its technologies are otherwise diverse, including light water reactors, high-temperature reactors, as well as fast reactors. Because SMR parts can be built at various factories across the country or around the world, and brought to the site for assembly, SMRs are believed to have a smaller up-front capital requirement and thus economic advantage over conventional size reactors.

The size of the upfront investment is particularly appealing to U.S. utilities. Unlike cohorts in many other countries, the U.S. power sector is comprised of over 3,000 electric utilities and their average financial capacity is quite small—certainly not large enough to comfortably undertake the nearly $10 billion commitment commanded by the construction of an average 1,000+ MWe nuclear reactor.

The U.S. nuclear industry is now focused on SMRs as a pathway to reverse its declining fortunes and to maintain its global competitiveness. Of the few U.S. manufacturers working to develop SMRs today, the mPower design by Babcock & Wilcox (B&W) (180-MWe pressurized water reactor [PWR]) and NuScale SMR design by NuScale (45-MWe PWR) both won a public-private cost-sharing grant from the U.S. Department of Energy (DOE). The $452 million grant, announced in January 2012, aims to help support the development, design certification, and licensing process for up to two SMR designs over 6 years. In its Fiscal Year (FY) 2014 budget request, DOE asked for $70 million, $3 million above the FY2013 funding level, to provide technical support for SMR licensing.[12] B&W has thus far received $101 million for the mPower project, including an initial grant of $79 million.[13] As for NuScale, the amount of the DOE grant is still to be negotiated out of the $452 million fund (as of December 2013). Moreover, DOE supports SMR demonstrations by essentially providing venues for demonstration reactors. In March 2012, DOE signed agreements to allow three companies to build demonstration reactors at DOE's Savannah River site in South Carolina: a 25-MWe fast reactor by Hyperion, a 140-MWe PWR by Holtec, and a 45-MWe PWR by NuScale.

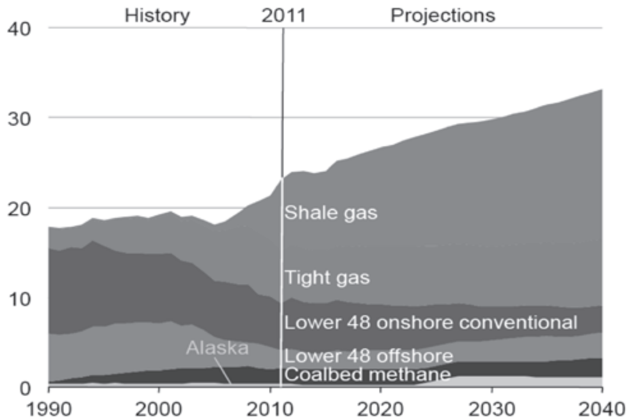
Some industry observers caution that the lower cost is only an estimate and unproven, and note that SMRs may not necessarily be cheaper unless they are produced and deployed in significant quantities. Others also note that there are many regulatory uncertainties and security considerations, such as the requirement for operational room design and staffing as well as physical protection requirements for multiple, smaller reactors at one site.

Meanwhile, the U.S. nuclear industry faces two critical challenges. First, the management of high-level spent nuclear fuel continues to be a key concern in the Congress and in the White House. The United States is essentially committed to an open fuel cycle—that is, no reprocessing of spent fuel—without political consensus on the permanent repository location. In order to manage the country's growing stockpile of nuclear waste, Congress passed in 1982 the Nuclear Waste Policy Act (NWPA) to establish a statutory basis for DOE to dispose of highly radioactive nuclear waste. According to the NWPA, DOE would remove spent nuclear fuel from commercial nuclear power plants, collect a fee from nuclear power providers, and transport it to a permanent geologic repository or an interim storage facility before permanent disposal. Following the designation of Yucca Mountain in Nevada as the sole candidate site for the repository in 1987, DOE has performed detailed site characterization studies and issued a formal finding of suitability for the site in 2002.

In 2008, DOE submitted a license application for a high-level waste repository to the Nuclear Regulatory Commission (NRC). Under the administration of President Barak Obama, however, the Yucca Mountain project has been deemed unviable for the permanent storage of nuclear waste. No funding was provided for continued work on design and development of the repository at Yucca Mountain in FYs 2011, 2012, and 2013. Nor was there funding requested for FY2014 to continue NRC licensing of the Yucca Mountain repository.[14] Following the federal court order in early-2013 that DOE halt collecting nuclear waste fees from utilities that aimed to build a disposal facility site for highly radioactive nuclear waste in the absence of active pursuit of the siting effort, DOE suspended the collection in May 2014. The fund had collected about $30 billion to date. Spent fuel management continues to be a highly political and divisive issue.

The second key challenge to the U.S. nuclear power sector is the availability of competitively priced natural gas due to the successful development of shale gas resources. A confluence of factors—including technology advancements, expertise, infrastructure, investments and property/mineral rights—unlocked the commercial potential of what had been long known to exist underground. Shale gas production increased at an average annual rate of 48 percent between 2006 and 2010, and growing shale gas production has essentially reversed the declining level of U.S. domestic natural gas production. Today, shale gas accounts for about one-third of domestic natural gas output in the United States (Figure 8-4). Various forecasts suggest that the share may grow to about 50 percent by 2040.

U.S. Dry Gas Production, Trillion Cubic Feet per Year.



Source: *Annual Energy Outlook*, Washington, DC: U.S. Energy Information Administration, 2013.

Figure 8-4. Growing Share of Shale Gas in U.S. Natural Gas Production.

Natural gas has become a base-load fuel for electricity production in the United States, and is beginning to challenge the economic viability of nuclear power as well as coal power generation. In 2013, four U.S. nuclear reactors permanently closed: Crystal River Unit 3 in Florida, Kewaunee plant in Wisconsin, and San Onofre Units 1 and 2 in California. The factors that drove the early retirement of the Kewaunee plant which in 2011 had its operational license renewed for additional 20 years, included low natural gas and regional electricity prices. The additional early retirements that loom large include the Vermont Yankee plant that is licensed to operate until 2032 but is now scheduled to shut down in 2014, and the Oyster Creek plant in New Jersey that has an operational license until 2029 but is now expected to retire by 2019. Both retirement decisions cited to a varying degree the competition from natural gas. In the most recent forecast by the U.S. Energy Information Administration, the share of nuclear energy will decline from 19 percent in 2012 to 16 percent in 2040 in the total U.S. power generation mix.[15]

RISING COMPETITION IN THE GLOBAL NUCLEAR MARKETPLACE

There are several key trends globally that offer continual challenges for the U.S. nuclear industry. In addition to shifting interest in nuclear power generation from mature to developing economies, as illustrated in the last section, several trends in the supply side of the global nuclear industry point to a competitive landscape for the U.S. nuclear industry. The first is the emergence of several new suppliers. The global supplier landscape was shaken up when the South Koreans won a contract to supply four reactors to the United Arab Emirates (UAE) in December 2009. The UAE tender had been viewed as a test case for nuclear energy expansion in the Middle East and the South Korean consortium competed fiercely for a contract alongside major suppliers from France, Japan, and the United States. Against expectations on the part of most market analysts that the contract would be awarded to AREVA of France, the Korean consortium landed the deal, dealing a major blow to its more established competitors. With assistance from its subsidiaries and other Korean companies like Doosan Heavy Industries, Samsung, and Hyundai, the Korea Electric Power Company significantly underbid its competitors, in the estimated range of $20 to $30 billion.[16] The offer entailed a full scope of work and services, including engineering, procurement, construction, nuclear fuel and operations, and maintenance support.[17] The Korean offer strongly implied that longer-term commercial interests, as opposed to more immediate financial gains, drove the bid formulation.

Another rising nuclear reactor supplier today is China. As part of its latent civilian nuclear power program development,[18] China has emphasized building capabilities to establish a fully integrated domestic supply chain—including "indigenous" nuclear fuel fabrication, self-reliance on design, and project management—with the objective of exporting next-generation nuclear technologies to a global marketplace. However, the technological reality has long lagged behind such aspiration. Prior to the Fukushima nuclear accident, reactors of older designs accounted for roughly half of the units under construction and many on order in China.[19] While the design itself may not be deficient, the older models lack many advances that now come with newer generation reactors—the so-called Generation III or III-plus—that are being built by western suppliers today. If deployed today, the Generation II reactors developed in the 1960s would be about a century behind leading technologies. In fact, the Chinese projects at the Chashma site in Pakistan involve Generation II reactors.

The 2007 purchase of Westinghouse AP-1000 reactors significantly boosted the technology base for the Chinese nuclear reactor industry. The sale of AP-1000 reactors included a technology transfer agreement that has allowed China's State Nuclear Power Technology Corp (SNPTC) to acquire over 75,000 technology transfer documents.[20] Bilateral commercial cooperation between the United States and China seems to be on the rise. For example, SNPTC and Shanghai Nuclear Engineering Research & Design Institute are now developing an AP-1000-based reactor with Westinghouse; the Chinese are eager to begin exporting these advanced PWRs later this decade.[21] Additionally, in May 2013, Westinghouse and SNPTC announced a joint venture to develop and deploy Westinghouse technology-based SMRs. Reportedly, the first overseas sale of the advanced Chinese reactor design is on the horizon. China is believed to be in the final phase of negotiating a sale of two ACP-1000 reactors to Pakistan, considered Generation III and said to be developed independently by Chinese suppliers.[22]

Another key trend is that successful export deals increasingly include features such as fuel provision, plant operation, and spent fuel management. A case in point is Russia's successful effort to win the contract to build Vietnam's first commercial nuclear power plant at Phuoc Dinh. The Russian bid included a guaranteed loan for the construction, the nuclear fuel, and the removal of spent fuel for reprocessing. Another creative marketing deal by Russia is its 2010 agreement with Istanbul to build, own, and operate four reactors at the Akkuyu site in Turkey, which is another new entrant into the world of nuclear power generation. Although the spent fuel take-back is not without controversy among the Russian public, export models like "build-own-operate" are reportedly peaking interest among Chinese suppliers. The trend to offer nearly a complete chain of nuclear power generation business—or the so-called "cradle-to-grave" approach—is a direct reflection of the lack of various capacities among new entrants. The pursuit of a nuclear power program requires more than the acquisition of hardware like nuclear reactors or the ability and means to procure fuels. These creative export deals attempt to compensate for new entrants' lack of such key capacities as regulatory and operational expertise, and spent fuel management.

In this regard, the absence of a spent fuel solution has handicapped the U.S. ability to expand its business in emerging markets. Additionally, in countries like France, Russia, and South Korea, where the domestic nuclear sector has one dominant manufacturer and utility, the nuclear export business is closely incorporated into industrial policy and government export advocacy carries a stronger undertone of sovereign guarantee. The notion of sovereign guarantee is particularly attractive to new entrants as nuclear power generation requires much more than reactor construction, such as the uninterrupted access to nuclear fuels.

Nuclear export is hardly a purely commercial endeavor. Aside from nonproliferation considerations that are by definition not commercial, many countries weigh noncommercial factors like geopolitics in reviewing tenders. For example, energy security through fuel and supplier diversification was one of the key drivers for Lithuania's interest—pre-Fukushima, that is—in a U.S.-Japan tender, since Vilnius had long sought to reduce its significant reliance on Russian natural gas. Also, the Czech consideration of both the U.S.-Japan and Russian tenders for the Temelin project carried some geopolitical undercurrent in that the Czech public generally favors the Westinghouse bid due to continued animosity toward Russia and out of reluctance to raise its energy dependence on Russia; meanwhile, the Czech business community was inclined to favor the Russian bid due to its promise of greater use of local content and labor force.[23]

CONCLUSION

The onset of competitively priced natural gas and declining domestic energy consumption, driven in part by a slowing economy and rising energy efficiency, have increased the difficulties the U.S. nuclear industry faces in its domestic market. Additionally, its prospects for overseas expansion are just as challenged, given the emergence of new suppliers and the growing synergy between the needs of new market entrants and the nuclear export features that are more readily possible in state-led export business models. Some questions loom large for national security policymakers as the U.S. nuclear industry may continue to struggle. First, will the stagnant industry base for manufacturing and exporting reactors and components diminish the relevance of the U.S. voice at international nonproliferation fora and institutions? In other words, is there a correlation between the competitiveness of the U.S. nuclear industry and the U.S. Government's ability to set the agenda and lead efforts in the area of nuclear nonproliferation? Second, does the struggling U.S. nuclear industry negatively affect the ability of the U.S. military to recruit talent for its nuclear-related programs? In other words, to what extent do job prospects in the civilian nuclear power sector influence one's occupational decision-making in the military services? Finally, what is the net impact of the emerging commercial engagement between The United States and China? Technology cooperation between the United States and China, two countries that have nuclear weapons, may not directly constitute a proliferation concern since China is a nuclear weapons state. Also, technology cooperation may help advance the safety standards for reactor operations in

China. Meanwhile, aside from the high eventuality of intense commercial competition between the U.S. and Chinese nuclear industries, may the technology cooperation and/or transfer inadvertently undermine U.S. national security objectives? Will China demand of potential supplier countries the high level of safety and security commitments the United States does? Neither answers nor solutions seem readily in sight for these questions.

ENDNOTES - CHAPTER 8

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14. Holt, p. 1.

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18. Although the Chinese government approved the country's first nuclear power plant decades ago in 1982, the sector only began to see dramatic acceleration during the 10th Five-Year Plan (FYP, 2001-05), when China launched a concerted expansion of its nuclear sector and constructed four reactors.

19. China's post-Fukushima safety plan calls for new reactors being built to meet safety standards of "third-generation" reactor technology, and the much stricter standards for new nuclear construction under the latest nuclear safety plan may accelerate interest in switching its fleet profile away from older designs to next-generation designs.

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CHAPTER 9

CHINA'S BURGEONING DEMAND AND ITS QUEST FOR RESOURCES

Michal Meidan

Since its reform and opening up in 1978, China's economic growth has skyrocketed on the back of sustained industrialization and urbanization, leading to a highly resource-intensive growth pattern. Government intervention in pricing and resource allocation has created imbalances in supply and demand and allowed for wasteful consumption that has also taken a high environmental toll on the country. Moreover, politically powerful energy conglomerates operating in a fragmented bureaucratic framework have shaped the contours of China's energy policy, both internally and overseas.

The Chinese government clearly recognizes that China's growth model must change, but under the leadership of President Xi Jinping and Premier Li Keqiang, policies to accelerate change in the economic growth model and resource allocation have risen to the top of the political agenda: Environmental degradation has become a growing source of public consternation and a potential political liability, leading Premier Li Keqiang to declare a "war on pollution" in March 2014. As a result, the government is looking to reduce emissions from power generation and transportation—the main culprits of China's "airpocalypse"—by replacing coal and oil with gas.

China's continued dependence on oil and rising demand for gas, that it will be incapable of supplying wholly from domestic sources, will sustain a high dependence on imported resources. With China's domestic oil production stagnating, the International Energy Agency (IEA) expects its import dependence ratio to reach 80 percent in 2030.

Over the past 2 decades, Beijing has made efforts to diversify its sources of imported oil, but it has only managed to tinker at the margins with its heavy reliance on the Middle East and Africa. As demand for imported oil and gas continues to grow, China's global exposure will also increase, and supply security will remain a prominent feature of China's energy strategy and its foreign policy calculus. Yet, China has neither the intention nor the capacity to safeguard its interests worldwide. Moreover, China is not ready to assume the U.S. role as provider of public goods such as freedom of navigation in international waters, or to secure the stability of producer countries. This chapter will assess these evolutions and their implications for the U.S. military.

CHINA'S ENERGY SECTOR: UNSUSTAINABLE AND UNCOORDINATED

Since the beginning of reforms and opening up in 1978, China's economy has grown at a staggering pace, with annual average rates of 10 percent. With industry and construction representing the lion's share of growth, China's economic rise has been highly energy-intensive.[1] In absolute terms, this has meant a six-fold increase in total energy consumption in China, from just over 400 million tons oil equivalent (MTOE) in 1980 to over 2,800-MTOE in 2013, as well as a substantial increase in China's share of global energy demand. In 2013, China accounted for almost a quarter of global energy demand, up from a mere 6 percent in 1980. Its share of Asian demand has also increased considerably, from 35 percent in 1980. In 2013, China accounted for more than half of Asia's energy consumption.[2]

On the eve of China's 12th Five-Year Plan (FYP, 2011-15), China had already become the world's largest energy consumer. It was also the world's largest coal producer and consumer, accounting for half of global coal consumption. While this has allowed Beijing to maintain a high degree of energy self-sufficiency, it has also afforded it a prominent position in the global ranking of carbon dioxide (CO2) emitters. Since 2009, Beijing has also become the world's second largest oil consumer, behind the United States, with oil consumption growth accounting for a third of global demand growth in 2013.[3]

China also has the second largest gas reserves in the Asia-Pacific region. But demand growth has already outstripped production and China became a net natural gas importer for the first time in almost 2 decades in 2007. Imports have increased dramatically in the past few years, jumping from a 12 percent share of total gas consumption in 2010 to 30 percent in 2013.[4]

Despite the growing importance of energy issues, the country's bureaucracy has consistently lacked the capacity to manage the energy sector effectively. China's energy administration has undergone numerous waves of reshuffling that resulted in authority being carved up between multiple institutions, most of which are understaffed and underfunded. In the absence of a strong regulatory institution, coordination across industries and ministries has been spotty, frustrating the formulation, implementation, and enforcement of energy policies.[5] This has also resulted in an outsized role for China's state planning agency, the

National Development and Reform Council (NDRC) as well as for the national oil companies (NOCs) in policymaking.

Despite various attempts to administer the sector, China's NOCs retain considerable power and avenues to influence policymaking. Their political power is derived from their origins as government ministries and the influence those ministries once held over the policymaking process, and, as a result, the general managers of China's NOCs also have direct access to the country's senior leadership.[6] There are also personal connections and strong patronage ties linking the heads of the oil companies to ministers and Politburo members[7] that China's new leadership is trying to sever with high-level anti-corruption campaigns involving the energy sector.[8]

The Chinese leadership is acutely aware of the problems plaguing the Chinese energy system. Reforms over the years have included pricing schemes, changes in the bureaucratic makeup, ministerial reshuffles, and attempts to rein in the power of the oil companies.[9] Yet, many of these inefficiencies remain unresolved, and the adaptation of the policy framework continues. In line with this, the FYP aims to address the imbalances and inefficiencies of the energy system and the Chinese economy more broadly.

THE FYP: A NEW ENERGY MODEL?

The FYP lays out ambitious targets aimed at reducing China's reliance on coal, cutting greenhouse gas emissions, and mitigating severe environmental degradation. The plan includes targets of reducing energy intensity per unit of gross domestic product (GDP) by 16 percent, cutting carbon intensity per unit of GDP by 17 percent (40 to 45 percent by 2020), and having nonfossil fuels account for 11.4 percent of the primary energy mix (15 percent by 2020).[10]

The government is making progress on boosting industrial efficiency and implementing more stringent environmental standards that will, nonetheless, lead to slower economic growth rates. But Beijing's assessment that the cost of inaction is higher than the risks associated with reform has led it to introduce a more aggressive environmental agenda[11] and expedite industrial consolidation plans in the aluminum, steel, and construction sectors in a bid to reach China's FYP goals.[12]

As Beijing looks to cap coal consumption, demand for renewable energy will increase in the medium to long term, but until the government sources enough renewable energy to manage this transition, gas demand will continue to rise. Beijing is looking to increase the share of gas in the country's energy mix from 3.9 percent in 2010 to 8.3 percent in 2015.[13] In order to supply this projected increase in domestic demand, the government plans to spur production of unconventional gas, especially shale gas and coalbed methane (CBM). But this is a long-term endeavor and in the coming 5 to 7 years, China will still rely heavily on imported gas.[14] As a result, in 2015, even as China's energy mix will likely comprise a greater share of renewable energy and coal, imported oil and gas will become increasingly significant contributors to China's overall energy use.

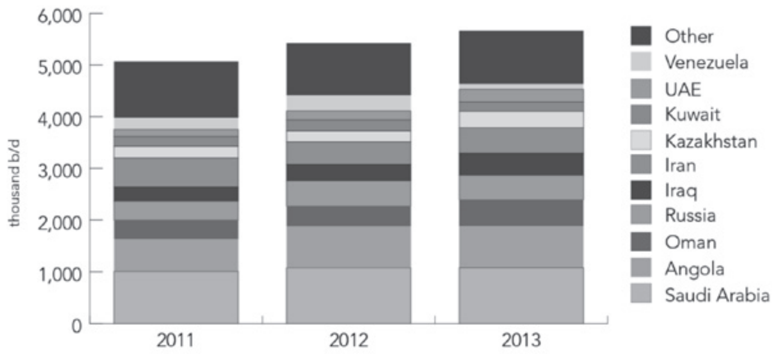
While projections of China's economic growth rates and energy demand vary widely, most "business as usual" scenarios, which assume relatively strong economic growth rates of roughly 7 to 8 percent and significant energy efficiency gains, suggest China will remain a major contributor to global energy demand.[15] BP estimates that over the next 20 years, China and India combined will account for all the net increase in global coal demand, 94 percent of net oil demand growth, 30 percent of gas, and 48 percent of the net growth in nonfossil fuels.[16] Gradually, nuclear and renewable energy will take up market share from coal in China. BP's estimates suggest that in 2030, coal's share of the total energy mix will fall from 70 percent to 55 percent as a result of the maturing industrial structure. But oil's share of consumption will remain flat at 18 percent in China. As overall energy consumption continues to rise, albeit at a slower pace, the International Energy Agency (IEA) expects China's total oil demand to rise to 12 million barrels per day (mbpd) in 2020 and 15-mbpd in 2030, up from 10-mbpd in 2011.[17]

Output from China's domestic oil resources is stagnating, and in 2012 the country reached a 56 percent import dependency ratio.[18] The IEA expects this ratio to reach 80 percent in 2030.[19] China will therefore remain heavily dependent on Middle Eastern and African oil transiting through the Straits of Malacca. Moreover, China's dependency on foreign gas is also set to increase in the coming 5 to 10 years, despite the country's promising shale potential and political commitment to developing it.

OIL INSECURITY VS. GAS INDEPENDENCE?

Already, China's ravenous demand for oil imports has gone from a mere 60,000 barrels per day (bpd) in 1993, to 5.6-mbpd in 2013, with roughly two thirds coming from the Middle East and Africa.[20] Indeed, despite Beijing's efforts to diversify its sources of imported oil, it has only managed to tinker at the margins with its heavy dependence on the Middle East and Africa and remains dependent on six countries for the bulk of its supplies: Saudi Arabia, Angola, Iran, Russia, Oman, and Sudan. Ongoing efforts to upgrade China's refining capacity will allow it to gradually process a larger variety of crudes domestically and increase its intake of oil supplies from a wider number of countries, including heavy oil from Ecuador, Venezuela, and Canada as well as a greater variety of Middle Eastern crudes.

In the future, China's shale potential could alter the country's energy landscape, akin to the U.S. shale revolution, but in the short and medium term, prospects for significant shale output in China remain dim.[21] In the meantime, demand for imported oil and gas will continue to grow, and supply security will remain a prominent feature of China's energy strategy and its foreign policy calculus. Consequently, Beijing has been looking for ways to mitigate the risk associated with heavy dependence on global markets and use it as an opportunity to propel its oil companies to become internationally competitive firms. See Figure 9-1.



Source: Chinese customs.

Figure 9-1. Chinese Oil Imports by Country.

Alongside growing import demands, Chinese firms have increased their investments in the global oil upstream. Promoted by their desire to become internationally competitive and save their profits from hefty domestic taxation and from losses incurred in the domestic downstream due to price controls, China's national oil companies have ventured overseas.[22] Their quest for equity oil around the world was only cautiously approved initially, but after 2 decades of overseas investments, it is now supported and encouraged by various government organs.[23]

CHINA'S GLOBAL ENERGY FOOTPRINT

Since the 1990s, China's international energy profile has changed significantly. It is now a major factor for global markets with variations in demand growth in China having ripple effects around the world. China is an important actor in the international upstream. Its appetite for producing assets, even in politically volatile countries, has raised concerns about its desire to work with unsavory governments, but has at the same time, generated more output. Linkages with other producers and consumers are also rapidly evolving. With a more diverse economy, rising environmental constraints, and new supplies available, Chinese investments in upgrading its downstream creates opportunities for the biggest producers within the Organization of Petroleum Exporting Countries (OPEC), which are gradually looking to China as their largest future growth market. As China hopes to secure supplies, global oil producers are also looking to secure demand and are becoming increasingly drawn to China's insatiable appetite for oil.

But Beijing's interactions with the global markets have not placated decisionmakers that the markets will ensure supplies. Beijing still views supply security as a major strategic vulnerability, a point that it has been reminded of all too often over the last decade, from the Iraq war in 2003 that Beijing believed to be a pure and simple quest for resource hegemony by the United States, to the Arab Spring and the turmoil in Libya in 2011 that led China to airlift home tens of thousands of Chinese workers. Aware of the numerous vulnerabilities it is exposed to, Beijing is trying to diversify its supply sources as well as its supply routes. It is hoping to reduce its dependence on maritime transportation by building cross border pipelines: An oil pipeline through Burma, that is expected to become operational in May 2013, will allow Beijing to reduce oil flowing through the Straits of Malacca. Additional pipelines from Central Asia and Russia are also conducive to Chinese efforts to hedge the risk of concentration.[24]

CHINA'S ELUSIVE SUPPLY SECURITY STRATEGY

Despite this, the IEA estimates that by 2030, China will be highly dependent on Iraq for oil imports,[25] and, while the Chinese government recently issued a goal of capping import dependency at 61 percent of total oil consumption,[26] there is an implicit recognition that China's oil security is inherently linked to the availability of global supplies. Moreover, pipelines through Myanmar, Central Asia, and Russia will reduce the amount of oil shipped by sea, but will not offset the fundamental reality that the Straits of Malacca will remain a potential choke point for Chinese imports.[27]

For China's oil companies, this presents an opportunity. With the leadership still concerned about supply security, the strategic need to gain access to resources tallies well with the NOCs' desire to become globally competitive firms, to gain access to knowhow and technologies, and acquire new assets in order to offset their declining assets at home.[28] Initially, in the early stages of China's global oil hunt, the "going out" policy, the government approved overseas investments reluctantly. But over time, the idea of creating national enterprises that could be competitive internationally gained ground. This coincided with growing concern about rising oil imports, and resulted in an expression of support for what the NOCs were already engaged in.

Government attitudes shifted from reluctant to approval to active support of overseas investments which involved supporting deal-making through high level visits, extending credit lines to the NOCs, or simplifying approval procedures for investments. Yet, the NOCs' overseas ventures have had limited success when measured both in commercial terms (profitability) and in political terms (supply security).[29] Indeed, Chinese sources estimated that, by the end of 2010, roughly two-thirds of Chinese oil companies' $70 billion in overseas investments were loss making. Moreover, only five million tons (100,000-bpd), one-twelfth of its overseas output, was shipped back to China, suggesting that these ventures did not afford Beijing greater security.[30]

The only example of state support to overseas deals that also resulted in supply security is China's energy-backed loans. While the NOCs expanded their investments into Bolivia, Brazil, Ecuador, Kazakhstan, Turkmenistan, and Venezuela, they also secured long-term oil and gas supplies through the loans-for-resources deals, backed by Chinese policy banks.[31] Moreover, these investments diversified the NOCs' supply sources outside of Africa, though they failed to reduce meaningfully China's reliance on the Middle East.

Some of the efforts by the NOCs to acquire producing assets overseas have, however, been successful. By acquiring Addax in June 2009, Sinopec was able to add producing assets and reserves in West Africa and Northern Iraq's Kurdish region. But each of these deals also exposed the NOCs' weakness in assessing political risk, as the acquisition had the additional result of irking Baghdad and preventing Sinopec's access to the Iraqi market.[32] Sinopec's peer and rival, CNPC, managed to establish a foothold in Iraq, with support from the government. Since 2009, it has won three contract bids and gained rights to develop the Rumaila and Halfaya areas with international partners such as BP, TOTAL, Turkish Petroleum, and Petronas. In 2008, CNPC also successfully resumed a contract for developing the Al-Ahdab oil field, which it had negotiated in 1997 under the pre-war Saddam Hussein regime. CNPC is the only NOC or international oil company (IOC) to have managed this renegotiation.[33]

Over the years, the Chinese NOCs have found themselves on a steep learning curve overseas: They have faced issues related to worker safety (in Nigeria, Ethiopia, and Sudan), political risk (CNOOC's failed takeover of Unocal and its highly contentious bid for Nexen), and regime change. When competing overseas, without the oligopoly status they have in China, they must operate more like IOCs. Backing from the Chinese government is not a universal solution to the problems of investing in other countries. Cooperation with other NOCs or IOCs has proven to be crucial for the NOCs to enter into many unfamiliar host countries and to reduce risks in their investments. This was particularly the case in 2009 when Chinese NOCs joined with other partners to participate in bidding rounds in Iraq. Bidding in partnership diversified the risk for each company in a highly risky and politically unstable country. Moreover, partnering with IOCs has allowed them to gain technical know-how and streamline their managerial capacity. China's NOCs have pursued expertise in deep-water exploration and in liquefied natural gas (LNG) through such partnerships.

When seeking new sources of supply close to home that will allow China to fill its ravenous appetite for energy, the South China Sea is becoming an increasingly attractive potential resource. As Chinese firms gradually acquire more sophisticated deep-water exploration know-how, their ability to explore for oil and gas in the South China Sea increases. Moreover, the NOCs now have a political window of opportunity to place exploration in the South China Sea on the political agenda, as tensions in Asia mount and there is greater willingness in Beijing to defend more assertively the country's diplomatic and economic interests. In the context of President Barack Obama administration's "pivot" to Asia and its reaffirmation of the U.S. economic and security commitment to Asia, Asian governments from Manila to Hanoi have become more willing to push China on long-standing territorial disputes in the South China Sea. China has tended to respond very forcefully to such provocations,[34] thereby strengthening Southeast Asian states' desire to reinforce Washington's strategic presence in the region and their security alliances with the United States.[35]

Beijing's top leadership likely seeks to avoid any confrontations or instability in the South China Sea throughout sensitive leadership transition periods. But Beijing must balance its desire for stability on the one hand with its need to maintain credibility on sovereignty issues in the face of increasingly hawkish and nationalistic voices on foreign policy on the other. Ongoing negotiations over a joint code of conduct in the South China Sea are unlikely to rectify these dynamics. Meanwhile, increasingly nationalistic sentiment in all the countries involved makes any real concessions that could pave the way for a long-term solution difficult in the short and medium terms. Even though China's new leadership is in the initial stages of consolidating power, these dynamics seem unlikely to change. The statements made in November-December 2012 were likely to have been approved, if not endorsed, by the incoming leadership. Moreover, Xi Jinping has, reportedly, since September 2012, been guiding China's maritime more closely.[36]

IMPLICATIONS FOR THE U.S. MILITARY

China's new leadership, under the guidance of the 12th FYP, is working to change China's energy consumption model and reach ambitious energy efficiency and carbon reduction goals. But even if they meet their targets, oil and gas are still likely to account for roughly a quarter of Chinese energy consumption. With declining domestic oil output and a shale revolution that is likely to take over a decade to emerge, China will remain dependent on imported oil and gas. For all its attempts to purchase assets, "lock in" resources, reduce reliance on maritime transports, or secure sea lanes of transportation, no strategy, as Beijing and its companies are learning, is infallible. The reality remains that much of the oil and gas that is vital to China's economic growth will continue to be produced in volatile countries, traded on international markets, and flow through the Straits of Malacca.

Even as traders in China may become increasingly savvy with global trading mechanisms, some leaders' hawkish views of supply insecurity, especially in light of the mistrust between Washington and Beijing, will continue to justify state support for energy security. The NOCs, as well as the Chinese navy, that seek additional financial support for their own parochial goals, will continue to feed these perceptions.

Southeast Asia inevitably finds itself in the midst of these dynamics. The South China Sea will become increasingly important in the Chinese calculus both as a transit point and as a source of oil and gas, especially since the NOCs do not need to pay royalties for resources produced there. While Beijing is unlikely to endorse unilateral exploration activities in contested areas, the recent geopolitical dynamics do not bode well for a negotiated code of conduct, and tensions could remain high.

Greater quantities of LNG will also transit through Southeast Asia, and, as the Asian gas market develops and becomes more liquid, Singapore could become an important regional trading (and pricing) hub. So while energy trade dynamics could very well bring Southeast Asia and China closer together, geopolitics will continue to drive a wedge between them. As China's neighbors look with growing concern at Beijing's growing assertiveness, they will seek to deepen and bolster their ties with Washington in pursuit of implicit or explicit military guarantees.

Further afield, as Chinese energy imports link it more closely to the Middle East, the country will be drawn into the complexities of regional geopolitics. Energy ties with Saudi Arabia, Iraq, and Iran, combined with competition from other oil producers for shares of the Chinese market (such as Kuwait and the United Arab Emirates) could lead to deeper engagement across the region. Israeli gas exports to Asia (an unlikely scenario at this point) could add another energy partner into the mix.

But China has extremely limited incentives to get more involved in regional politics. Looking back at the past 2 decades of its involvement in the Middle East, Chinese diplomacy has been skillful at avoiding the pitfalls of power politics and maintaining commercial ties, thereby also reaching consensus and catering to the interests of numerous Chinese stakeholders. A reassessment of China's Middle East policy is probably already underway, but this is in response to increasing economic risk more broadly and not just energy security. The Arab Spring, the conflict in Libya, and the need to airlift Chinese citizens, combined with the subsequent criticism of this move in China, probably provided the main trigger for this reassessment. The outcome of the internal debate is therefore likely to factor in all of China's economic interests in the region, as well as its long-standing political connections and will probably include a desire for greater scrutiny over outbound investments and better mechanisms to deal with risk. Put simply, it will generate caution rather than boldness. Those hoping to see Beijing shoulder more of the burden in the Middle East will be disappointed by an increasingly cautious Chinese foreign policy there.

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CHAPTER 10

THE CHANGING CALCULUS OF INDIA'S ENERGY SECURITY

Tom Cutler

India's growing demand for energy and its quest for energy security impact U.S. national interests in a variety of ways, ranging from energy policy to trade and investment, to clean energy technology and climate change, and to geo-politics and military strategy. Energy considerations were at the center of the transformation of the Indo-U.S. strategic relationship in 2005 with the announcement of the civil nuclear deal and its signing after 3 years of negotiation in 2008, and since then, cooperation in clean energy has been a driving force in taking the Indo-U.S. energy relationship to a new level. Looking ahead, it appears that Indian concerns about its energy security, including its desire to import U.S. liquefied natural gas (LNG), will come to the forefront as its growing import dependence and America's growing energy self-sufficiency change the calculus of India's energy security. This changing calculus will have important implications for U.S. military planners.

Although slowing, India's annual economic growth rate of around 8 percent in recent years has fueled dramatic increases in its demand for energy. Even though its per capita energy consumption is only about one-third of the global average, India is now the world's fourth largest energy consumer.[1] India's demand for energy is expected to double over the next 20 years, supplied by growing consumption of high-ash, coal-fired power and increased imports of oil, natural gas, coal, and uranium. Given the sheer scale of India's energy needs—based in part on the fact that it will become the world's most populous nation sometime in the 2020s—it seems inevitable that India's growing demand will have regional and global impacts of military significance.

The Asian Development Bank (ADB) projects India's economy to grow at a rate of 5.7 percent annually through 2035, while energy demand will grow at a much slower rate, 2.7 percent per year. Most of this demand will be driven by the transport sector, which relies on oil for 93 percent of its total energy needs. However, coal will remain the dominant fuel in India, accounting for a 43 percent share of all energy used by 2035. Oil will have a 25 percent share while the biggest jump will be for natural gas, growing at 4.8 percent annually to reach an 11 percent overall share of demand by 2035. Meanwhile, hydro-power will be about 2 percent and nuclear just under 4 percent, with renewables accounting for the rest of commercial demand. Although noncommercial fuels such as firewood and animal waste have long been a staple of India's actual overall consumption of energy, the migration of the country's population from rural areas to urban cities and other factors will lessen its share over time.

During this time frame, imports of oil, gas, and coal will increase significantly as domestic production fails to keep up with demand. India's import dependence from 2010 to 2035 for each of the primary fossil fuels is as follows: Dependence on coal doubles from 16 percent to 33 percent, oil jumps from 76 percent to 92 percent, and gas, mostly LNG, grows from 20 percent to 36 percent.[2] Most of these imports will come by sea, which adds naval dimensions to India's supply vulnerability, and is the crux of India's energy security challenge.

OIL IMPORT VULNERABILITY CENTRAL TO ENERGY SECURITY

The Middle East accounts for about two-thirds of India's oil imports, with Saudi Arabia having the largest share at around 20 percent. New Delhi is making efforts to diversify its supply sources and has reached out to countries such as Angola, Nigeria, and Venezuela for supplies despite the much greater distance. Another aspect of its supply security strategy is for Indian state oil companies to acquire equity stakes in overseas production projects on the premise that this will provide a reliable supply stream. Meanwhile, sanctions against Iran have proven to be a dilemma for Indian refiners as they are a natural market for Iranian crude. However, they have taken steps to reduce their off take and have been able to obtain waivers from the United States to purchase lower volumes and still be in compliance with U.S. law.

The International Energy Agency (IEA) forecasts that India's demand for oil will grow faster than that of any other nation between now and 2035, and its market size will exceed that of Japan's before 2020.[3] In an effort to increase its domestic production of oil from current levels of around 850,000 barrels per day (b/d) to satisfy consumption of about 3.5 million-b/d, India has courted large American oil and gas companies to invest in its upstream oil sector. But for the most part, the companies have shied away from bidding on Indian exploration blocks due mainly to uncertainty about price controls and government supply allocation, concerns that were reinforced by the experience of Reliance in marketing natural gas from its huge discovery in the Krishna-Godavari basin off India's east coast in 2002.

Downstream, India's refinery sector took on new significance in 2011 when it became a major net product exporter. Large refinery complexes have been constructed, notably the Reliance refinery at Jamnagar, Gujarat, which is conveniently located near crude suppliers in the Persian Gulf. Mostly privately owned, the refining sector is a major foreign currency earner for India and includes some world-class facilities whose market reach has included providing gasoline to the U.S. East Coast. India is well positioned to be a supplier of fuel to the U.S. military, which could shorten supply lines and minimize the oil supply vulnerability of U.S. forces deployed in the region.[4] However, it should be pointed out that India's growing appetite for oil will likely relegate it to being a net product importer in the next decade or so.

A most important step in safeguarding India's oil security was the decision in 2005 to establish a strategic petroleum reserve, initially 37 million barrels at three locations to provide a few weeks supply.[5] The U.S. Department of Energy (DOE) provided some technical assistance during this process as did the IEA whose out-reach program to nonmember countries such as India and China has played an important role in helping assure global cooperation in the event of an oil market emergency. Although India is not eligible to become a member of the IEA because it is not a member of the Organization for Economic Cooperation and Development (OECD), it is in the U.S. interest that, as an emerging major oil importer, its actions be coordinated with the IEA in the event of an emergency, including oil stock drawdowns and implementation of the IEA's oil sharing scheme. To that end, India and the IEA have conducted a number of joint activities, including seminars on oil stocks and joint emergency response simulation exercises, and in October 2011, they signed a Memorandum of Understanding (MOU) for "Cooperation in Oil and Gas Security." These efforts will enable the development of Indian policy doctrine governing the deployment of its strategic stockpile to be informed by IEA principles.

WHAT THE GOLDEN AGE OF GAS MEANS FOR INDIA

India's natural gas demand has nearly doubled from 2004 to 2011, as gas is seen as a clean alternative to coal in the power sector. Natural gas plants account for 10 percent of India's total electricity generation capacity, but many of them sit idle due to nonavailability of gas. A further 8,000 megawatts (MW) of newly completed gas-fired power plants are not being commissioned due to the gas shortage. While the demand for gas depends upon the financial viability of the power sector to pay for the fuel, efforts to secure affordable gas from proposed gas pipeline projects from Bangladesh and Iran have floundered for political reasons. At present, India is pursuing possible gas supplies from the proposed Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline project. New Delhi signed gas supply contracts with Turkmenistan in May 2012, but it is unclear if the project will come to fruition.

India began to import LNG in 2004, even though it was more expensive than domestically produced gas. It currently has three receiving terminals in operation and plans are moving forward to bring more facilities on stream and to import increasing amounts of LNG. India currently gets most of its LNG from Qatar, and beginning in 2014 from Australia, plus purchases on the spot market. Access to American-sourced LNG has emerged as a top priority for the Indian government as evidenced at the June 2012 meeting of the U.S.-India Strategic Dialogue when the Indian government made a high-level formal request for guaranteed supplies of LNG. Although U.S laws regulating the approval process for LNG exports to non-Free Trade Agreement countries such as India could not be changed without an act of Congress, the DOE export review process has produced positive results. India's Gas Authority of India, Ltd. (GAIL) already has gas supply contracts in place for two of the first four LNG export projects which have received conditional approval by DOE—the Cheniere Sabine Pass project and Dominion Resource's Cove Point project.

India has also been moving to exploit its unconventional gas reserves, but there is no expectation that shale gas will be the game changer it has become in the United States. Nevertheless, firms such as Reliance and GAIL have invested in U.S. firms exploring and producing unconventional gas to acquire technology and expertise.

New Delhi's quest for natural gas supply security also includes encouraging increased U.S. LNG exports in general on the premise that relatively inexpensive U.S. gas might result in lower world LNG prices. In April 2013, Indian Ambassador to the United States Nirupama Rao wrote an op-ed in *The Wall Street Journal* that concluded that increased U.S. LNG exports and Indian investment in the U.S. shale gas sector "will further consolidate our strategic ties."[6]

COAL IS STILL KING

Despite the growth in natural gas use, coal is still king in India. Coal accounts for half of India's energy consumption and is the energy source for two-thirds of its generation of electricity. Nevertheless, in spite of having the fifth largest coal reserves in the world and being the world's third largest producer, India imports increasing amounts of coal. This trend is adding a new dimension to India's energy security.

The inability of state-run Coal India Ltd., to operate efficiently and an assortment of regulatory obstacles and environmental hurdles have meant there is not enough domestic coal to satisfy demand. Domestic price controls force the state coal monopoly to sell coal below market prices and deter additional production. Rail and other infrastructure bottlenecks cause delays and shortages. Government controlled electricity prices force many coal-fired power plants to operate at a reduced capacity using domestic coal supplies, or at a loss using expensive imported coal. Insurmountable political resistance to opening up the sector to private firms has left India no choice but to import increasing amounts of higher priced foreign coal, about 142 million metric tons in 2012. Indonesia and South Africa are primary sources, while the United States exported nine million tons of coal to India last year. This trend reinforces the notion that importing energy fuels from the United States is becoming an increasingly important component in the formulation of Indian energy security.

THE CRISIS IN POWER PERSISTS

India will never become a global superpower so long as it is beset by persistent shortages of electricity. An estimated 25 percent of its population lives without any access to electricity and lifting these hundreds of millions of people out of poverty is a major national priority. India has set ambitious targets for additional power generation capacity from fossil, nuclear, and renewable sources but the country currently has a 10 percent peak load deficit, fuel shortages, and high transmission losses. The Indian government has made slow progress in getting new power plants built or upgrading the grid as the sector is not financially viable. Indian politicians win votes by offering free electricity to farmers and low-income citizens, forcing state-owned electricity distribution companies to absorb over $37 billion in losses per year, leading to power cuts and blackouts during peak demand.

To meet growing demand, India is trying to increase its renewable power generation capacity. Plans call for additional hydropower plants (currently 21 percent of total capacity), and nuclear plants (currently about 3 percent of total capacity). India's Jawaharlal Nehru National Solar Mission hopes to add 20,000-MW of on-grid solar and 2,000-MW of off-grid capacity by 2022. India's installed wind capacity was 14,158-MW in 2011, and there is still considerable room for growth as the country has an estimated onshore wind potential of 65,000-MW. However, one of the setbacks in promoting wind power has been market-distorting government tax incentives that rewarded investment in wind power but not its actual operation.

Although renewables will never play a big enough role in India's energy mix to make it energy self-sufficient, improved energy efficiency could make a big difference. As the Indian economy continues to develop, there is tremendous potential for game changing savings to be realized through improved energy efficiency, especially in buildings.

To realize this potential and other opportunities on both the supply and demand sides of the equation, the ADB estimates that India will need $2.3 trillion in investment in its energy sector by 2035.[7] However, India will have to improve its investment climate and do a better job of applying market-based pricing in its energy sector if it is to attract the capital it needs. This will be hard to accomplish. Plus, as the sector is modernized new energy security threats will emerge. For example, the deployment of smart grid technologies will only heighten the risk of cyber threats to the reliability of its energy infrastructure.

TOO MANY KEY PLAYERS IN INDIAN ENERGY POLICYMAKING

India's approach to energy governance relies upon a decentralized institutional structure that can complicate policy formulation and render policy implementation difficult. The IEA recommends that "India should overhaul its current patchwork of energy policies in favor of a comprehensive clear-cut policy," as there is no central Ministry of Energy at the national level.[8] Instead, there are five main separate ministries with primary energy responsibilities: the Ministry of Power, the Ministry of Coal, the Ministry of Petroleum and Natural Gas, the Ministry of New and Renewable Energy, and the Department of Atomic Energy. In addition, the Ministry of Environment and Forests has a major impact upon the energy sector because it can block or delay energy projects, while the Ministry of External Affairs has its own energy security division.

The high level Planning Commission is also a key player. It plays an overarching role in energy policymaking, among its other economic policy responsibilities and seeks to facilitate coordination among the various ministries. The Planning Commission prepares the Integrated Energy Policy and the Five Year

Plans that are the key policy frameworks used by the Government of India. There is also the National Action Plan on Climate Change, which is composed of eight "Missions," including the Jawaharlal Nehru National Solar Mission and the National Mission for Enhanced Energy Efficiency. However, implementation of these and other energy policies frequently depends upon actions by the states which have important legal authorities and jurisdictions, especially in relation to electric power, and this adds another layer of politics to India's energy landscape.

U.S.-INDIA CLEAN ENERGY COOPERATION: A BRIGHT SPOT

Energy cooperation between the United States and India has evolved significantly over the years. One key development in recent years has been the U.S.-India Energy Dialogue, led on the U.S. side by the DOE and on the Indian side by the Planning Commission. This Dialogue functions as a coordinating mechanism for cooperation designed to enhance energy security, promote increased energy trade and investment, facilitate the deployment of clean energy technologies, and support the safe use of civil nuclear power. Activities involving a number of different U.S. Government agencies have included energy resource assessments; technical exchanges regarding civil nuclear power; site visits to the U.S. Strategic Petroleum Reserve; and workshops on clean coal technology, fiscal and regulatory regimes for oil and gas exploration, the deployment of renewables, energy efficiency programs, and scientific research on gas hydrates oil stock. This cooperation rose to a new level in November 2009 when Prime Minister Manmohan Singh met President

Barack Obama in Washington, and the two leaders signed an MOU between the Government of India and the Government of the United States of America to Enhance Cooperation on Energy Security, Energy Efficiency, Clean Energy, and Climate Change.

Out of this MOU was borne a new initiative to advance clean energy research and deployment entitled the Partnership to Advance Clean Energy (PACE). It is implicitly based on the premise that if two countries cannot agree on the politics of climate change then perhaps they can at least cooperate in the science of clean energy. PACE includes a research component featuring the establishment in November 2010 of a Joint Clean Energy Research and Development Center, which is a 5-year, $125 million initiative to sponsor joint research in solar energy, energy efficiency in buildings, and second generation biofuels.[9]

Amid all this positive collaboration is the festering issue of India's Local Content Restrictions on imported solar photovoltaic cells and modules, which, if not properly managed, could escalate into a mini-trade war. This state of affairs, where there is joint scientific research simultaneous with trade frictions in the area of solar power, is one of several ironies and paradoxes in U.S.-India energy relations.

THE UPS AND DOWNS OF U.S.-INDIAN CIVIL NUCLEAR COOPERATION

India's civil nuclear sector has 19 reactors operating which provide just under 4 percent of the nation's power supply. Although it was the U.S. Agency for International Development (USAID) that helped India build its first commercial reactor at Tarapur in 1969, India has since developed an essentially indigenous program that has become a source of great pride after having been ostracized following its first test of a nuclear weapon in 1974. Although it has modest reserves of uranium, India has large reserves of thorium, and so it has embarked upon a long-term, three-stage program using indigenous pressurized heavy water reactors and foreign supplied light water reactors with the goal of developing a thorium fuel cycle for advanced reactor designs, including Fast Breeder Reactors. Despite the nuclear power plant disaster at Fukushima, India is soldiering onward in its nuclear development to increase its generating capacity from about 5 gigawatts (GW) now to 60-GW by 2030, and has several reactors under construction of both domestic and Russian design.

Because it is not a signatory to the Nuclear Non-Proliferation Treaty, a key development for India was the signing of the Peaceful Uses of Nuclear Technology Agreement (123 Agreement) in 2008, known as the Hyde Act. This led to India's acceptance into the Nuclear Suppliers Group restrictions in 2008, essentially based upon an exception whereby it would separate its military weapons programs from its civil nuclear activities. However, if the measure of success is genuine commercial opportunities for U.S. firms, then the civil nuclear deal has yet to fulfill its expectations. Although India has designated sites in Gujarat for Westinghouse and in Andhra Pradesh for George Eastman House, a key obstacle to commercial progress has been its lack of clear liability laws for nuclear damage consistent with the Convention on Supplementary Compensation.

Other problems in administering provisions of the 123 Agreement, in nuclear security cooperation, and in other areas of scientific collaboration, have contributed to a high level of frustration, with the United States feeling certain segments of the Indian establishment are trying to undermine the deal, while some in India feel the United States has shifted the goal posts. What both sides do agree on is that India has not been a proliferator of nuclear materials, and that there is a desire for nuclear peace amid their frictions with neighboring—and nuclear weapons capable—Pakistan.

SOUTH ASIA REGIONAL ENERGY INTEGRATION CRUCIAL TO FUTURE ENERGY SECURITY

India's energy footprint dominates South Asia, where the considerable potential for intraregional trade in natural gas, hydro-power, and electricity remains unrealized. The precarious state of Pakistan's energy sector represents an unpredictable threat to India's interests if Pakistan were to destabilize under the weight of its energy woes.[10] In his assessment of South Asia's looming energy crisis, Charles Ebinger has warned:

> The region's governments can no longer solve their energy problems in isolation. There is no choice but to look outward for much of the energy their countries will need over the coming decades. To that end, the most egregious decision by governments throughout the region has been their willingness to allow political disputes and rivalries to overshadow the potential 'win-win' economic benefits of energy collaboration. Long term energy security is simply unattainable without intraregional and interregional cooperation.[11]

The U.S. Government has recognized this need and sought to bring the parties together to promote greater regional integration and cross-border trade, notably through USAID's South Asia Regional Initiative-Energy. Looking outward from South Asia, one cannot ignore India's geographic location astride the sea lanes in the Indian Ocean, where 70 percent of the world's oil trade, 60 percent of LNG, and 70 percent of coal trade is transported, and where some predict the United States, India, and China will inevitably compete for blue water dominance.[12] Indeed, the most important military implication of India's growing energy needs is its increased reliance upon sea borne trade in energy and uncertainties regarding the future U.S role as a guarantor of safe passage.

CONCLUSION

It is in the U.S. interest for India to be energy secure. But India faces many difficult challenges and its leadership will be under increasing pressure to satisfy its growing energy needs.[13] There are issues where the United States can be helpful and issues where it cannot. Many of the solutions to India's energy challenges require domestic political will on the part of policymakers in New Delhi. Controversial issues such as the adoption of true market pricing and privatization of key energy para-statals are all subject to the vagaries of India's vibrant democratic process. But as imports rise, India can no longer insulate itself from the supply fluctuations and price volatility of world energy markets, and it will need to develop strategic alignments and expand its universe of international cooperation to ensure its energy security. As an emerging energy supplier and as a key partner of India with a number of proven bilateral mechanisms for energy cooperation already in place, the United States is poised to forge even closer civil and military ties to enhance mutual energy security.

ENDNOTES - CHAPTER 10

1. *International Energy Outlook*, Washington, DC: U.S. Energy Information Administration (EIA), 2013. The EIA's reference case forecasts 2013 consumption to rise from 26 quadrillion British thermal units (BTUs) to 49 quadrillion BTUs in 2035.

2. See "Asian Development Outlook 2013: Asia's Energy Challenge," Manila, The Philippines: Asian Development Bank, 2013, pp. 261-267.

3. *World Energy Outlook*, Paris, France: International Energy Agency, 2013, p. 504.

4. Sourcing fuel from U.S. territory is not always the best way to secure supplies for U.S. forces operating in distant regions. See Tom Cutler, "Myths of Military Oil Supply Vulnerability," *Armed Forces Journal*, July 1989.

5. India is setting up strategic crude reserves at three locations—Visakhapatnam, Mangalore, and Padur. Although the existing sites have yet to become operational, India has already announced plans to expand these reserves significantly. See "India Country Analysis," Washington, DC: U.S. Energy Information Administration, March 18, 2013.

6. Nirupama Rao, "India is Ready for U.S. Natural Gas," *The Wall Street Journal*, April 8, 2013.

7. As quoted in *The Economic Times of India*, October 14, 2013. See also "Energy Outlook for Asia and the Pacific," Manila, The Philippines: Asian Development Bank, October 2013, pp. 261-267.

8. Sun-Joo Ahn and Dagmar Graczyk, "Understanding Energy Challenges in India: Policies, Players and Issues," Paris, France: International Energy Agency, 2012, pp. 7-9.

9. There is also a major PACE program in deployment. See Progress Report on the "U.S.-India Partnership to Advance Clean Energy (PACE): An Initiative of the U.S.- India Energy Dialogue," Washington, DC: U.S. Agency for International Development (USAID), June 2013.

10. Michael Kugelman, "Pakistan's Energy Crisis: From Conundrum to Catastrophe?" Seattle, WA: National Bureau of Asian Research, March 13, 2013.

11. Charles Ebinger, "Energy and Security in South Asia: Cooperation or Conflict?" Washington, DC: Brookings Institution Press, 2011, p. 11.

12. Robert Kaplan, *Monsoon: The Indian Ocean and the Future of American Power*, New York: Random House, 2010, pp. 5-11.

13. India defines its energy security in two main ways: affording access to energy for the hundreds of millions of impoverished people who do not have access to electricity; and in terms of security of supply, especially imports. The environment and the energy-water nexus are also concerns. The ADB developed an Energy Security Index based upon 20 indicators across a range of energy factors; India ranked second worst out of 18 Asia-Pacific countries, ranking only above Myanmar. "Asian Development Outlook 2013," p. 64.

CHAPTER 11

ENERGY DEMAND IN THE DEVELOPING WORLD

Deborah Gordon

The 2010s generally found energy demand leveling off in developed countries and taking off in the developing world. Between 1970 and 2010, global energy demand doubled and shifted from the developed to developing regions. The aggregate share of energy consumption in the countries that comprise the Organization for Economic Cooperation and Development (OECD) shrank significantly from 60 percent to 41 percent, off a much larger base, as seen in Figure 11-1. The countries and regions that grew their energy consumption the most over the past 40 years included China, the Middle East, Asia, and Africa.

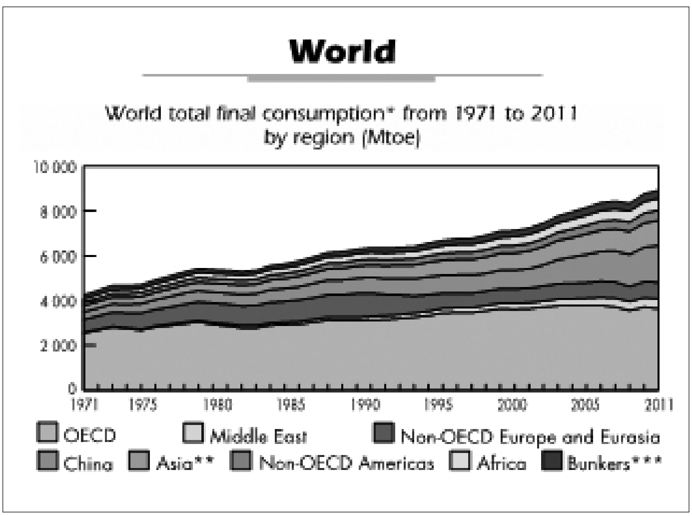
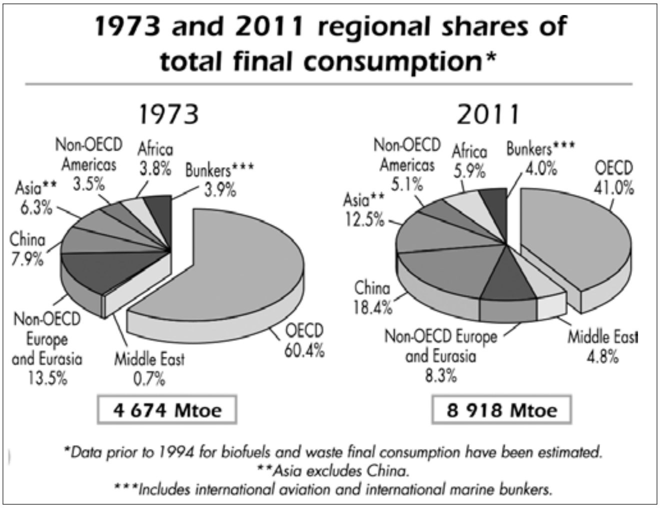


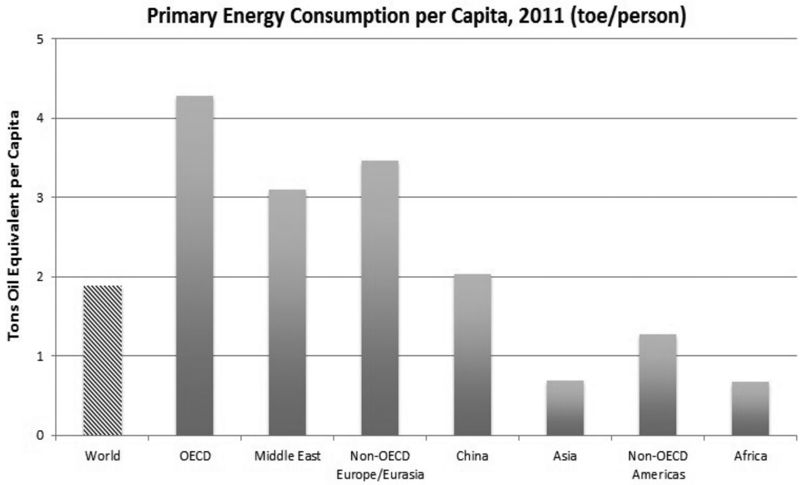
Figure 11-1a. Global Energy Consumption.



Source: *2013 Key World Energy Statistics*, Paris, France: International Energy Agency (IEA), available from *www.iea.org/publications/freepublications/publication/KeyWorld2013_FINAL_WEB.pdf*.

Figure 11-1b. Global Energy Consumption.

Future growth trends are expected to continue in this direction, with energy demand expanding faster in the developing world. This should not be surprising. The OECD nations ranked well above average in global per capita energy demand and most of the developing nations are situated below the bar as seen in Figure 11-2. This creates a powerful impetus for less-developed nations to catch up. As the citizens in the developing world become more affluent this will drive greater modernization and mobility. These trends, in turn, will increase energy consumption more rapidly in developing nations.

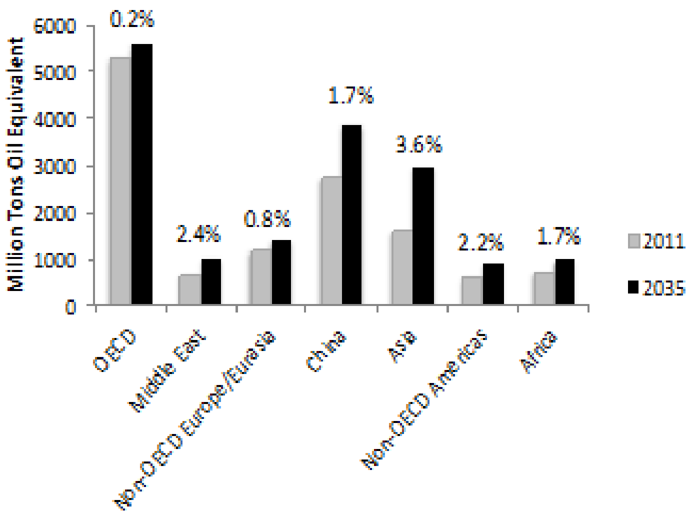


Source: Author's image; IEA, 2013 *Key World Energy Statistics*.

Figure 11-2: Per Capita Primary Energy Consumption, 2011.

PROJECTING FUTURE TRENDS

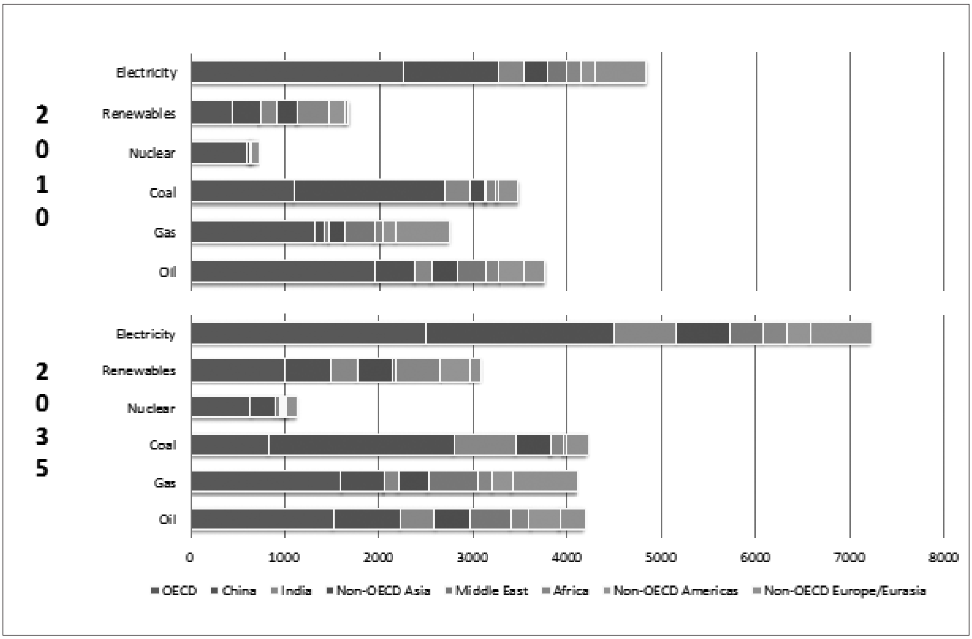
According to the International Energy Agency (IEA), between 2011 and 2035, world primary energy demand is projected to increase at an average annual rate of 1.3 percent. The OECD countries are expected to grow more slowly than the rest of the world, as seen in the annualized growth rates noted earlier, each of the bars in Figure 11-3. While the OECD countries currently consume more energy than the countries of any other region, starting in 2025, it is anticipated that Asia in its entirety (including China) will demand more energy than the OECD nations combined. The global share of energy consumed in the OECD is projected to contract from 40 percent to 32 percent through 2035, continuing a downward trend that began in the later part of the 20th century. China, India, Brazil, Indonesia, the Middle East, and Africa are among the developing nations and regions that are expected to experience the most rapid growth in energy demand in the years ahead.



Source: Author's image; IEA, 2013 *Key World Energy Statistics*.

Figure 11-3: Growth in Primary Energy Demand, by Region, 2011-35.

Disaggregating demand by energy sources indicates significant changes ahead. Looking out to 2035, non-OECD nations are projected to dominate energy consumption across the board—except for nuclear power, as seen in Figure 11-4. The majority of future energy demand in fossil and nonfossil fuels is expected to occur in China, India, Africa, and other non-OECD regions. While the story of China's massive energy demands is not particularly novel, in reality other non-OECD nations could collectively consume one-half of tomorrow's oil, gas, and renewables.



Source: Author's image; IEA, *World Energy Outlook*, 2012, Appendices.

Figure 11-4. Projected Energy Demand Growth, by Source and Region, 2010 vs. 2035 (million tons oil equivalent [MTOE]).

ELECTRIC POWER

Electricity generation, powered by renewable resources and natural gas, is projected to increase in the OECD countries, especially in all developing regions. A projected 50 percent growth spurt in future electricity generation will create both challenges and opportunities. Electricity generated with fossil fuels, especially coal and residual oil, will exacerbate air pollution and climate change concerns. As the OECD's coal consumption declines, China, India, and non-OECD Asia are projected to increase their use. By contrast, future electricity demands in emerging economies could ramp up consumption of renewable and distributed, small-scale nuclear and other cleaner energy sources, creating economies of scale for alternatives to fossil fuels.

FOSSIL FUELS

Moving beyond fossil fuels will be no small feat, however. Oil, gas, and coal consumption are projected to expand to comparable levels—4,000-Mtoe each—by 2035. More fossil fuels will flow to the developing world than to the OECD countries. Natural gas demand is expected to ramp up fastest. While generally cleaner, the potential to pollute with natural gas through excessive venting and flaring is a mounting concern. Many of the air quality and climate problems that natural gas could address run the risk of making environmental matters worse in emerging nations if best practices, strict regulations, and tight enforcement are not enacted.

If emerging nations continue to motorize following patterns established in the countries of the OECD, oil consumption will expand across the board in all developing regions. Heavier oils in Venezuela, Canada, Saudi Arabia, and elsewhere that are not suited for transportation fuels increasingly could be used to generate power, fuel maritime movements, and serve as industrial inputs. As oil use grows in emerging nations, the OECD countries are expected to reduce collective oil demand by an estimated 25 percent, largely due to advances in vehicle fuel efficiency. High global oil prices will encourage these automotive trends in affluent nations while dampening auto ownership and use in less-affluent regions. Compact urban development, especially in the world's expanding megacities, could also help emerging nations contain their oil demand in the years ahead.

NUCLEAR

Nuclear energy is the only source that is expected to remain dominated by the countries of the OECD in 2035. Outside the OECD countries, only China is expected to witness future growth in nuclear power. But even in the United States, where nuclear power increased 25 times from 1970 to 2003 before leveling out, this source seems to have turned a corner. For the first time in 15 years, operating U.S. nuclear plants are being forced to close, and energy companies are scuttling plans for new plants and upgrades to existing ones. This is due to cheap natural gas alternatives, flat energy demand, and renewed safety and regulatory concerns, especially after the 2011 Fukushima nuclear accident. It is unclear how these nuclear trends will extend beyond the United States. Nevertheless, nuclear is expected to have the smallest increase in energy demand in 2035 compared to all other sources.

ENERGY-RELATED SECURITY IMPLICATIONS BEYOND THE 2010s

All of these changes in energy consumption patterns will play out against the larger backdrop of increasingly dynamic energy supplies, with massive new resources being unlocked in the Western hemisphere. Geographic imbalances between supply and demand will lead to increased global fossil fuel movements. A significant portion of the projected 2,750-Mtoe increase in fossil fuel demand in 2035 will circumnavigate the globe as it moves from producers to manufacturers and on to consumers.

While this growth of energy trade could increase worldwide economic integration, it could also intensify global risks from terrorism, accidents, and damages wrought by climate change. Looking ahead, it is important to understand what these energy demand trends may imply for developing countries and for global energy self-sufficiency and energy security.

ELUSIVE ENERGY SELF-SUFFICIENCY

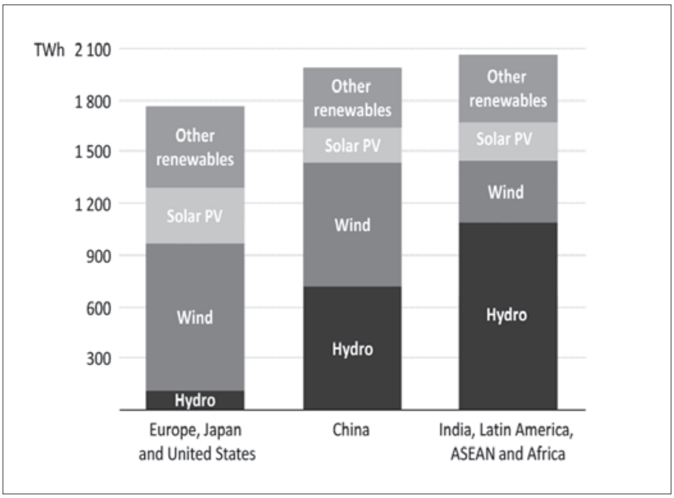
Overall, the developing world is projected to become less energy self-sufficient in the decades to come.[1] The developing countries are planning to invest an estimated $23 trillion (in 2011 dollars) on energy infrastructure through 2035, nearly twice as much as OECD nations.[2] Oil investments are projected to be distributed across all developing countries, while gas, coal, and power investments will be centered largely in Asia's developing nations. These infrastructure investments will likely lock in energy consumption patterns through the middle-to-end of the century. Selecting energy investments wisely will be critical. But it will also be difficult.

Many emerging nations have a long history of massively subsidizing fossil fuel consumption. In 2011, these subsidies topped $0.5 trillion, with the majority in the Middle East, North Africa, and Asia.[3] These expenditures amounted to six times the level of support to renewable energy. The IEA estimates that 15 percent of global carbon dioxide emissions currently receive an incentive of $120 per ton in the form of fossil-fuel subsidies, while only 8 percent of emissions are subject to a carbon price.[4] Growing budget pressures strengthen the case for fossil-fuel subsidy reform worldwide. While G20 and Asia-Pacific Economic Cooperation (APEC) countries are moving to phase out subsidies, Middle East and African nations will need to follow suit.

Taken together, oil and gas are expected to continue to dominate energy demand into the future. Increasing consumption will be met by an increasing array of unconventional hydrocarbon resources. Transportation costs, surprisingly, are a not a major part of energy supply chain economics because they currently use inexpensive residual oil (bunker fuel).[5] While their transport is highly polluting, fossil fuels move around the globe with relative ease and affordability. These dynamics will invite more suppliers to vie for market share in a world that becomes increasingly energy interdependent. While greater competition for oil and gas trade could increase risks of price volatility and short-term fossil fuel supply interruptions, it could also promote energy alternatives.

ROLE OF DISTRIBUTED, RENEWABLE ENERGY GENERATION

As electricity demand explodes, especially in emerging countries, renewables are expected to meet nearly half of the net increase.[6] With China in the lead and non-OECD Asia, Africa, and Latin America at their side, growth in hydroelectric power, wind, and other renewables is projected to be more than double that in the OECD, as seen in Figure 11-5. But to realize these gains, the conditions will have to be right.



Source: IEA, *World Energy Outlook*, 2013.

Figure 11-5. Growth in Electricity Generation from Renewables, 2011-35.

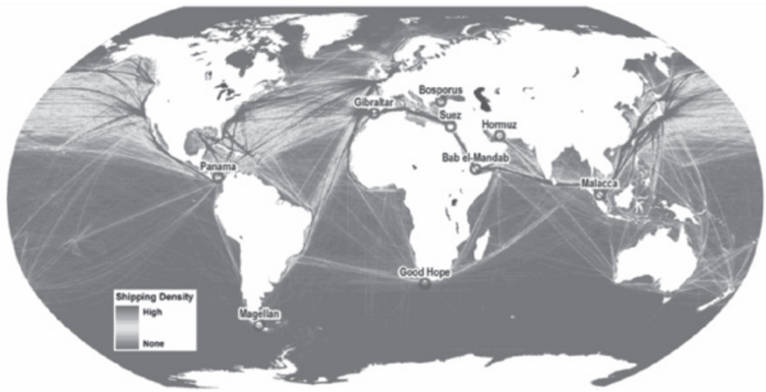
Financial support to renewable sources of energy totaled $101 billion compared to over five times that amount for fossil fuels in 2012.[7] The expansion of non-hydroelectric renewables, however, depends on subsidies that more than double to 2035.[8] This requires significant changes to existing policies and social contracts. Moreover, additions of wind and solar will have implications for power market design and costs that must be managed under new regimes that differ from those governing fossil fuel power generation. Today's share of fossil fuels in the global mix, at 82 percent, is the same as it was 25 years ago. The strong rise of renewables only reduces this to around 75 percent in 2035.[9] In other words, while critical, renewable energy will be necessary but not sufficient to stem global energy security implications in the future.

STRUGGLES WITH ENERGY SECURITY

Energy demand in the 2010s and beyond will have significant impacts on the U.S. military. As energy trade continues to globalize, it will take more resources to maintain energy and economic stability throughout the world. Leadership will remain critical. At the same time, America will need to play an increasingly discerning, collaborative, and nuanced role in its dynamic and interdependent energy future.

The importance of the Middle East and North African oil producing countries will not fade despite rising North American oil and gas supplies. Non-OECD Asia is projected to become the unrivaled center of global oil trade through the limited number of strategic transport routes. Asian fossil fuel deliveries are projected to come not only from the Middle East and Africa, but also from Russia, the Caspian area, Latin America, and Canada.

Geographic choke points for fossil fuel trade are not expected to ease in the future, as seen in Figure 11-6. If anything, they could become even more concerning. Oil will move as raw crude and petroleum products and natural gas will be moved by pipeline over land and increasingly liquefied and moved by maritime shipping from continent to continent. By 2035, for example, a significantly increased amount of oil and gas could be moving through the Straits of Malacca and Hormuz.[10] The Singapore Strait will be another potential problem area, given the amount of fossil fuels destined for Asia in the decades ahead.

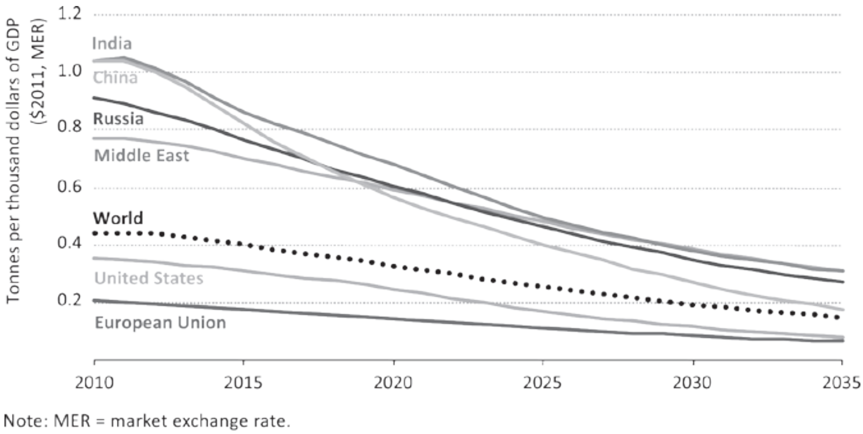


Source: *Energy Geopolitics*, available from *energeopolitics.files.wordpress.com/2012/09/international-maritime-route.png*.

Figure 11-6: Mapping of Global Maritime Transit Density with Select Choke Points.

CHALLENGED BY CLIMATE SECURITY

The energy sector is the key to limiting climate change but the trends are headed in the wrong direction, especially in emerging nations. Non-OECD countries now account for 60 percent of global emissions, up from 45 percent in 2000.[11] As such, India, China, Russia, and the Middle East are far more energy intensive than the United States, the EU, and others in the OECD, as seen in Figure 11-7.



Source: *World Energy Outlook Fact Sheet*, Paris, France: IEA, June 2013.

Figure 11-7. Carbon Dioxide Intensity in Selected OECD and Non-OECD Regions, 2010-35.

With more fossil fuels destined for emerging nations in the decades ahead, these areas are walking a tight rope. They will drive the very changes to the climate that they are least prepared to deal with, including increased droughts and water scarcity, reduced agricultural yields and food shortages, greater disease and morbidity, heightened storm intensity and infrastructure vulnerability, and dislocation and violence. The IEA forecasts that global carbon dioxide emission intensity will have to be halved to meet the 450 parts per million emissions target. But this burden will not be born equally. Emerging nations will require the most significant reductions in climate intensity for environmental and economic reasons.

While climate change alone is currently considered unlikely to be a primary cause of conflict, it is thought to be an important secondary cause, as shown in Figure 11-8. Hence, the governments and militaries in 110 countries have identified climate change as a threat to their security. Ultimately, however, the security consequences of climate change will likely be determined by how rising global temperatures affect and interact with local political, social, and economic conditions as much as by the magnitudes of the climatic shift itself.[12]

Source: American Security Project, available from *americansecurityproject.org/issues/climate-energy-and-security/climate-change/impacts/*.

Figure 11-8. Global Risks from Climate Security.

TOWARD A GLOBAL ENERGY POLICY

The global energy paradigm is shifting. As the Western hemisphere taps into unconventional oil and gas resources, overall energy demand is growing rapidly in emerging countries in the Eastern hemisphere. But the more energy market fundamentals change, the more the underlying energy situation is expected to remain the same. Fossil fuels are expected to meet the bulk of tomorrow's energy needs absent public policies that correct market failures associated with these utilization patterns. Continuing to extract, convert, and combust dirtier hydrocarbons—especially extra-heavy oils, gas-to-liquids, coal gasification, coal liquefaction, methane hydrate extraction, and oil liberated from carbonates—will, in turn, exacerbate pollution and drive climate change. China, with its choking smog, is starting to witness firsthand the dangerous consequences that fossil fuels bring.

An increasingly affluent world desires—and deserves—universal access to cleaner energy. According to the IEA, an estimated $1 trillion in cumulative investment is needed (primarily in emerging nations) to achieve universal energy access by 2030. In addition to serving the energy impoverished, energy investments upward of $40 trillion will be required over the next 2 decades to expand global energy supply capacity and replace obsolete energy equipment.[13] Given the long lifetimes of energy infrastructure, it will be critical that, over the long term, both consumers and producers must be able to live safely side-by-side with the energy systems they ultimately choose to invest in.

Significant challenges lie ahead. There are barriers to change, and laissez faire systems encourage the energy status quo. It is entirely rational for the current fossil fuel based energy enterprise to endeavor to play a significant role in meeting growing demands, and for good reason. Energy is an extremely vital and hugely profitable endeavor. International corporations and nationalized oil companies along with wildcatters and

Wall Street are all eager to claim a stake in tomorrow's emerging energy market.

The economy and energy are so intertwined that it will take a delicate balancing act to manage them, especially in the context of growing globalization. Future global energy policy will have to address mounting market failures. The asymmetry of information that impedes competition must be combated with expanded, standardized, verifiable, and transparent global energy data collection. Environmental externalities, including climate change and the pollution of air, water, and land must be internalized in energy pricing. Only the most robust global energy policies hold out hope of changing course to deliver more efficient energy markets for tomorrow's global citizens.

ENDNOTES - CHAPTER 11

1. *World Energy Outlook 2012*, Paris, France: International Energy Agency (IEA), Figure 2.15.

2. *Ibid.*, Table 2.5.

3. *Ibid.*, Figure 2.13.

4. *Redrawing the Energy-Climate Map*, Paris, France: IEA, June 2013, available from *www.iea.org/publications/freepublications/publication/WEO_Special_Report_2013_Redrawing_the_Energy_Climate_Map.pdf*.

5. The economics of LNG transport are less favorable due to increased cost for liquefaction, regasification, and the need for special shipping containers that can carry cryogenic LNG.

6. *World Energy Outlook*, Fact Sheet, Paris France: IEA, 2013, available from *www.worldenergyoutlook.org/media/weowebsite/factsheets/WEO2013_Factsheets.pdf*.

7. *Ibid*.

8. *World Energy Outlook 2013*, London Release, Paris, France: IEA, November 12, 2013, available from *www.worldenergyoutlook.org/media/weowebsite/2013/LondonNovember12.pdf*.

9. *Ibid*.

10. *World Energy Outlook 2012*, Figure 2.18.

11. IEA, June 2013.

12. Andrew Holland and Xander Vagg, "American Security Project: Preliminary Results," *The Global Security Defense Index on Climate Change*, March 21, 2013, available from *americansecurityproject.org/ASP%20Reports/Ref%200121%20-%20Global%20Security%20Defense%20Index%20P-Results.pdf*.

13. *World Energy Outlook* 2012.

CHAPTER 12

NEW SUPPLY ROUTES—NEW CONFLICTS?

Michael T. Klare

Access to vital sources of energy has been a source of conflict throughout modern history. This is so because an adequate supply of energy is essential for the functioning of all large economies and because many countries cannot satisfy their energy needs from domestic reservoirs but must rely, at least in part, on energy acquired from foreign sources—in some cases, from reserves located in unstable or unfriendly countries. Because of the importance accorded to the acquisition of these supplies, energy-importing states have often employed military means to safeguard their ties with overseas energy suppliers and to deter (or repel) attacks on critical foreign reserves.[1] While energy technology is constantly changing, conflict over energy is likely to recur so long as major consuming states continue to rely on supplies derived from distant and unruly areas.

The use of force to ensure the safety of overseas energy supplies is often associated with efforts by the major energy-consuming states to establish dominance over key energy producing areas and to protect friendly producing countries against external and internal attack. This was, for example, the principal motive for British involvement in the Persian Gulf area following the discovery of oil in southwestern Persia (later Iran) in the early years of the 20th century, and for U.S. involvement in the same area after World War II.[2] But military operations have also been taken to protect the supply lines that connect the major energy-producing areas to major consuming nations. These supply lines are often at risk of attack from insurgents, terrorists, pirates, and other violent parties, and so pose a distinct security problem for the energy-importing countries.

The disruptive consequences of any significant interruption in the delivery of foreign energy supplies became painfully evident in 1973-74, when Arab members of the Organization of Petroleum Exporting Countries (OPEC) imposed an embargo on petroleum shipments to the United States in retaliation for U.S. aid to Israel during the 1973 Arab-Israeli war. The embargo produced a severe shortage of oil in the United States, leading to long lines at gasoline filling stations and a slowdown in the economy as a whole.[3] Although not caused by an attack on supply lines per se, the 1973-74 "oil shock" exposed the nation's vulnerability to disruptions in the global flow of energy and sparked vigorous efforts to minimize these vulnerabilities, in part through "diversification" of the nation's sources of imported oil and in part by devoting greater military effort to the protection of global supply lines. "I'm determined that our nation will never be held captive," to another such interruption in supply, President Ronald Reagan declared in May 1987, when ordering U.S. warships to protect Kuwaiti oil tankers in the Persian Gulf against Iranian attack. "We will not return to the days of gas lines, shortages, economic dislocation, and international humiliation."[4]

As will be shown, the United States has devoted enormous effort to fulfilling this promise. But the problem of ensuring the safety of the world's energy supply lines is becoming increasingly difficult due to the magnitude of the global energy trade, the vast distances covered, and the geographic complexity of international transit routes involved. Some impression of this challenge can be gleaned by examining the tables, charts, and maps provided by energy giant BP in its *Statistical Review of World Energy*, published annually. In 2012, for example, international shipments of oil amounted to 55.3 million barrels per day (mbd), or 62 percent of total world oil consumption of 89.8-mbd; shipments of natural gas in 2012 totaled 1,033 billion cubic meters, about two-thirds of which were delivered by pipeline and one-third in the form of liquefied natural gas (LNG). Not only are these volumes substantial, but they also represent significant growth over previous years: According to BP, international oil shipments rose by 27 percent between 2002 and 2012, while LNG shipments rose by 119 percent.[5]

As shown by the maps provided by BP, these shipments of oil and gas are conducted via a complex network of international trade flows. The 2012 oil map, for example, shows supply lines radiating outward from the Middle East to the rest of the world, carrying 3.5-mbd to Japan, 2.9-mbd to China, 2.5-mbd to India, 2.3-mbd to Europe, 2.1-mbd to the United States, and 5.5-mbd to other countries in Asia and the Pacific.[6] Similar lines extend outward from Russia, West Africa, and other key producing areas. (See Table 12-1.)

From	To									
	USA	So/ Cent. Am	Europe	China	India	Japan	Singapore	Other Asia/ Pac	Rest of World	World-Total
United States	-	934	601	125	18	102	122	23	756	2,680
So. & Cent. Am.	1,978	-	424	636	455	33	226	45	36	3,834
Canada & Mexico	3,986	25	243	52	75	13	2	1	25	4,422
Europe	555	165	-	21	6	18	225	283	901	2,174
Former Soviet Union	545	27	5,792	1,215	49	187	141	367	274	8,597
Middle East	2,163	124	2,261	2,900	2,474	3,543	1,119	4,518	598	19,699
North Africa	341	88	1,577	221	89	18	8	94	166	2,604
West Africa	861	192	1,313	1,033	548	98	2	434	84	4,564
Other suppliers	158	248	277	959	157	731	1,118	2,448	643	6,739
Total imports	10,587	1,803	12,488	7,162	3,871	4,743	2,963	8,213	3,483	55,313

Source: BP, *Statistical Review of World Energy*, June 2013, p. 18.

Table 12-1. Inter-Regional Oil Trade Movements, 2012 (in millions of barrels per day).

A quick glance at the maps in the *Statistical Review* tells another important story about these international trade flows: Many pass through or near areas of instability and conflict. The largest flows of oil for example, pass from perennial conflict zones in North Africa and the Middle East to Europe and East Asia, often traveling through narrow "chokepoints" that have proved powerful magnets for insurgents, terrorists, and pirates. The Energy Information Administration (EIA) of the U.S. Department of Energy has identified seven such chokepoints, including the Strait of Hormuz (between the Persian Gulf and the Indian Ocean), the Straits of Malacca (between the Indian Ocean and the South China Sea), and the Bab el-Mandab (between the Red Sea and the Arabian Sea). Together, these three passageways carried approximately 35.6 million barrels of oil per day in 2011, or the equivalent of about 40 percent of total world oil consumption.[7]

These supply lines have come under attack—or the threat of attack—from a variety of actors, each pursuing its own particular agenda. Nations at war have on occasion attacked oil shipping as a way of punishing their adversaries or their adversaries' allies. During the Iran-Iraq War of 1980-88, for example, both sides targeted their opponent's oil tankers to deprive them of vital oil income, while the Iranians also attacked Kuwaiti and Saudi tankers to punish those countries for giving loans to the Iraqis.[8] (It was these attacks that prompted President Ronald Reagan to authorize the "reflagging" of Kuwaiti tankers with the American ensign and authorized their protection by U.S. air and naval forces.) Attacks on Persian Gulf shipping have also been mounted by al-Qaeda, in retaliation for what are seen as Western crimes against Islam. "Do your best to prevent [the Western powers] from stealing our oil," Osama bin Laden declared in 2004. "Focus your operations on it, especially in Iraq and the Gulf."[9] For pirates, the motive is more pecuniary: Oil-laden tankers are seen as a particularly valuable prize, worth many millions of dollars in ransom payments.[10]

Although the nature and the geography of the threats to the world's energy supply lines are likely to be modified in the future, they are not likely to decline in frequency and severity. If nothing else, the sheer increase in global energy shipments—and their extension to ever more remote corners of the globe—is bound to attract the attention of pirates, terrorists, and others with a predatory interest in impeding (or exploiting) these deliveries. It is likely, moreover, that the intrusion of pipelines, electric pylons, and other energy infrastructure into new areas will be seen as an incitement to attack by militant groups with an anti-government, anti-Western, or anti-globalization agenda.[11]

THE UNITED STATES AND THE PROTECTION OF ENERGY SUPPLY LINES

As a major energy importer itself and as one of the leading guarantors of the international order, the United States has long assumed responsibility for maintaining the security of the world's energy supply lines. Although the extent of U.S. reliance on imported oil has fluctuated over the years—it was 58 percent in 2002 and 47 percent in 2012[12]—it has remained substantial. Given the importance of these imports to the effective functioning of the U.S. economy, American officials—like Reagan—have consistently spoken of the need to ensure their unimpeded delivery. But in addition to guarantying the safety of America's own energy imports, U.S. leaders have also perceived an enduring responsibility to protect those of its friends and allies—and, in the process, to help assure the stability of the global economy. "As the world's only superpower, [the United States] must accept its special responsibilities for preserving access to worldwide energy supply," a group of senior officials, including former Secretary of Defense James Schlesinger, declared in November 2000.[13]

The United States first assumed significant responsibility for protecting overseas oil supply lines near the end of World War II, when President Franklin D. Roosevelt met with King Abdul Aziz of Saudi Arabia and promised to protect the Kingdom in return for exclusive U.S. access to Saudi oil. In establishing this relationship, Roosevelt sought to acquire a reliable supplement to America's own petroleum reserves—which he believed were being depleted at a rapid pace—and to obtain oil for America's allies in Europe and Asia. To help ensure the safety of both Saudi Arabia and the supply lines stretching from that country to the United States and its allies, Roosevelt and his successors approved the establishment of the first U.S. military bases in the region, the air base at Dhahran, and the naval base at Bahrain.[14]

At first, the United States assumed a relatively low profile in the Persian Gulf area, content to allow Great Britain—then the dominant Western power in the region—to carry the major burden of regional security. When British forces were withdrawn from the Gulf in 1972, Washington again chose to assume a low profile by relying on Iran—then headed by the pro-Western Shah—to serve as a regional "gendarme."[15] But when the Shah was overthrown by anti-American Islamic clerics in January 1979, and the Soviet Union followed 11 months later with its invasion of Afghanistan, this hands-off stance no longer appeared tenable; from then on, American leaders concluded, the security of the Persian Gulf oil flow would have to be assured by the United States itself.[16]

The result was the "Carter Doctrine" of January 23, 1980, the most explicit statement of America's commitment to the safety of global oil shipments. Incorporated into President Jimmy Carter's State of the Union address for that year, the statement began by high-lighting the strategic threat posed by the Soviet invasion. "The Soviet Union is now attempting to consolidate a strategic position . . . that poses a grave threat to the free movement of Middle East oil," he warned. Declaring that any hostile attempt to impede this flow would be regarded "as an assault on the vital interests of the United States of America," Carter pledged that "such an assault will be repelled by any means necessary, including military force."[17]

To implement this edict, Carter acquired additional basing facilities in the Persian Gulf area and assembled the nucleus of what was to become, under President Reagan, the U.S. Central Command (CENTCOM).[18] In consonance with the Carter Doctrine, Reagan also authorized the use of force to protect Kuwaiti oil tankers when they came under attack by Iranian gunboats during the Iran-Iraq War of 1980-88. "The use of the sea lanes in the Persian Gulf will not be dictated by the Iranians," he declared in 1987. "The Persian Gulf will remain open to navigation by the nations of the world."[19] Three years later, when Iraq invaded and occupied Kuwait, President George H. W. Bush again authorized the use of force to protect the safety of oil supply lines, citing Iraq's threat to Saudi Arabia and the entire Gulf region.[20]

Although the United States is no longer as reliant on oil imports from the Persian Gulf as once was the case, American leaders have continued to reaffirm the U.S. commitment to ensuring the safety of oil shipping through the Strait of Hormuz. This is so because many of America's key allies, including Japan and the European North Atlantic Treaty Organization (NATO) powers, continue to rely on Middle Eastern oil for a large share of their energy requirements, and also because the stability of the world economy rests, to a considerable degree, on the uninterrupted flow of oil shipments from the Gulf. "We will ensure the free flow of energy from the region to the world," President Barack Obama told the United Nations (UN) General Assembly on September 24, 2013. "Although America is steadily reducing our own dependence on imported oil, the world still depends on the region's energy supply, and a severe disruption could destabilize the entire global economy."[21]

U.S. SUPPLY-LINE PROTECTION BEYOND THE GULF

The Persian Gulf, therefore, remains a major focus of U.S. efforts to ensure the safety of global energy flows. But U.S. leaders have also extended such efforts to other areas of the world that have come to play a significant role in satisfying the world's energy needs. This is due, in large measure, to the strategy of "diversification" adopted by Presidents Bill Clinton and George W. Bush in response to what was perceived as excessive reliance on Persian Gulf oil. By increasing reliance on other areas of the world, they argued, the risk of a disruption in energy supplies caused by a major flare-up in the Gulf area could be diminished.[22] "Diversity is important not only for energy security, but also for national security," Bush affirmed in May 2001. "Over-dependence on any one source of energy, especially a foreign source, leaves us vulnerable to price shocks, supply interruptions, and, in the worst case, blackmail."[23]

To implement this policy, both Clinton and Bush sought to expand U.S. energy ties with other oil-producing areas, especially the Caspian Sea region and West Africa. These two areas appealed to Washington because they harbored large untapped reserves of hydrocarbons and because their leaders, for the most part, were eager to improve relations with Washington. But while attractive as alternatives to the Gulf, these areas contain their own sources of conflict and instability, and U.S. policy has been aimed not only at securing access to Caspian gas reserves but also at ensuring the safety of whatever supply lines have developed out of these ties.[24]

The Caspian Sea states first attracted significant U.S. interest in the early-1990s, following the collapse of the Soviet Union. Until then, oil and natural gas production in the Caspian region was under the control of government officials in Moscow, leaving little space for participation by international companies. After the breakup of the Union of Soviet Socialist Republics, however, the energy-rich states of the region—Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan—opened their oil and gas fields to foreign investment, usually in conjunction with newly established state-owned companies.[25] Despite keen international interest in these prospects, however, the exploitation of Caspian energy has posed substantial obstacles to the companies involved. To begin with, the Caspian Sea possesses no outlet to international waters, and so all oil and gas exiting the region must be carried by pipeline. In addition, most of the existing pipelines traveled through Russia on their way to international markets—a rather unappetizing feature for most Western companies. In order to transport Caspian oil and gas to foreign markets, therefore, international firms have had to build new pipelines across the Caucasus to the Black Sea or the Mediterranean; this, in turn, has posed a whole host of additional problems, as many of the trans-Caucasus routes pass through or near major areas of conflict, including Chechnya, Nagorno-Karabakh, and South Ossetia.[26]

In consonance with the strategy of diversification, American leaders have sought to facilitate the construction of new pipelines across the Caucasus and, in recognition of the turmoil there, have taken steps to bolster the military capabilities of transit countries, especially Azerbaijan and Georgia. This effort began under President Bill Clinton, who took a personal interest in the funneling of Caspian energy to Western markets. By engaging in such efforts, he told President Heydar Aliyev of Azerbaijan at a White House reception in 1997, "We not only help Azerbaijan to prosper, but also help diversify our energy supply and strengthen our nation's security."[27] In line with this outlook, Clinton played a direct role in negotiations leading to the construction of one of the new energy arteries, the Baku-Tbilisi-Ceyhan (BTC) pipeline, which extends from Baku on Azerbaijan's Caspian Sea coast to the Georgian capital and thence to Ceyhan on Turkey's Mediterranean coast.[28]

Having assumed a significant role in the construction of the BTC pipeline, the United States has also sought to help ensure its safety by bolstering the military capabilities of the nations through which it passes, especially Azerbaijan and Georgia. Beginning with President Clinton and continuing under his successors, the United States has been a major source of military aid and training to these two countries.[29] In requesting $108 million in military aid for Georgia for Fiscal Year 2005, for example, the Bush administration affirmed that by agreeing to host the BTC pipeline, Georgia would "become a key conduit through which Caspian basin energy resources will flow to the West, facilitating diversification of energy sources for the United States and Europe."[30] Sustained U.S. military aid over the ensuing years undoubtedly helped enhance the combat capabilities of Georgia's armed forces, but it may also have had the unintended consequence of encouraging President Mikhail Saakashvili to assume a more belligerent stance toward Russia regarding the contested territory of South Ossetia, helping to spark the Russia-Georgia War of August 2008.[31]

The strategy of diversification has also driven increased U.S. interest in the oil-producing areas of West Africa. Keen to reduce U.S. reliance on the Persian Gulf area and to increase drilling opportunities for American oil firms, the Bush administration placed particular emphasis on increased U.S. energy operations there. "African oil is of national strategic interest to us," Assistant Secretary of State Walter Kansteiner declared in 2002, "and it will increase and become more important as we go forward."[32] But while West Africa harbors significant reserves of oil and natural gas, it, too, is prone to conflict and instability. To ensure the safety of African production and exports, the U.S. Government has stepped up its military assistance to friendly governments in West Africa, especially Nigeria—the leading producer in the area and the site of recurring anti-government violence.[33]

As in the Caspian area, much of U.S. military aid to African states is aimed at improving the combat capabilities of local powers and enhancing their capacity to protect pipelines, oil terminals, offshore platforms, and other production infrastructure. However, in recognition of the growing threat to oil shipping in the Gulf of Guinea from pirates, insurgents, and other predators, the United States has also increased its air and naval presence in the region. In May 2003, for example, NATO Supreme Commander General James Jones declared that the carrier battle groups under his command would be shortening their future visits to the Mediterranean and "spend half their time going down the west coast of Africa."[34] Although Jones' successors may have announced other priorities for the deployment of carrier battle groups, there has been a marked increase in U.S. naval exercises and training missions in the Gulf of Guinea.[35]

NEW CONSUMERS, NEW SUPPLY ROUTES

Many of the initiatives undertaken by American leaders since 1945 to ensure the safety of energy supply lines remain in effect today. But the global energy security equation is now experiencing dramatic change, leading to significant shifts in both the direction of trade flows and the identities of the key actors involved in protecting these flows. Among the most important of these developments are:

1. A shift in the center of gravity of world oil consumption from the older industrialized nations of the Organization for Economic Cooperation and Development (OECD) to the developing nations of Asia, especially China and India.
2. The assumption of an increased role in protecting energy supply lines by China, India, and other major energy consumers in the developing world.
3. A shift in import dependence from existing reserves of oil and gas to newly-developed deposits in "frontier" regions, such as Siberia, Central Asia, the Arctic region, and deep-offshore areas.

Each of these developments has profound implications for the future of the global energy supply picture, and so deserves close attention.

Shift in the Center of Gravity of Global Oil Consumption.

For most of the period covered by this chapter, the bulk of energy imports was consumed by the Western industrialized nations, the members of the OECD. In 2000, for example, the OECD countries accounted for approximately 60 percent of global energy consumption. The further we look into the future, however, the greater the degree to which world energy consumption will be dominated by the developing nations of Asia, especially China and India. In 2040, the Energy Information Agency (EIA) predicts, non-OECD nations will account for approximately 65 percent of world energy demand, reducing the OECD share to a mere 35 percent. China alone will account for about 27 percent of world energy demand in 2040, and 25 percent of world oil consumption. (See Table 12-2.)[36]

This shift in the center of gravity of world energy consumption from West to East will have profound consequences for the global economy, for world affairs, and not least for the global flow of energy supplies. Whereas previously the bulk of traded oil and gas used to flow in a westerly direction, from the Middle East and Africa to Europe and the United States, it will now mainly flow in an easterly direction, toward India, Southeast Asia, and East Asia. As a result, the sea lanes and pipeline routes over which these easterly flows will travel—the Indian Ocean and South China Sea in the case of tankers, Central Asia in the case of pipelines—will acquire added geopolitical importance. "The new geography of supply and demand means a re-ordering of global oil trade toward Asian markets," the International Energy Agency (IEA)

Countries and Regions	2010		2040	
	Consumption, mbd	Imports or (Exports), mbd	Consumption, mbd	Imports or (Exports), mbd
OECD, total	46.0	24.6	46.4	21.6
-United States	18.9	9.5	18.6	6.9
-OECD Europe	14.8	10.2	14.4	10.5
-Japan	4.4	4.4	3.9	3.9
-Russia	3.0	(7.1)	3.9	(7.7)
Middle East	6.7	(18.7)	9.9	(26.9)
Non-OECD Asia	19.8	11.6	39.0	30.3
-China	9.3	5.0	19.8	14.2
-India	3.3	2.4	8.2	7.1
Africa	3.4	(7.5)	4.5	(8.9)
South & Central America	6.0	(1.4)	8.2	(5.8)
Total for all import-reliant countries	65.8	36.2	85.4	51.9

mmb = million barrels per day
OECD = Organization for Economic Development and Cooperation

Source: U.S. Energy Information Administration, *International Energy Outlook 2013*, Tables A5, G1.

Table 12-2. Oil Consumption and Imports in Selected Countries and Regions, 2010 and 2040.

observed in 2013, "with implications for cooperative [and, conceivably, competitive] efforts to ensure oil security."[37]

The Growing Role of China and India.

The obvious question arising from this shift is: To what degree will China and India assume some of the burden long carried by the United States in ensuring the safety of these shifting supply lines? At present, it would be premature to say that either China or India possesses the formal intention of replacing the United States as the leading protector of the world's energy supply lines, or even of assuming a significant share of the burden. However, it is also evident that officials of both countries are inclined to enhance their nation's capacity to perform a significant protective role as their reliance on imports grows and doubts arise over the future reliability (or impartiality) of America's commitment in this regard.

China, which is soon expected to overtake the United States as the world's leading importer of oil, currently relies on imports for approximately 70 percent of its oil supply.[38] In 2012, according to BP, it obtained the largest share of its imports (about 40 percent) from the Middle East; other large contributions were obtained from West Africa, the former Soviet Union, and South America.[39] Chinese officials have worked very hard to establish close ties with their Middle Eastern oil suppliers, especially Iran and Saudi Arabia, and continue to pursue close relations with the major Gulf producers.[40] But, like the United States, China also seeks to diversify its sources of supply, both to minimize the risk of disruption in deliveries due to the perennial disorder in the Gulf and to reduce reliance on shipments through the Strait of Hormuz—which is heavily patrolled by the U.S. Navy and so could, in some hypothetical future crisis, be closed to Chinese oil vessels.[41]

To reduce its reliance on the Middle East, China, too, has turned to suppliers in the Caspian Sea basin and West Africa. The Caspian basin is of particular interest to Beijing because local rulers have shown a willingness to allow participation by Chinese energy firms in the development of their countries' oil and gas reserves and because the region's energy exports can be carried by pipeline directly to the Chinese border. This will eliminate the need for reliance on tankers that would have to travel through waters patrolled by the U.S. Navy. To establish such links, Chinese leaders have provided their Caspian and Central Asian counterparts with substantial development aid and showered them with diplomatic attention. Building on this foundation, China's state-owned energy companies have acquired significant shares in Caspian energy enterprises and built new pipelines across Central Asia to Xinjiang in Western China.[42]

As is true of pipelines extending westward from the Caspian Sea, across the Caucasus to the Black Sea and the Mediterranean, pipelines heading eastward across Central Asia toward China pass through areas of ethnic unrest and terrorist violence. Kyrgyzstan, Tajikistan, and Uzbekistan have all been roiled in recent years by internal conflict of some sort, and this unrest has sometimes spilled over into neighboring states. China, for example, is particularly concerned over support allegedly provided by militant groups in Central Asia to Uighur separatists in Xinjiang. To combat insurgency and separatism throughout the region and, at the same time, help ensure the safety of vital energy infrastructure, China has invested heavily in the Shanghai Cooperation Organization (SCO), a body originally intended to foster border security and counterterrorism in Central Asia, but now devoted to a wide range of missions, including energy security.[43] Under the SCO's auspices, China has provided arms and military assistance to its member states—Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan—and participated with them in joint military maneuvers.[44]

Africa is attractive to China as a source of energy because local governments are generally agreeable to increased Chinese involvement and because the Western presence—though substantial—is less substantial than in the Persian Gulf area. Resource flows from Africa to China also bypass the Strait of Hormuz, thus avoiding the risk of disruption from conflict there or possible interference by the ever-present U.S. Navy. In order to cultivate ties with African oil producers and allow for increased participation in their extractive operations by Chinese firms, Beijing has provided them with substantial economic aid and invited their leaders to diplomatic extravaganzas like the Forum on China-Africa Cooperation. These efforts have resulted in a significant increase in Chinese involvement in African oil production, especially in Angola, Nigeria, and Sudan. As in Central Asia, moreover, China has provided friendly African governments with various forms of military assistance.[45]

Although attractive to Beijing in many respects, increased Chinese reliance on African energy has also raised security concerns of one sort or another. Chinese oil-production personnel have been kidnapped or attacked by rebel groups in Ethiopia and Sudan, and Chinese shipping—like that of other oil-importing countries—has been put at risk by pirate activity in the Gulf of Guinea and waters off Somalia. In response to these threats, the Chinese have taken a variety of steps to enhance the safety of their resource operations in Africa, ranging from increased support to the security forces of friendly governments (for example, in Nigeria and Sudan), participation in UN peacekeeping operations (South Sudan), and involvement in antipiracy operations.[46] China's engagement in antipiracy operations in waters off Africa is especially noteworthy, as it has provided the Chinese People's Liberation Army Navy (PLAN) with considerable experience in complex, "blue water" (deep sea) naval operations. "Over 4-plus years," Andrew Ericson and Andrew Strange wrote in 2013, the PLAN "has deployed 34 warships with 28 helicopters in 14 task forces, safely shepherding more than 5,000 commercial vessels" in these operations. "Nearly 10,000 select personnel have sharpened their skills, improved coordination mechanisms, and tested new platforms and technologies."[47]

China's growing reliance on imported energy and concern over the safety of its international supply lines has also added to tensions in the South China Sea, through which much of the country's oil and LNG imports travel on their way to receiving terminals in southern China. The tensions in this maritime area have largely been fueled by other (if somewhat related) issues: a set of disputes over the ownership of the Spratly and Paracel Islands, two groups of atolls and islets that are believed to sit astride large undersea oil and gas reserves. China and Taiwan, citing historical precedents, claim all of the islands; Brunei, Malaysia, the Philippines, and Vietnam each claim some of them.[48] These ownership disputes have triggered a series of confrontations and shooting incidents in recent years, and remain one of the most significant sources of friction between China and the Southeast Asian countries.[49] At the same time, China's increasing assertiveness in pushing its claims to these islands has increased anxiety about the safety of international shipping in the South China Sea, and this has drawn the United States into the matter. Although professing neutrality on the issue of the islands' sovereignty, Washington has affirmed that it will take whatever steps are necessary to ensure the freedom of navigation in the South China Sea, just as it has in the Persian Gulf.[50]

All of this has put a bright spotlight on the Chinese navy and raised critical questions about Beijing's ultimate intentions regarding the use of military power to protect its global supply lines and otherwise advance its national interests. Although reticent to speak too openly on this topic, Chinese naval officials have become increasingly outspoken on China's need to enhance its ability to safeguard its supply lines. "With the expansion of the country's economic interests, the navy wants to better protect the country's transportation routes and the safety of our major sea lanes," Rear Admiral Zhang Hua-chen declared in 2010. "In order to achieve this, the Chinese Navy needs to develop along the lines of bigger vessels and with more comprehensive capabilities."[51] Recent comments by President Xi Jinping suggest that top government officials share this outlook: According to one account, Xi told a Politburo meeting in 2013 that China must become a "maritime strong power."[52] China is also acquiring new warships, including an aircraft carrier, and is undertaking more deep-sea naval maneuvers like those in the Gulf of Aden.[53] It remains unclear, however, if China aims to acquire a full-scale global fleet like that possessed by the United States, or seeks something more modest.[54]

India, although trailing China in terms of national wealth and industrial might, is also experiencing a period of sustained growth and an accompanying need for added energy. According to the EIA, India's net energy demand will jump from 24.4 quadrillion British thermal units in 2010 to 55.0 quadrillion in 2040—at which point its consumption will exceed that of every nation except China and the United States.[55]

Like China, moreover, India must rely on imports for an ever-increasing share of its energy requirements. Again using EIA projections, India's oil import requirement will climb from 2.4-mbd in 2010 to 7.1-mbd in 2040, about the same amount as that needed by the United States.[56] Although a relatively minor actor today, India is destined to emerge as a major player in the global competition for access to the world's tradable energy supplies. [57]

Much like their Chinese counterparts, India's leaders are well aware of the strategic implications of their country's growing reliance on imported energy supplies and are determined to take steps to enhance the security of their vital supply lines. For India, the geographic challenge is somewhat less complicated than it is for China, as it obtains most of its energy imports by sea from nearby suppliers in Africa, Southeast Asia, and the Middle East. As these imports travel by ship across the Indian Ocean—a body of water considered by Indian elites to be a natural extension of India's strategic space—India has sought to bolster its sea-control capabilities in this maritime region. "India's economic resurgence is directly linked to her overseas trade and energy needs, most of which are transported by sea," a 2007 strategic blueprint released by the Indian Navy declared.

> The primary task of the Indian Navy towards national security is, therefore, to provide insulation from external interference, so that the vital tasks of fostering economic growth and undertaking developmental activities can take place in a secure environment.[58]

In consonance with this policy, India is steadily enhancing its deep-sea naval capabilities—focusing in large part on the Indian Ocean, but also extending to neighboring bodies of water like the South China Sea. Much speculation has thus arisen over whether these efforts will, at some point, produce a clash of some sort with China—which also perceives a vital interest in maintaining a degree of control over supply lines in these areas. Such a clash was one of several hypothetical scenarios incorporated into the National Intelligence Council's 2025 assessment of the future world strategic environment, *Global Trends 2025*. (In this scenario, India cooperated with the United States in imposing an arms embargo on Iran, precipitating a naval clash with China when the latter attempted to supply anti-ship cruise missiles to Tehran in violation of the sanctions.[59]) More recently, the potential for a Sino-Indian naval clash has arisen over a decision by an Indian state-owned energy firm, ONGC Videsh Limited, to join with state-owned Petro-Vietnam in developing offshore oil blocks in waters of the South China Sea claimed both by China and Vietnam. Indian officials have promised to defend India's economic interests in the area, while China has threatened to expel foreign energy vessels and personnel from areas of the South China Sea it says are under Chinese control.[60]

New Supply Zones.

The challenge of ensuring the safety of global energy supply routes is further complicated by the emergence of new oil and natural gas producing zones, made possible by the utilization of new extraction technologies. As reserves in older production areas have become depleted—a natural consequence of the intense production we have witnessed over the years since World War II—energy firms are being forced to rely on ever more remote and hard-to-exploit deposits. Through the development of advanced extractive technologies, however, many such regions—notably the Arctic, northern Siberia, and the deep oceans—have now become accessible to drilling.[61] But this, in turn, has introduced new wrinkles into the problem of protecting global supply routes.

The prospect of expanded drilling in the Arctic region has sparked particular interest. This region, encompassing the northern reaches of Alaska, Canada, Norway, and Russia plus the Arctic Ocean itself, occupies but 6 percent of the Earth's surface but is believed to house approximately 30 percent of the world's undiscovered gas reserves and 13 percent of its undiscovered oil.[62] Until now, the Arctic's harsh weather conditions and ice cover have made it extremely difficult for energy companies to operate in this area; as a result of climate change, however, these firms are now finding it easier to drill in the region. With sea ice now vastly reduced in summer months, the drilling season is being extended and drilling platforms can operate further north. To take advantage of these conditions, oil companies are stepping up their efforts to exploit the Arctic's energy resources.[63] Royal Dutch Shell is attempting to drill in areas of the Beaufort and Chukchi Seas off Alaska, while Statoil is extracting gas from Norway's sector of the Barents Sea and Russia's Gazprom is preparing to drill in the Pechora Sea, off northern Siberia. Many other such endeavors, including a collaborative effort between Exxon and Rosneft to exploit oil reserves in the Kara Sea, are likely to get under way in the years ahead.[64]

Although promising as a fresh source of energy, the development of the Arctic's oil and gas reserves is likely to spark new geopolitical tensions. This is so because of the region's immense resource potential and the fact that disputes have arisen over the location of offshore boundaries in the Arctic Ocean—and thus over the ownership of certain promising energy reserves. The United States, for example, has a boundary dispute with Russia in the Bering Sea and with Canada in the Beaufort Sea; Canada has a dispute of its own with Greenland over their mutual boundary, while Greenland has one with Iceland.[65] These disputes would not provoke much concern in the absence of major energy deposits in the region, but take on increased significance when the states involved hope to procure significant economic benefits from the disputed areas. As noted by Secretary of Defense Chuck Hagel in November 2013, "a flood of interest in energy exploration [in the Arctic] has the potential to heighten tensions over other issues."[66]

The risk of tension and conflict in the Arctic is further exacerbated by the determination of key regional policymakers to rely on military power to reinforce their claims to prized Arctic real estate. Although the Arctic states have pledged to refrain from the use of force in asserting their claims, most have taken steps to enhance their capacity to engage in combat operations in the area.[67] Russia, for example, has announced plans to establish new bases in the Arctic and to deploy specially equipped combat forces there. This buildup, said President Vladimir Putin, "will make it possible to substantially strengthen our military and border security and also increase the effectiveness of the protection of natural resources."[68] Canada has also taken steps to bolster its presence in the Arctic, establishing a new base at Resolute Bay on Cornwallis Island and ordering a new fleet of ice-hardened patrol ships.[69] Norway, which shares a border with Russia in its far north, has relocated its combined military headquarters to Boda, above the Arctic Circle, and taken other steps to bolster its Arctic combat capabilities.[70]

All this has also underscored the importance and sensitivity of disputes over the control of the maritime trade routes that traverse the Arctic region. If the Arctic and northern Siberia are to play a significant role in satisfying the world's future oil and natural gas requirements, energy firms will require assurance that their production and delivery vessels will be immune from interference. But doubt has arisen about the legal status of the Arctic's two major shipping routes: the Northwest Passage, from the North Atlantic to the Pacific via waters off northern Canada and Alaska; and the Northern Sea Route, from the Barents Sea to the Pacific via waters off northern Siberia. Canada insists that the Northwest Passage lies almost entirely within its inland waters, while Russia claims that the Northern Sea Route lies within its territorial waters; both also insist that they, and they alone, possess the right to patrol these waters and ensure their security. These claims are not, however, universally accepted. The United States, for example, does not accept Canada's claim to sovereignty over the Northwest Passage but says it crosses through internationals straits.[71] How all this will play out cannot be foreseen, but the Arctic and its supply routes are certain to attract increasing attention from strategic planners in the years to come.

CONCLUSION: THE UNCERTAIN PATH AHEAD

For decades, the safety of the world's energy supply lines has been a major concern of the United States and its allies. As America's reliance on imported oil increased, this country devoted considerable effort to the protection of the maritime trade routes connecting overseas energy suppliers to U.S. ports. In its role as a leading guarantor of the stability of the international system, moreover, the United States also assumed responsibility for protecting the routes on which its friends and allies relied. For most of this time, the major focus of U.S. protective efforts was the Persian Gulf and the Strait of Hormuz; under the strategy of import "diversification," Washington extended such efforts to other oil-producing areas, including the Caspian Sea area and the Gulf of Guinea. Although America's reliance on imported oil is declining, the United States appears—at least for now—committed to retaining its role as the principal protector of the world's energy trade routes.

Looking toward the future, this picture is likely to undergo dramatic change. To begin with, the magnitude of international energy shipping and diversity of global supply routes is growing, posing new threats to the safety of energy deliveries. With many existing oil and natural gas reservoirs in decline, the major energy-consuming states must rely increasingly on supplies derived from ever more distant (and often problematic) locations. At the same time, the center of gravity of world energy demand is shifting from West to East, adding to the level of energy shipping in eastern waters—the Indian Ocean, the South China Sea, and the Western Pacific—and raising questions about the future role of China and India in protecting their growing energy imports. From all that can be ascertained, these countries are determined to enhance their capacity to defend their sea lines of communication—thus increasing the potential for future clashes between the two of them, and between China and the United States.

Among the big unknowns is the degree to which increased oil production in the United States and Canada will erode Washington's continued determination to serve as the world's leading protector of energy supply routes. By applying advanced extractive technologies—notably horizontal drilling and hydraulic fracturing ("fracking")—to hydrocarbon-rich shale formations, U.S. energy firms have succeeded in significantly boosting U.S. oil output.[72] According to the latest projections from the EIA, domestic U.S. oil output will jump from 5.7-mbd in 2011 to 9.0-mbd in 2025—a remarkable increase for a country long thought to be in decline.[73] At the same time, increasingly stringent vehicle fuel-efficiency standards are resulting in diminished U.S. oil demand. With Canada expected to supply an ever-increasing share of America's reduced import demand, the United States will need less and less oil from Africa, South America, and the Middle East.

With America's reliance on extra-hemispheric imports in decline, should we expect a decline in America's willingness to bear the burden of protecting global energy supply lines? At this point, it is too early to make any firm predictions in this regard. As noted earlier, President Obama has said that the United States will not abandon its commitment to protect the free flow of oil through the Strait of Hormuz. Retaining a robust naval presence in the Persian Gulf and adjacent waters would also provide the United States with a distinct advantage in any future crisis or confrontation with China—which, of course, is precisely what Beijing fears. Nevertheless, it is hard to imagine that American taxpayers and members of Congress will be inclined to continue subsidizing America's role as the world's supply-line protector when the United States no longer relies on imported oil.

Either outcome—a diminished or undiminished U.S. role as the world's paramount protector of global supply lines—will have a profound impact on world affairs. If the United States were to diminish its role, China, India, Russia, and perhaps other powers are bound to assume an increased role, producing great anxiety in Washington, Tokyo, Riyadh, and most European capitals. If, however, the United States chooses to retain its protective role, we can expect growing friction with China and Russia, along with recurring involvement in local conflicts and upheavals. Clearly, this is one of the most important strategic issues the United States will face in the years ahead, and one deserving close leadership attention.

ENDNOTES - CHAPTER 12

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> As a Pacific nation and resident power, the United States has a national interest in the maintenance of peace and stability, respect for international law, freedom of navigation, and unimpeded lawful commerce in the South China Sea. We do not take a position on competing territorial claims over land features and have no territorial ambitions in the South China Sea; however, we believe the nations of the region should work collaboratively and diplomatically to resolve disputes without coercion, without intimidation, without threats, and without the use of force.

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CHAPTER 13

THE ARMY'S APPROACH TO INSTALLATION AND OPERATIONAL ENERGY SECURITY CHALLENGES

Katherine Hammack

The United States is facing significant challenges, including those of a political nature, as it strives to maintain energy security. A recent White House Champion of Change recipient stated that veterans voicing their concern over clean energy and climate change might help the country rise above the political divide of these issues being right or left, politically speaking, and make sure they are instead **American** issues. Indeed, all Americans must act as catalysts for the change that is necessary for a sustainable future.

To this end, the U.S. Army has taken a number of significant steps. Before outlining them though, it is important to place the Army's energy use in perspective. The U.S. Army manages almost one billion square feet of building space. It has over 100,000 homes on its bases that are utilized by 2.2 million Soldiers, families, and civilians. U.S. Army installations and posts around the world are comparable to 152 small cities. With this amount of people and infrastructure, the U.S. Army has the distinct privilege of being the largest facility energy consumer in the Federal government, at a cost of $1.3 billion dollars in Fiscal Year (FY) 2012. The Army spent another $3.5 billion in FY12 on liquid fuel to support overseas contingency operations. In addition to being one of the U.S. top consumers of energy, the Army supply chain requires a significant amount of water and generates a significant amount of waste.

The Army cares about its sizable energy footprint because its ability to accomplish its mission depends on secure, uninterrupted access to energy, water, and other natural resources, both at home and abroad. Energy supply shortfalls and power distribution failures represent a strategic vulnerability—increasing risk to specific missions, the U.S. Government's pocketbook, and the Army's reputation. Ensuring energy security through increased efficiencies and diligent management of resources reduces this vulnerability.

Today, the U.S. Department of Defense (DoD) faces multiple threats and nontraditional challenges, all of which jeopardize the future security environment. The Army's intelligence community reports that the key element of the complex future operating environment will be the "Lack of Governance or Rule of Law." Driving this breakdown in governance will be an increasing, world-wide demand for scarce resources. The rise of oil prices, scarcity of water, unstable weather conditions, and effects of climate change will increase global tensions.

Climate change will also have physical effects on military installations through sea level rise and drought. It impacts soldiers by constraining training options and increasing safety and occupational health risks. The increase in natural disasters will translate into more missions for soldiers at home, especially those in the National Guard and Army Corps of Engineers. Whether it is Army Soldiers or a joint effort, the Army frequently provides support to civil authorities in emergency response and recovery operations, for example by evacuating residents from the Colorado floods, supporting tornado relief and reconstruction efforts in Oklahoma and Illinois, and assisting the Hurricane Sandy victims all along the East Coast.

Climate change has also increased the number of humanitarian missions overseas. For example, the U.S. military recently distributed over 650,000 pounds of critical supplies to survivors of Typhoon Haiyan in the Philippines.

In response to these threats, DoD is working to build a resilient Army that can adapt rapidly to change. A more flexible and adaptable Army is more capable of performing its mission in a resource-constrained environment. Army installations will become platforms of stability, resiliency, and endurance. These platforms will promote highly-efficient electricity usage, on-site power and water generation, and integrated "smart" microgrid infrastructure.

Appropriately managing resources and consumption is a challenge the Army has been addressing through technologies, policies, and programs, such as the Net Zero Initiative. Since 2011, this initiative has been the cornerstone of Army energy security and sustainability efforts. Through the principles of integrated design, the Net Zero strategy strives to bring the overall consumption of energy, water, and waste on Army installations down to an effective rate of zero. The Army defines a Net Zero Energy Installation as an installation that reduces overall energy use, maximizes efficiency, implements energy recovery and cogeneration opportunities, and then offsets the remaining demand with the production of renewable energy from on-site sources. A Net Zero Energy Installation produces as much energy as it uses over the course of a year. Army installation energy managers understand that achieving Net Zero requires a systems-of-systems, holistic approach. Therefore, Net Zero efforts include water and waste because it takes energy to pump, treat, distribute, collect, and dispose of water resources; and it takes energy to transport and properly dispose of waste.

Sharing lessons learned from several test-bed pilot installations is important because the Army is planning to eventually expand the Net Zero challenge to all permanent installations and forward operating bases. Best practices include conducting thermal building envelope analysis, implementing leak detection on the potable water distribution system, and improving purchasing practices to reduce or eliminate waste at the source. In the coming years, the Army's collective challenge will be to adopt and embed these types of best practices into all the Army does.

The success of the Net Zero Initiative will be based on collaboration. Partnering with third parties has contributed to the Army's reduction in energy use intensity and allowed the Army to focus on its core competencies. Many Federal agencies, small businesses, and innovators have contributed to the progress to date. Partnering helps the Army improve energy security. Installations and surrounding communities have experienced increased power outages due to a vulnerable electric distribution system. In the last 10 years, the Army has seen over a four-fold increase in power interruptions on its bases. Due to the need for expansive maneuver areas, Army installations are typically isolated and at the end of utility lines. By reducing consumption and increasing renewable energy projects, the Army increases energy security; reduces vulnerability in the event of power outages; and reduces utility bills that increase much faster than inflation.

In an environment of declining budgets, it is the Army's responsibility to stabilize and/or reduce its energy costs. Every project must have a positive economic benefit over the course of its life-cycle. Each of the military services has committed to generate one gigawatt of renewable energy on military installations by 2025. This is equivalent to the electricity needed to power over 750,000 U.S. homes. To achieve this end, the Army established the Energy Initiatives Task Force (EITF). The EITF serves as the central managing office to plan and execute large-scale, renewable energy projects greater than 10 megawatts on Army installations. The EITF leverages private-sector financing and expertise to gain access to up-front capital investments in return for a long-term power purchase agreement.

In support of the EITF, the U.S. Army Corps of Engineers initiated a Multiple Award Task Order Contract (MATOC) to identify a pre-approved list of project developers in four technology areas: geothermal, solar, wind, and biomass. The total contract ceiling across all four technologies is $7 billion and allows for maximum flexibility for use by other military Services and Federal agencies. The MATOC is one of the contract vehicles and procurement options that will help the Army in its efforts to plan and execute a cost-effective portfolio of renewable energy projects. While the MATOC was in the procurement process, the Army has moved forward on seven projects. These projects represent more than 175 megawatts of power, which is almost 20 percent of the Army's goal, and many of them began implementation in 2014.

Behind the initial EITF project releases, the Army has a pipeline of four gigawatts of potential projects that it is currently assessing or validating. Some of these projects may be halted or delayed due to market conditions or as a result of further critical analysis. As projects are validated and advance through the pipeline, new opportunities are selected from the Army enterprise to begin initial assessment.

In addition to utilizing renewable energy, improving energy security begins with improving energy efficiency. The U.S. Army is leveraging limited budget dollars with private sector funding through energy savings performance contracts (ESPCs) and utilities energy services contracts (UESCs) to implement energy conservation measures on Army bases. Performance-based contracting enables the Army to partner with Energy Service Companies and utilities, which finance efficiency projects and are repaid from the value of energy savings realized from their investment over the life of the contract.

In 2011, President Barack Obama issued a performance contracting challenge, which directed the Federal Government to award $2 billion in new ESPCs and UESCs over a 25-month implementation period, ending December 31, 2013. During that time frame the Army was the only Federal entity to exceed its goal significantly. The Army executed and awarded $498 million in contracts, which was 29.7 percent above its $384 million goal. The projects are projected to save 1.396 trillion British Thermal Units per year through such measures as lighting upgrades and controls, building envelope improvements, central energy plant upgrades, and modifications to energy intensive process equipment. Building on success, President Obama has issued a second challenge to all federal agencies, and the Army continues to leverage alternative means of financing to help overcome budgeting uncertainties.

Microgrids are an innovative solution to improving energy security and resiliency on Army installations. The combination of on-site energy generation and storage, together with a microgrid's ability to manage local energy supply and demand, allows installations to shed nonessential loads and maintain mission-critical loads if the electric grid goes down. The Army has invested in a smart-charging microgrid outside the headquarters of Wheeler Army Airfield in Hawaii. The system consists of 25 kilowatts of solar power, 200 kilowatt-hours of battery storage, and four plug-in electric vehicle charging stations. The system can power electric vehicles and has the ability to provide instant backup power to support three buildings for 72 hours. These buildings are able to operate totally independent of the commercial power grid.

Fort Carson, Colorado, is home to another microgrid, which includes a bidirectional vehicle-to-grid pilot project. The bidirectional charging units are capable of providing up to 300 kilowatts of power to plug-in electric vehicles and can also discharge a similar amount of stored energy from the vehicle batteries to the grid or microgrid. Power stored in the vehicle batteries provides energy security and increases transmission efficiency from the local utility through a power correction factor.

In addition to integrating vehicles, renewable energy, and backup generators into the energy management systems at permanent installations, the Army is also working to integrate such technologies and capabilities at contingency locations and forward operating bases (FOBs). On the battlefield, the Army is partnering with the other military services to ease the aggregate burden of powering the tactical edge, while still providing the amount of power and resources required by soldiers. Fuel and water comprise 70 to 80 percent of ground resupply convoys, by weight, and represent significant risks to Army missions and U.S.

Soldiers. Resource-informed principles, such as Net Zero, become particularly important at contingency bases where operations emanate from austere environments and are supported by extended supply lines traveling through hostile terrain.

For example, a U.S. FOB in Afghanistan was receiving a regular aerial resupply that consisted of 70 percent fuel and water. Every 3 days, American Soldiers needed to stop their primary mission, and come down out of their secure mountaintop location to establish an area for the air-drop. They then had the task of taking the supplies back up into their protected operating base. The Army sent an operational energy team in for 30 days to examine the base's fuel and water usage, and, with the team's recommendations, the Army was able to get that base down to one resupply every 10 days, with 30 percent fuel and water. By enhancing mission effectiveness in this way, the Army helped to ensure its Soldiers are less vulnerable, that they are exposed to less risk, and that they are able to focus on their primary mission.

New technologies are being tested at home and in combat theaters that will increase mission agility through better power management and more flexible power sourcing. The Army has been able to establish tactical microgrids, new and more efficient generators, and onsite renewable power at combat outposts and FOBs due to the type of testing and evaluation that takes place at the Base Camp Integration Lab at Fort Devens, Massachusetts. Soldiers now carry 9.7 pounds of rechargeable batteries, as compared with 14 pounds with back-ups, for a 72-hour load. Innovation that reduces fuel demand and resupply requirements undoubtedly increases mission effectiveness.

Despite these successes, there are ongoing challenges from the financial, technical, and social standpoints. DoD has had to work under continuing resolutions for at least some portion of each fiscal year for the past several years. This funding uncertainty makes investment decisions much more difficult.

Additionally, there are challenges in terms of how to value energy security. Installing energy efficient products and microgrids reduces risks and vulnerabilities, but comes with a tradeoff and cost. Traditional cost-benefit analyses can help assess an energy project; however, quantifying the risks involved with failures to energy supply and power distribution systems requires nonmarket valuation. This is beyond the scope of traditional cost-benefit analyses and proves to be a challenge in the budget appropriation process because of competing priorities.

President Theodore Roosevelt stated, "Far and away the best prize that life has to offer is the chance to work hard at work worth doing." The U.S. Army will continue to work hard to build financial and technical partnerships with third parties and defense communities, because this will help it remain "Army Strong" despite the many energy security challenges facing it today.

CHAPTER 14

OPERATIONAL ENERGY AS A STEPPING STONE TOWARD NATIONAL RESILIENCE

Paul Roege

Operational Energy (OE) is an emergent approach to managing energy in its various forms and attributes to maximize its value for military purposes. The discipline has gained attention and support in large part because of the logistic challenges associated with projecting U.S. force into Southwest Asia during the early-21st century. Hundreds of analyses, briefings, and articles—including the February 2008 *Defense Science Board Report* entitled, "More Fight—Less Fuel"—have highlighted estimates that energy and water collectively represented at least 70 percent of ground logistics in Iraq and Afghanistan.[1]

This dramatic statistic has had real and significant implications to military reach and sustainability, and ultimately motivated the emergent focus on energy associated with military operations. At times, U.S. forces in Afghanistan have relied almost entirely upon ground resupply lines extending thousands of kilometers through former Soviet states to deliver fuel.[2] During the initial phases of Operations ENDURING FREEDOM (OEF) and IRAQI FREEDOM (OIF), energy was a recognized logistic challenge, but no more. As the operations ground on, that logistic challenge turned into a significant tax on operational resources, driving eventual investments in efficient shelters and air conditioners, renewable energy, and microgrid systems, which collectively returned dramatic reductions in fuel consumption.[3]

More substantially, OE now is being institutionalized across the services, from establishment of a Senate-confirmed Assistant Secretary of Defense position down to deployment of energy advisors embedded in field units. As the U.S. military and national foci shift from deployed operations in Southwest Asia, the opportunity exists to build off of OE insights gained to date, reinforced by a growing popular interest in energy, to improve the nation's economic and security posture.

ENERGY-INFORMED CONCEPT

Congress defined OE as, "the energy required for training, moving, and sustaining military forces and weapons platforms for military operations. The term includes energy used by tactical power systems and generators and weapons platforms."[4] For purposes of capability development and management, the U.S. Army expanded its operating definition to include management not only of the energy itself, but also the associated information systems and processes.[5] In an initial exercise to develop a foundational strategy,[6] an Army working group surveyed and characterized the variety of ways in which energy attributes influence military capabilities and performance. One important conclusion was that the interrelationships are complex—from power capacities that support sensor precision and range to energy density associated with platform mobility and endurance, to efficiency, impacting cost, logistic effort, and ultimately force vulnerability. The team concluded that it had to supplant the traditional commodity view of energy with one that balances multiple attributes toward the ultimate goal of providing the greatest net operational benefit.

Moreover, the team recognized that ground operations are entrepreneurial in nature.

Every Soldier or Marine deploys with some level of training, equipment, and leadership. Nevertheless, each individual—whether assigned to small units or a large headquarters—invariably faces unanticipated situations and demands. These unforeseen challenges require troops to draw upon their arsenal of energy-enabled capabilities and adapt to achieve the mission as safely as possible. Recognizing the overwhelming importance of informed behaviors and decision processes, the Army's strategy team advanced a guiding concept of "Energy-Informed Operations." This principle calls upon Soldiers, leaders, and organizations at all levels, to understand energy implications within their span of influence and act (expertly) to achieve the greatest net operational benefit.

Armed with this fundamental emphasis on operational outcomes, the Army and Marine Corps set out collaboratively to develop concepts and capability requirements that would maximize the contributions of energy in the field. The Army started with a Concept of Operations document,[7] which established an analytical taxonomy based upon dismounted, mounted and air maneuver; and contingency base sustainment. The next step was development of the system-level "Initial Capabilities Document for Sustained Ground Operations," which identified functions and capability gaps across the maneuver domains and prioritized needs such as networking and energy management. Figure 14-1 provides a visual depiction of the conceptual overview. In a parallel and collaborative effort, the Marine Corps focused on the specific operational challenges of forced entry from the sea. The joint outcome was a pair of documents: one addressing energy requirements in a specific operational context; the other describing an overall system architecture and cross-cutting capability needs. These approved documents constituted a watershed step by establishing energy as a bona fide component of operational capability—in the process, enabling energy solutions to compete for resources on that basis, not purely as cost-saving measures.

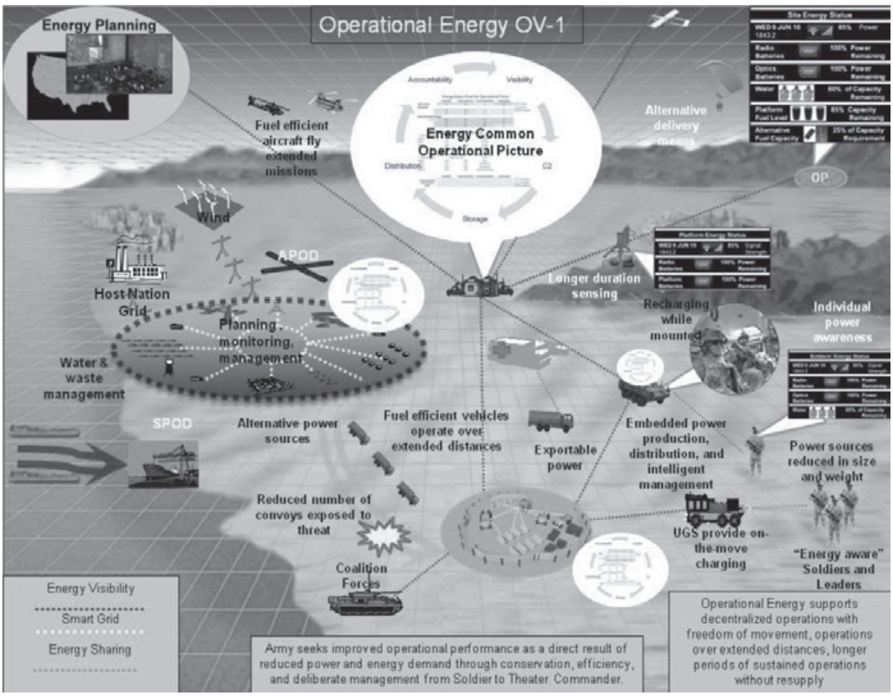

Figure 14-1: Army Operational Energy Concept Overview.

Some would note that this conceptual evolution is following the example of the information domain in military operations. As late as the early-1980s, information was valued largely in terms of quantity. More was better, as soldiers and commanders were starved for information, which was difficult to manipulate and share. Today, information is plentiful and fungible; its value depends upon its applicability and contribution to important outcomes. Flexibility, concision, and effectiveness now overshadow quantity as measures of utility, and everyone in the formation has become a savvy user.

CULTURE CHANGE

Since 2010, each of the services has aggressively advanced OE doctrine, plans, technology investment, and institutional management integration. The Secretary of the Army explicitly added energy to the portfolio of his assistant responsible for installations and environment, and assigned army staff responsibility for OE to the Director of Logistics, G-4. Meanwhile, Training and Doctrine Command (TRADOC) assigned proponency for respective OE capability development domains to the Maneuver, Aviation, Contingency Basing and Sustainment Centers of Excellence. In Fiscal Year 2012, the Secretary established an Army Campaign Plan objective to "achieve energy informed operations," in turn providing senior-level visibility on progress through the enterprise Strategic Management System. The ultimate goal of this exercise was to institutionalize OE across organizational boundaries and to instill the characteristic OE outcome focus throughout Army business processes and initiatives. Campaign-level performance metrics emphasizing operational outcomes were established, for example, maximizing dismounted agility and endurance as represented by reductions in the weight that carried power adds to an average dismounted soldier's load for a 72-hour operation. Such high-level lagging indicators would move slowly, but they would provide for relevance and alignment of subtasks and more leading indicators.

While campaign plans, performance management systems, and investment decision tools represent important steps toward long-term organizational change, the Army—as well as the other services—recognizes individual behavior as the most important determinant of collective performance. At the October 2012 Association of the U.S. Army (AUSA) Symposium, the Secretary of the Army announced a new initiative to achieve an "Energy-Informed Culture,"[8] which unleashed a flurry of initiatives and communications targeting the total Army, including civilians and families. The Army is populating a library of resources from pamphlets and videos to reports and magazine articles, many of which are available online.[9]

Given demonstrable senior-level support, the next step is to understand that culture comprises more than individual attitudes. A simplistic view concludes that, "if they cared about energy, we would automatically achieve our goals." Alternatively, the Army has adopted a more holistic model that recognizes the interaction of human factors, information, hardware/software tools, and techniques to achieve informed outcomes. In the tactical environment, a truck driver must choose energy-related behaviors based upon personal values, training, and unit leadership, superimposed with information about the mission and operational situation. This means balancing fuel consumption (endurance), speed (mission requirements), and route alternatives (risk) based upon such indicators as fuel gauge, speedometer, and location of refueling points. That same driver must be prepared to make split-second decisions based upon new information—for example, accelerating out of an ambush zone. Regardless of the scenario, the goal is to use energy to the greatest net benefit.

EXPANDING PERSPECTIVE

Nearly every military role, from the lowest ranking enlisted soldier to the Chairman of the Joint Chiefs, must take energy implications into account as they fulfill their responsibilities. Tactical use cases are easy to visualize, involving dismounted soldiers and vehicle drivers. Operational and strategic-level considerations and decisions are somewhat more complex. In 2009, the President ordered a build-up of forces in Afghanistan. Energy was a significant consideration for military leaders faced with balancing strategic goals, cost and risks associated with force projection into a land-locked country surrounded by rugged terrain. Later, energy supply routes became an important factor in negotiations with Pakistan. Meanwhile energy factored into operational plans, impacting force sustainability, flexibility, simplicity, and cost, even as it also played an important role in building local, regional, and national stability through measures which included local energy resource development and improvements to the national grid.

The significant role of energy in stability operations has received inordinately little attention in Army doctrine and requirements domains, despite repeated lessons. In 2004, then Major General Peter Chiarelli made headlines when he described how his 1st Cavalry Division had observed and leveraged a correlation between improvements in energy and other essential services, and local stability—in turn supporting operational outcomes.[10] Many others have recognized this connection, and energy continues to be an important component of U.S. national strategy in Afghanistan, and as well as in Africa.[11] Despite this significance to stability operations and the implications to national military strategies, Army doctrine and training remain largely silent with respect to energy solutions and their contributions toward stability operations goals.

To date, OE efforts have focused on the context of deployed maneuver operations, with Afghanistan and Iraq at the center of attention. Fortunately, the high operational tempo brought to the forefront military capabilities of agility, endurance, and effectiveness and, in turn, their dependence upon such energy attributes as density, flexibility, and conversion efficiency. Moreover, the new energy-informed concept seeks to mature the energy exercise from an algebra of "using less" to the calculus of "being more effective." Unfortunately, the remote nature of these conflicts has enabled a persistent and comfortable mental separation between domestically-based activities, in which consumers continue to seek energy minimization, and "operational" thinking with its more complex focus on national security outcomes. For example, the military has formalized and strongly delineated "installation" and "operational" energy concepts, procedures, and authorities. As the operational tempo subsides and attention returns to enduring operations, this artificial distinction is becoming problematic.

THE INSTALLATION ENERGY DILEMMA

Even before OE became a recognized concept, military energy requirements were diverse and decentralized, as were management processes. Cost control and environmental concerns motivated various executive orders and laws, in turn forming the basis for broad energy sustainability goals. Mission assurance and critical infrastructure programs developed separately to address concerns about potential interruptions to energy supply and their disproportionately negative impacts to ongoing missions—especially given the growing potential for adversaries to trigger such disruptions through asymmetric physical or cyber attack. Energy sustainability goals, tracked through installation management chains, focused upon minimization while critical infrastructure programs, managed within operational channels, justified incremental expenditures necessary to add layers of protection. As energy performance responsibilities have aggregated within each service to a single authority, those leaders now face a confusing dilemma as they wrestle with apparently competing demands of minimization, performance, and risk management.

Meanwhile, the current taxonomy of "operational" versus "installation" energy is less of a logical anomaly than "mixing apples and oranges"—it is rather like comparing apples to eating. OE relates requirements to the nature of activities—the verb of the military—which range from ground maneuver to sustainment, intelligence, network, and space operations. Installations, on the other hand, are the noun; the enduring locations that, in fact, support diverse operations as well as "force generating" functions, such as education and family support. One obstacle to progress is the common presumption that it would be necessary, but confusing or disruptive to reshuffle organizational authorities, and especially to change the accounting of energy that is already tracked through different reporting systems. This notion, however, ignores the true nature of OE concepts and defers progress toward a unified approach; one that would universally embrace the concept of energy as a component of operational success. Deriving and implementing operationally-based energy capability and performance requirements for activities on fixed installations would no more require a transfer of authority than does the implementation of safety or anti-terrorism standards in those same facilities.

The 2010 *Quadrennial Defense Review* recognized that energy is important to national security, not only at a tactical level but in light of strategic issues and long-term impacts.[12] Local or regional availability of energy supplies and force flexibility, for example, can impact national options to project force. Climate changes could impact not only sustainment of future operational capabilities, but regional stresses and conflict. Moreover, many argue that economic stability is the strongest underpinning for national security, and that the heretofore growing dependence upon imported fossil resources, financed by foreign debt, has steadily undermined America's security posture. With energy in the forefront, military energy leaders are seeking ways to reconcile everyday budget challenges with tactical concerns about cyber attack and natural disasters, meanwhile seeking ways to strengthen the U.S. domestic energy posture. The United States military must apply "energy-informed" thinking to reconcile these complex sets of issues and time frames.

RESILIENCE AS THE FUTURE DIRECTION

Fortunately, analysts across a number of communities have identified a common language that promises to provide a unifying framework for the panoply of energy concerns. Forward-thinking leaders are converging on resilience as a concept to guide us toward a more robust future in the face of growing uncertainty and change. Resilience is rapidly gaining attention in the form of books and even dedicated research centers at Northeastern University, the University of Toronto, and Stockholm University. It is becoming a consistent theme within national security guidance, including presidential guidance on the National Response Framework[13] and climate change.[14]

A recent National Academies of Science report describes resilience as the ability of a system to perform four functions with respect to adverse events: planning and preparation, absorption, recovery, and adaptation.[15] This concept is scalable in extent and time. Organisms and devices may be deemed resilient, while the newly-formed President's task force on climate change is considering much broader and longer-range issues. Resilience goals seek to reinforce a system's capacity to achieve important outcomes under a broad range of changing conditions. Resilient design postures for the unexpected by ensuring that underlying systems are robust and by eliminating vulnerable relationships, rather than simply protecting them against predicted threats. More importantly, promoting resilience naturally aligns efforts, such as cyber security or sustainability, that otherwise might seem unrelated or even in conflict. (See Figure 14-2.)

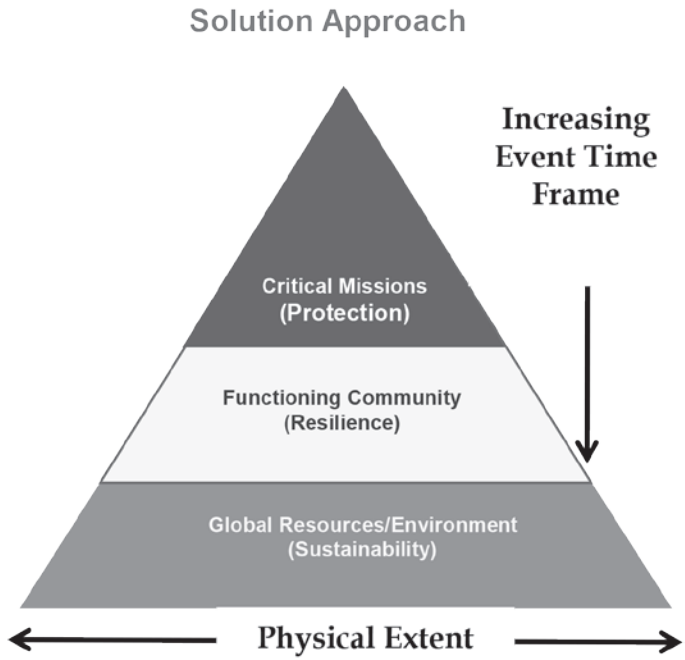

Figure 14-2. Resilience Fills the Solution Gap.

Resilience is naturally aligned with energy-informed thinking. The latter challenges each person to understand how energy supports the operational objective—not just by using less of a commodity, but by balancing complex factors to achieve desired outcomes under a range of conditions. The human factor is also common, as the resilience of human organizations invariably depends most heavily upon the posture of the population. Tornado-prone communities in Kansas exhibit resilience, not because they have well-established "911" networks, but because citizens emerge from their cellars after the storm with first aid kits, food, and water to help their neighbors. They work together to clean-up, rebuild, and support each other as they grieve their losses.

Transforming the nation from its trendy concern about the "threat of the day" will require yet another adjustment. The February 2008 Defense Science Board report triggered a flurry of interest in establishing capabilities to "island" military installations in the event of extensive power grid outages. Subsequent initiatives have advocated for additional actions that target specific vulnerabilities, such as large power transformers (pre-stage spares) and specific cyber exploits. Protecting against known threats is a logical complement to resilient design, but such narrow solutions will not sustain social order, economic health, and military capabilities under a broad range of conditions. In simplest terms, few U.S. military installations are "islandable." Instead, they share essential capabilities with their surrounding communities. Food, water, transportation, communications, health care, law enforcement, and emergency response represent just an abbreviated list of services for which military installations rely upon civilian capabilities. Building resilience would necessarily entail collaboration across a community and even a region.

CONCLUSION

Energy no longer can be treated simply as a commodity to be minimized. Like information, energy is a multi-attribute entity whose net contribution to capabilities and performance depends upon how it is managed. OE has emerged as a model to enable informed use of energy to achieve the greatest net value for a given situation. Implementing this energy-informed concept, though, requires individual and organizational understanding of the business or operational objectives, the various effective energy contributions and liabilities, and tools to manage energy use in the application at hand. This new concept has led each of the military services to undertake "energy culture" initiatives with heavy emphases on education and training, but balanced with investments in enabling technologies.

Although focus to date has been on deployed operations, the energy-informed approach to OE applies equally to global operations at all levels—tactical to strategic. This suggests the need to engage operational communities such as space, network, and intelligence operations that have not yet been central to service OE efforts. This expanding perspective will bring additional challenges. First, many of these operations involve more complex technologies and systems, thereby complicating the challenge of sorting out energy implications and decisions. As with most changes, organizational aspects promise to be the greater challenge. To date, OE principles have been implemented within deployed operations, but largely ignored in installation energy management programs. Applying energy-informed principles to missions projected from enduring infrastructure will require reconciliation of the multi-attribute OE capability and performance model with existing installation management processes, in which energy currently is treated essentially as a commodity.

Ultimately, OE offers a prospective platform from which to launch a broader resilience thrust across military communities and beyond. Resilience provides not only a means to relate energy to outcomes; it also represents a useful model to address uncertainty and change in a dynamic, globalized world. Adoption of resilience principles will require a difficult mental transition from traditional methodologies that seek to quantify and definitively disposition risk, yielding to more fundamental systems analyses and collaborative processes which, in turn, posture the overall system to perform well under a broad range of conditions. This adjustment inevitably will be uncomfortable for some, but most will quickly recognize that military operations are not self-reliant; that nearly every essential service depends upon nonmilitary partners. Teaming for energy resilience is simply a next logical step, building upon such existing community partnerships as those in health care and law enforcement. Energy is a key element in U.S. economic success, social order, and national security. OE and its natural outgrowth of resilience offer important pathways to align each of these concerns through mutually-supporting objectives.

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CHAPTER 15

HACKS ON GAS:
ENERGY, CYBER SECURITY, AND U.S. DEFENSE

Chris Bronk

Cyber security in the energy sector can trace its start to an account (that may or may not be true) about U.S. involvement in a computer based attack on the energy infrastructure of the Soviet Union during the Cold War. Elements of the incident are described in the memoir of Thomas C. Reed, an official in the administration of President Ronald Reagan and a former National Reconnaissance Office director.

The incident, part of what is known as the "Farewell Dossier," involved Soviet Secret Police (KGB) officer Vladimir Vetrov's service to French intelligence from 1981-82. Vetrov is alleged to have provided key Soviet technologies for both military and civilian applications, including computers used for process control in industrial technology. As the story goes, Vetrov's alleged counterintelligence work eventually led to the delivery of a faulty computer design to the Soviets. Designed to fail, the device allegedly caused a massive pipeline explosion in 1982, but there are differing accounts and disputes on the details. However, according to the Central Intelligence Agency's (CIA) Center for the Study of Intelligence, the United States supplied flawed technologies to the Soviet Union through the KGB's "Line X" intelligence effort.

The CIA and the Department of Defense (DoD), in partnership with the Federal Bureau of Investigation, set up a program to do just what was mentioned previously: Modified products were devised and "made available" to Line X collection channels. The CIA project leader and his associates studied the Farewell material, examined export license applications and other intelligence, and contrived to introduce altered products into KGB collection. American industry helped in the preparation of items to be "marketed" to Line X. Contrived computer chips found their way into Soviet military equipment, flawed turbines were installed on a gas pipeline, and defective plans disrupted the output of chemical plants and a tractor factory.[1]

Exactly what wound up where and produced what particular outcome is subject to debate. Jeffrey Carr, a security blogger and author, asserts that the Farewell cyber incident is no more than an "oft-repeated rumor" that has been generally accepted as fact. He asserts that the real cause was a pipeline operator ignoring warnings and allowing pressure to build, causing the catastrophic blast.[2]

While it is unclear if a major Siberian blast took place in 1982, operator error was likely to blame for an explosion in 1989, when natural gas liquids leaked adjacent to the Kuybyshev Railway near Ufa, Russia, and passing trains ignited the resulting gas cloud. The major detonation killed more than 500 people.[3] In remarks to the Soviet Congress of People deputies, Mikhail Gorbachev attributed the explosion to pipeline operators miles away who, after noticing a drop in gas pressure, simply turned up the pumps rather than investigate the issue.[4]

CYBER INSECURITY AND ENERGY SECURITY

Cyber security has grown to be a preeminent concern for the national security organs of the U.S. Government.[5] Within certain circles, one need only say "cyber" to indicate the topic of cyber security. It has become an area of great interest, but in cyber security, there is also tremendous ambiguity. How great is the threat to the United States? Its overseas interests? The U.S. economy or armed forces? Cyber security practitioners and experts have some idea, but there is a degree of hyperbole surrounding the issue and some heads in the sand as well.

How cyber security issues fit into energy puts some boundaries on the problems faced, but it is important to consider what is meant by "energy security." Writ large, energy security for the United States is the capacity for U.S. consumers—be they individuals, organizations, corporations, or government agencies—to gain access to the energy supplies they need or want.[6] Foreign embargos, tropical cyclonic activity, midstream plant disasters, and military action are all potential threats to energy security for the United States. Energy production in the United States is changing, however, and affecting how America meets its energy needs.

We cannot consider threats to energy security without acknowledging the rise of oil and gas production in the United States over the last decade. Computer-aided, horizontally drilled, hydraulically fractured oil and gas drilling has produced a dramatic rise in domestic production, now totaling some seven million barrels of oil per day[7] and 2.1 million cubic feet of natural gas per month.[8] U.S. production gains provide a degree of security from disruptions in international supply, but it is necessary to acknowledge that oil is traded on a global market, and regional gas markets may increasingly become interlinked over time. Thus a disruption in the Persian Gulf, East Asia, or Africa does not insulate prices paid for oil or even gas in the United States.

In addition to the supply of energy, including coal, nuclear power, and other sources (each with its own environmental issues), there are the matters of processing and distribution. This represents the remainder of the energy supply chain, which, among other items, includes gas, coal, and nuclear power stations; electricity grids; oil and gas refineries; and pipelines. We should be concerned with cyber security in energy because, as with other areas of the global economy, computing has been widely adopted in the energy industry. Supercomputing is a key component to seismic analysis. Refineries are increasingly driven by Supervisory Control and Data Acquisition (SCADA) systems. The U.S. electrical grid has incorporated "smart" elements, including digital sensors, meters, and monitoring systems. The ubiquitous Internet Protocol interconnects many of these computers.

If there were no networked computers in the energy supply chain (from exploration to the pump or outlet), discussion of cyber security issues would be moot. But for decades, computation has been deeply incorporated into energy exploration, production, distribution, and consumption, as well as into the corporate and managerial activities supporting these functions. Thus, cyber security is an issue for the energy industry. While many scenarios posit a massive hack of the electricity system and its catastrophic failure, there are plenty of other more likely and less spectacular energy cyber security issues.

Three major cyber concerns in the oil and gas sector have been identified[9]: (1) theft of core intellectual property; (2) disruption or destruction of a physical plant and other points of capital investment; and, (3) compromise of communications by executive decisionmakers regarding key business decisions. Cyber security research related to energy is punctuated by breaches that align, to some degree, with the potential incidents we can imagine. It is important to remember that the Stuxnet worm (a piece of self-propagating malicious software) was ostensibly aimed at an energy target—the Iranian nuclear enrichment infrastructure. Another worm, Shamoon, spread rapidly across the personal computers of Saudi Aramco at an incredible speed, deleting the contents of perhaps as many as 30,000 hard drives and also impacting systems at other companies.[10]

What such cyber attacks mean to U.S. energy security and the security of energy needed by DoD requires some consideration. At a global level, we need to consider how likely an oil or gas disaster produced or facilitated by cyber means actually is and what can be done to mitigate that threat. For DoD, important questions need to be raised about the security of computer systems employed in the distribution of electricity and fuels from major bases to forward deployed elements in contact with hostile forces.

There are likely three major areas of energy related cyber vulnerability that are relevant to the U.S. Army: (1) the provision of electricity to bases and facilities by the electrical grid, both in the United States and abroad; (2) the distribution of fuels to forces often operating some distance from major logistical hubs; and (3) major cyber attacks against suppliers of fuels that would result in a significant disruption of supply or a rise in price. Other scenarios of attack are no doubt possible and are limited only by vulnerability, technical know-how, and imagination. This is very much a ranked order, however, as cyber attacks against the grid are alarming and potentially achievable. Cyber attacks against Army logistics should be taken as a given, and a massive cyber attack against the oil and gas industry would be of great concern far beyond DoD.

CYBER ATTACK AGAINST THE ELECTRICITY SYSTEM

In a 2008 report, the Defense Science Board (DSB) stated, "critical national security and Homeland defense missions are at an unacceptably high risk of extended outage from failure of the grid." In 2006, DoD consumed some 3.8 billion kilowatt-hours (kWh) of electricity and spent $3.5 billion for energy to fixed installations. Electricity services for DoD are sourced overwhelmingly from the private sector. "About 85 percent of the energy infrastructure upon which DoD depends is commercially owned, and 99 percent of the electrical energy DoD installations consume originates outside the fence." The electricity grid is characterized by the DSB as, "fragile, vulnerable, near its capacity limit, and outside of DoD control."[11]

Threats to the stable operation of the grid include overload, natural phenomena such as earthquakes or storms, physical acts of sabotage, and cyber attack. The broad impact of major outages and prolonged disruption to the electrical grid have been felt by many in the United States. A blackout in the northeast on August 14, 2003, affected as many as 50 million Americans and Canadians. Hurricane Sandy, which struck the New York City metropolitan area late in autumn 2012 at Category 3 force, left as many as 7.9 million customers without power, many for a week or more.

Before delving into hypothetical cyber attacks on the electrical grid, it is important to note how an electrical grid can fail, as well as the problems faced in restoring electrical service. In the 2003 blackout, the cause was improper trimming of trees near a power line, which led to a series of cascading failures. It is necessary to emphasize the relevance of these cascading failures, and the amplified butterfly effect of one small disruption potentially triggering a major fault in the system. When the grid overloads, electricity production is taken offline until the load can be successfully rebalanced. The restoration process may be hampered by damage to key components for which spare inventories are generally scarce and producers are few.[12]

This system—one that is highly dynamic, but needing to remain in equilibrium between supply and demand; prone to cascading failures; and posing significant difficulty in repair—is why there is great concern in policy and cyber security circles regarding its vulnerability to cyber attack. The grid is also changing rather rapidly. Among the most visible manifestations of this change were utility company deployments of smart grid technologies funded with $11 billion under the American Recovery and Reinvestment Act of 2009 and by private investments.[13]

Smart grid technologies are intended to bring computational resources to the management of the electrical grid. While the most common and visible pieces of the smart grid systems being deployed in the United States are digital meters appearing where spinning dial analog meters once resided, smart grid activities are designed to do much more than change the measurement vehicle for billing. A smart grid implementation should offer enhanced reliability, increased efficiency, and load adjustment, as well as the capacity to incentivize use of electricity outside of peak use periods. An additional argument for a smart grid, falling under the category of "reliability," is the potential to better observe damage to the physical infrastructure through the deployment of sensors throughout.

It is this deployment of computer-driven sensors and other devices designed to change the state of the electrical grid that is of concern with regard to cyber security. SCADA systems in electricity are an ongoing activity, as in all manner of other sectors from manufacturing to water distribution. What is relatively new is the networking of these SCADA devices together. Deployment of SCADA devices and other pieces of computing hardware into the electrical grid expands its notional attack surface.[14]

How much this attack surface is exposed to unauthorized users and vulnerable to manipulation is the key question. Setting aside the worst case, such as scenarios of a massive disruption bringing down the grid for weeks or months, there are many unanswered questions about how we can measure the degree to which deployment of computing throughout the grid has made its ongoing operation riskier. But we know from attempted and successful physical attacks on the grid that there are vulnerabilities.

In April 2013, an assailant(s) fired more than 100 rifle rounds into a Pacific Gas and Electric substation in San Jose, California, severing nearby fiber optic cables in the process.[15] On August 21, 2013, power transmission lines were severed in Central Arkansas. Two days later, a fire was set at an Extra High Voltage switching facility nearby.[16] The alleged assailant in the Arkansas cases was apprehended and indicted, and disruption in both incidents was fairly minimal.

A widely confirmed, well-documented cyber attack against the electrical grid that definitively demonstrated a disruption of service has not occurred.

Rumors abound, but reliable evidence is scant. The Idaho National Lab did stage a cyber attack on a generator, causing it to self-destruct in 2007. On the matter, known as Aurora, security technologist Bruce Schneier commented:

> I haven't written much about SCADA security, except to say that I think the risk is overblown today but is getting more serious all the time—and we need to deal with the security before it's too late. I didn't know quite what to make of the Idaho National Laboratory video; it seemed like hype, but I couldn't find any details.[17]

Several years later, such an attack remains largely hypothetical, although the Stuxnet cyber attack against the Iranian nuclear program's enrichment facilities demonstrated the viability of a cyber attack against a SCADA system in an energy facility. In the wake of Stuxnet, the North American Electric Reliability Corporation (NERC) published a major cyber attack task force review providing guidance to the electricity sector beyond the cyber elements of its NERC–Critical Infrastructure Protection (NERC-CIP) standards.[18]

Beyond NERC, Congress has taken up the issue of electricity vulnerability to cyber attacks. In 2013, Edward Markey, then a U.S. Representative from Massachusetts, and Representative Harvey Waxman released a report based on surveys sent to over 150 utilities and other providers of electricity in the United States. The report concluded that utilities are regular cyber attack targets, and that, while they comply with mandatory standards, they often do not implement voluntary NERC recommendations. What remains unclear is how often the electrical sector is attacked in a manner that directly targets SCADA systems impacting production or distribution of electricity.

While actors in the electricity sector may be "attacked," the definition of a cyber attack is broad, so that anything from viruses to email phishing campaigns is counted as an attack. However, the security of relevance to national security is an attack against the computing infrastructure directly involved in getting power to customers.

While discussion on electricity and cyber security is largely focused upon disruption via compromise of SCADA systems, some have pointed out that energy demand reported from the grid by computerized sensors could be replaced with false information.[19] Such activity could then be used to subvert the function of the pricing market for electricity. While this represents a hypothetical vulnerability, informal reporting from electricity distributors indicates that, if anything, deployment of smart grid sensing facilitates rapid detection of electricity theft. We can assume that where such theft occurred by cyber means without swift remedy, it might go undetected for some time.

Clearly, cyber security and electricity in the United States and abroad present many issues of concern. DoD would be well served to carefully engage in efforts similar to those undertaken by the Department of Homeland Security to improve the cyber defenses of industrial control systems deployed in electricity. Exactly how DoD would do this in an atmosphere charged by the Eric Snowden leaks and valid industry concerns of onerous and imprecise federal regulations on cyber security is to be determined. Nonetheless, there is a real threat, and the most significant issues likely remain either unknown or unreported. This is likely also the case in oil and gas production as well.

HACKING THE OIL AND GAS SECTOR AND THE DOD ENERGY SUPPLY CHAIN

Cyber threats to energy production in the oil and gas sector are of rising concern to industry and government. Like participants in other major industries, oil and gas firms are frequently targets of espionage activity, which has heavily migrated online. But a less generic concern is the targeting of critical infrastructure employed to produce, transport, refine, and distribute oil and gas. This issue was summarized in a 2013 report by the Council on Foreign Relations:

> [A] major risk facing the oil and gas industry is the disruption of critical business or physical operations by attacks on networks. As information technology's role in all phases of oil and gas production—from exploration and production to processing and delivery—expands, the vulnerability of industry operations to cyberattacks increases. A hacker with the right tools, access, and knowledge could, for instance, identify the Supervisory Control and Data Acquisition systems (SCADA) and industrial control systems (ICS) used to operate critical infrastructure and facilities in the oil and gas industry and that are connected to the Internet.[20]

Much like electricity, there is reason for significant concern about cyber attacks against the infrastructure of the oil and gas industry. SCADA systems abound in production and refining operations, and there is valid concern that a compromise of such a system could produce a major spill or explosion. Security of SCADA computing is the primary mission of the U.S. Department of Homeland Security's Industrial Control System–Cyber Emergency Response Team (ICS-CERT). ICS-CERT's core mission is to provide the operators of SCADA systems with warnings of threats or compromises that would damage business operations or the public at large.

The Shamoon malware incident of August 2012 was perhaps the most significant cyber attack to be directed against the oil and gas industry. Delivered to the computer network of Saudi Aramco, likely by insertion upon a computer inside a company facility, Shamoon significantly impacted the computer network and computing infrastructure of the company. According to Aramco officials, it did not impact production by the Saudi national oil company. What Shamoon did do was to delete the digital contents of computer hard drives, very quickly.[21] Perhaps as many as 30,000 computers were affected at Aramco,[22] plus additional machines at RasGas, a joint venture of QatarGas and Exxon-Mobil. Because Shamoon was a piece of self-propagating software, concern over its spread leapt beyond Aramco, which was the ostensible target, to companies providing services to Aramco, and quite possibly to almost any organization interfacing with the Aramco network.

According to Aramco, Shamoon did not impact oil and gas production, indicating that it did not jump to computers involved in that production. Fear of a cyber attack able to impact computers responsible for driving physical infrastructure is a foremost concern in the oil and gas sector, both as a security and safety issue. A related concern is the compromise of process control computing in the petrochemical industry. While it may be routine to hear of Cyber Pearl Harbor scenarios, there is the potential for considerable loss of life or environmental damage from a "Cyber Bhopal" event.

Ralph Langer, who contributed heavily to the reverse engineering of the Stuxnet malware, made important points on this oft-neglected area for concern. In an interview with former National Security Agency (NSA) general counsel and Department of Homeland Security (DHS) official Stewart Baker, he stated:

> Chemical plants run on industrial control systems; they could be remotely instructed to release gases that will kill the people in surrounding neighborhoods in a Cyber Bhopal scenario. That's a huge problem because there are several thousand potential chemical targets in the U.S alone.[23]

While the possibility of subverting the systems of the petrochemical industry remains a hypothetical scenario, the response to such an event would most certainly require intervention of federal agencies. This is an obvious homeland security concern, and one that will require diligence from the petrochemical industry as well as the intelligence community. Broader concern about a massive hack disabling the oil and gas sector should be bounded by an understanding of what can be attacked and how.

The probability of a massive cyber attack disabling the oil and gas industry's production, refining, and distribution likely is very low, as each piece of infrastructure is generally constructed with computing components available at the time of construction, possesses a far more limited feature set, and is usually designed to perform a single function. An attack like Shamoon was able to be significant because it compromised a massive number of homogenous computer systems designed to run a fairly broad set of applications. Achieving the same impact against a massive number of programmable logic controllers across multiple facilities is a far more difficult task to accomplish.

For DoD, vulnerability exists in the distribution of fuels, where there are also likely issues of cyber attack and disruption. Much like other large organizations, DoD has adopted networked computers for all manner of administrative and logistical activity. The Defense Logistics Agency (DLA) holds the mandate for fuels provision for the armed services and has developed enterprise computing tools to perform its fuels supply mission.

Since the 1990s, DoD has built upon the Fuels Automated System (FAS) a variety of applications that now fall under the label of the Enterprise Business System (EBS).[24] DoD fuels management is paperless, and utilizes Windows-based client-server applications and Web-based applications where data is entered and received via an Internet browser. Rather than develop an entirely bespoke fuels management system, DLA has deployed an Enterprise Resource Planning (ERP) software package including commercial, off-the-shelf technology, including components from SAP, the self-described market leader in enterprise application software.[25]

Employment of commercial software allows it to be run on commodity computer hardware, such as Intel-based personal computers and servers running the Windows operating system. This has been done for economic reasons, as the Windows-Intel platform has grown to near ubiquity in the U.S. Government and throughout corporations in the United States. DLA's EBS Energy Convergence program will deploy further SAP elements designed to function easily with oil and gas industry standards and practices.[26]

Regarding cyber security of fuels data, a sophisticated attacker is likely aware that DoD is running SAP products on DoD's Non-classified Internet Protocol Router Network (NIPRNet), which includes connectivity to the public Internet. While some other DoD networks are protected by an air gap, a complete physical disconnect from networks connected to the Internet, the logistical activities of DoD are primarily unclassified and Internet-connected so as to benefit from automation in business processes accepted as proper practice in logistical activities. This is not aberrant behavior, as maintaining a classified computing environment to manage fuel acquisition and distribution with private sector organizations would be technically infeasible and uneconomical.

The question then turns to how secure the systems employed in managing fuels for DoD may be. Evidence of the level of cyber security on DoD fuels systems is fairly scant, with the exception being a 2006 DoD Office of Inspector General audit on information security controls in the DLA's business systems modernization. It noted a number of Internet technology (IT) security problems in the EBS modernization, including: incomplete system certification and accreditation; failures in addressing security weaknesses; incomplete user management procedures; inconsistency of security training; and out-of-date continuity of operation plans.[27]

The EBS audit results, however, do not necessarily reflect upon the capacity of DLA's software to stand up to a cyber attack; rather, they highlight organizational shortcomings in meeting cyber security requirements spelled out in the provisions of the 2002 Federal Information Security Management Act (FISMA). In 2006, the Office of Management and Budget (OMB) gave

DoD a failing grade for its FISMA report. But OMB's measurement of cyber security efforts, and, indeed, any relation between FISMA scores and maintenance of an effective cyber security effort at an agency level, has been questioned. Richard Bejtlich, a well-regarded cyber security expert, expressed his opinion of the process when the 2006 scores were released. He argued:

> Agencies with high scores are no more secure than agencies with low scores. High-scoring agencies just write good reports, because FISMA is a giant paperwork exercise that makes no difference on the security playing field.[28]

That DLA has difficulty meeting all of the requirements of FISMA in deploying computer systems should be no surprise. What is important, however, is the capacity for resilience, which ensures continuity of operations for DoD and Army fuels logistics. This appears to be a rising trend in cyber security, as the mindset shifts from a network defense model in which the goal is to keep intruders out, to one where resiliency and recovery are embraced as core objectives.

CYBER AND ENERGY: SOME PRESCRIPTIONS

Some time ago a colleague asked a well-regarded cyber security analyst for some guidance on a message for top corporate leaders regarding the problems faced by their IT security staff. He offered the following: "The Chinese are on your network and you probably know about it; the Russians are on it and you probably don't know about it; and give up." While the U.S. Army clearly cannot give up on cyber security, an acceptance of cyber vulnerability is required with regard to its computer systems and those upon which it depends to perform its missions.

In coping with cyber security issues as they pertain to energy security matters, it is worthwhile to consider several items moving forward.

- Recognize that cyber incidents, like safety or disruption events, are not just organizational issues, but also issues of potential concern across an extensive, interconnected energy supply chain.
- Develop trusted third party and clearinghouse relationships aimed at developing better cyber intelligence and analysis.
- Produce and constantly refine models of cyber risk intelligence, merging the valuation of assets/processes, threats, and reasons for potential compromise.
- Consider the cyber security ramifications as the Internet expands to cover more and more infrastructure, including hundreds of millions of energy-related computing devices.
- Connect the spheres of geopolitics and the technical aspects of cyber security to develop holistic models for coping with the cyber security problem.

These recommendations represent an initial thrust of activity, but instituting them will require difficult shifts in behavior for government and industry. Additionally, it is worth considering how cyber incidents can play out very quickly. For instance, the compromise of the Associated Press's Twitter feed by the Syrian Electronic Army and its transmission of a bogus tweet regarding an attack on the White House led to the issuance of a high volume of sell orders in the New York Stock Exchange (NYSE) due to trading algorithms that "read" the tweet. In less than 2 minutes, the value of the NYSE fell by roughly $136 billion. The index recovered quickly, but there were both winners and losers on the deal. Although the energy industry may not hold a similar sort of vulnerability, we must assume that foreign adversaries, including states and transnational actors, will target it. Deep analysis not only on vulnerability, but also on the resiliency of the energy supply chain to cyber attack is therefore necessary.

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CHAPTER 16

THE NORTH ATLANTIC TREATY ORGANIZATION'S (RE)ENGAGEMENT ON ENERGY SECURITY: MANAGING UNMET EXPECTATIONS

John R. Deni

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The role of the North Atlantic Treaty Organization (NATO) in energy security has been growing in recent years in practical terms and certainly rhetorically. However, the results of NATO's efforts have been decidedly mixed. On the one hand, the Alliance has clearly become engaged in what appears to many member states as a compelling security issue. As early as 2006, and arguably since the 1999 strategic concept, the Alliance has recognized that it may have a role to play in energy security, particularly beyond the traditional realm of energy in a logistical military context, or **operational** energy security.[1]

On the other hand, though, there remains a rather conspicuous lack of progress or activity much beyond the realm of operational energy security. This somewhat ironic outcome reflects the lack of consensus within the Alliance on granting any further authority or responsibility to NATO for broader energy security issues, despite the Kremlin's use of energy as a political weapon against European countries. As a result, and despite the often expansive rhetoric used by Alliance leaders and in official declarations, the practical outcomes and related implications of NATO's efforts have been quite limited. Nevertheless, there are steps the United States can take, including leveraging the role of NATO, to enhance energy security for all of the allies.

NATO'S (LATEST) ARRIVAL ON THE ENERGY SECURITY SCENE

In 2005, Gazprom, the Russian natural gas monopoly noted for its heavy-handed negotiating tactics and for essentially functioning as an arm of the Kremlin,[2] informed leaders in Kyiv, Ukraine, that it "would demand higher gas prices from Ukraine in 2006." Specifically, Gazprom sought to increase the rate paid by Ukraine in 2006 from $50 per 1,000 cubic meters to $220-$230 per 1,000 cubic meters, or roughly what the countries of Western Europe were charged.[3] Certainly not by coincidence, these demands were leveled just months after the Kremlin's preferred presidential candidate in Ukraine, Victor Yanukovich, had lost in a rerun of a November 2004 election, which was marred by extensive fraud.[4] The government of Ukraine's new, more Western-leaning president, Victor Yushchenko, naturally could not afford to pay Western rates, and so negotiations remained stuck through the end of 2005.

Subsequently, on January 1, 2006, Gazprom made good on its threats and cut off all gas supplies to Ukraine. Although Gazprom claimed it was still sending natural gas to its other European customers through pipelines that cross Ukrainian territory and Ukraine claimed it was not siphoning off gas to which it was not entitled, falling pressures and/or nondelivery of gas were reported by European gas companies in Austria, France, Germany, Hungary, Italy, Poland, Romania, and Slovakia.[5]

The cutoff lasted only a few days, and following a preliminary agreement that provided some reasonable stability in prices through mid-2006, the gas supply to and through Ukraine was resumed. Nevertheless, the lesson for many in Europe was clear—Russia had the willingness and ability, through Gazprom, to employ energy as a political weapon. Given the dependence of many Eastern European members of NATO on Russian energy supplies, it came as little surprise, then, to see that NATO would address energy security in some form at its next summit, in Riga, Latvia, just a few months later.[6]

During the Riga summit meeting, in November 2006, the Alliance declared its support for a coordinated, international effort to assess risks to energy infrastructures and to promote energy infrastructure security. More broadly, the member states directed the international staff at NATO headquarters in Brussels, Belgium, to consult on the most immediate risks in the field of energy security. The purpose of these consultations would be to define those areas where NATO could add value to safeguard the security interests of the allies and, when requested, assist national and international efforts. None of these planned activities—"consultations," "assessments," coordination of "efforts"—were particular earth-shattering in terms of their practical implications. Nevertheless, in sum, the Alliance had clearly decided to take a limited but decisive step into the realm of energy security.

However, the Alliance's response at Riga to the 2006 Ukraine-Russia gas dispute was not the first time NATO had expressed interest in energy security.

During the Cold War, the Alliance's concerns over energy security primarily focused on **operational** energy security—that is, the energy needed for allied military forces to operate effectively. As a result, the Alliance tended to think about energy from a logistical perspective, and it focused on initiatives such as the NATO Pipeline System (NPS), a collection of military fuel storage and distribution systems.[7] Today, the NPS consists of eight national pipeline networks—in Greece, Iceland, Italy, Norway, Portugal, Turkey (two separate systems—east and west), and the United Kingdom (UK)—as well as two multinational pipeline systems—the North European Pipeline System (NEPS) located in both Denmark and Germany, and the Central Europe Pipeline System (CEPS) in Belgium, France, Germany, Luxembourg, and the Netherlands.

The 2006 summit declaration represented a serious shift to consider energy security beyond the realm of fuel handlers and supply chains. Nevertheless, it was still unclear following the Riga summit just how far NATO's energy security focus would grow beyond logistics to perhaps address critical energy infrastructure protection or even the impact of energy shortages or price hikes on economic growth and societal stability.[8]

The Alliance attempted to refine its approach through 2007, the result of not simply guidance from the Riga summit but also continued pressure from allies such as Poland and the challenges brought on by increasing energy prices around the world.[9] As a result, during the April 2008 Bucharest, Romania, summit, the Alliance declared its intent regarding energy security somewhat more concretely. That is, the Alliance agreed to take several steps in the realm of energy security:[10]

1. Engaging in energy security-related information and intelligence fusion and sharing;

2. Projecting stability;

3. Advancing international and regional cooperation;

4. Supporting consequence management;

5. Supporting the protection of critical energy infrastructure; and,

6. Continuing to consult on the most immediate risks in the field of energy security.

However, there was still some glaring vagueness in this agenda, such as projecting stability. Just 2 years later though, in 2010, NATO adopted energy security in its Strategic Concept. In that document—essentially the Alliance's strategy or mission statement—NATO declared that communication, transport, and transit routes on which energy security depends require greater international efforts to ensure their resilience against attack or disruption. The Alliance then resolved to develop the capacity to contribute to energy security, including through protection of critical energy infrastructure and transit areas and lines, cooperation with partners, and consultations among allies.

To summarize, during the second half of the last decade, NATO took some significant steps toward becoming more involved in energy security, compelled in part by Russian policies toward several of its Eurasian gas customers and subsequently by the somewhat predictable reactions of Poland and other newer members of the Alliance. The Alliance did so with an eye toward moving beyond the more rudimentary focus on logistical supply chains and toward protection of critical infrastructure and the safeguarding of broader member state energy interests. Unfortunately, the Alliance's plans to move beyond **operational** energy security, into what might be thought of as the traditional energy security sphere, have proven difficult to implement.

NATO STUMBLES

Since the release of the 2010 *Strategic Concept* and the initiation of NATO's efforts to move into the more traditional energy security realm, the Alliance has struggled to get beyond the conceptual. This is rather ironic, given the Alliance's clearly expressed intent in both summit statements and strategic plans. It is also rather surprising considering that in early-2009, Russia instigated **another** natural gas crisis in Eastern Europe. This time, Bulgaria, Romania, Poland, Slovakia, and Hungary were among those most affected by the inability of officials in Ukraine and Russia to come to agreement on energy prices and Moscow's subsequent cutoff of gas supplies to the West, which lasted 2 weeks in January 2009. Indeed, the 2009 crisis further spurred the European Union (EU) to pursue increased internal market integration and to promote greater diversification of supplies.[11] Given that most EU members are also members of NATO, it would seem natural for Alliance member states to accept a growing role for NATO in energy security as well.

However, the primary reason why the Alliance has failed to make progress in the broader, traditional, energy security realm—beyond operational energy security—is because there remain fundamental divisions within the Alliance in terms of attitudes toward energy security. Many states in the Alliance want energy security writ large on the agenda, and the other half is largely ambivalent. Complicating matters is the fact that, in some limited cases, there are some member states that are actually hostile to including energy security in NATO's portfolio.

Those that want the Alliance to adopt a broader approach to and be more involved in energy security include, but are not necessarily limited to, most of the newer Alliance members in Eastern and Central Europe. For these countries, vivid memories of life under Soviet domination continue to color most aspects of their relations with Russia, especially in policy areas where Moscow seemingly holds more cards.[12] As the Ukrainian-Russian gas dispute of 2005-06 gave way to other, similar disputes between Russia and Azerbaijan, Belarus, and Georgia, the newer NATO allies of Eastern and Central Europe became increasingly frustrated by the lack of an EU-wide approach toward energy, especially in the face of increasingly aggressive Russian tactics.[13] As a result, within the halls of NATO, these Eastern and Central European countries have become adamant supporters of including energy in the Alliance's portfolio, and these same countries were then largely responsible for forcing energy security onto the agenda at the Riga summit.[14] Unfortunately, they did so without much of a long-term, practical roadmap for what NATO would do specifically in this issue area, or for how they would reverse, overcome, or merely co-opt the ambivalence or hostility of other Alliance members toward securitizing the energy sphere. As a result, the NATO energy security agenda may appear to lack consistency or even much substance beyond the official declarations.

At the other extreme are some members that remain hostile toward Alliance involvement in this issue area, for a variety of reasons. Some in this camp argue, not incorrectly, that critical energy infrastructure protection is a national responsibility and/or a commercial matter, and so, for them, NATO involvement is an anathema.[15] Given the fact that energy security is increasingly taking on strategic importance for developed countries—as well as developing countries, particularly China and India as discussed in other chapters of this edited volume—it is perhaps understandable that Alliance members are reluctant to devolve too much sovereignty and decisionmaking to an intergovernmental organization, even one as successful as NATO, preferring instead to split responsibility and authority between national capitals and the EU.[16]

Some members believe NATO's engagement in energy security unnecessarily militarizes a nonmilitary sphere.[17] Indeed, precisely **because** the EU has become more involved in energy security issues—in a policy space where it, and not NATO, has clear purview—many in the Alliance believe that NATO's presence in this realm is unnecessary, and even unwelcome. The negative consequences for Europe of appearing to militarize the energy realm may be to discourage investments in energy exploration and infrastructure, place relations with producers on a confrontational footing, and generally **increase** political-military risks at a time when most in Europe are pursing the opposite.[18]

Finally, some believe NATO involvement in this issue area would offend Russia too greatly, potentially upsetting the delicate economic and trade interdependency that continues to develop between Russia and the rest of Europe. This group tends to include countries such as Germany and France, as well as some of the older allies. In Germany in particular, interest groups in the energy sector as well as several politicians argue that Russia remains a reliable energy partner, if only because Russia **needs** Europe—or at least the parts of Europe, such as Germany, that provide Russia with critical manufactured goods, advanced technology, and knowledge—as much as Europe needs Russia.[19] The degree of interconnectedness is no accident, and is indeed a product of purposeful post-Cold War German policy aimed at modernizing and democratizing Russia by cooperating with Moscow across a range of issue areas.[20] Today, the web of interconnectedness—especially in energy and energy-intensive industry—between Germany in particular and Russia is unprecedented since the end of the Cold War. Those who seek to protect and promote it believe that giving NATO too great a role in broader energy security issues beyond the very delimited issue area of operational energy security, a subject clearly within the Alliance's purview, risks upsetting that delicate web.

As a result, the Alliance has been unable to make much headway in implementing any significant energy security agenda. The Kremlin-instigated energy crises of 2006 and 2009, as well as Moscow's threats to cut off gas to Ukraine (and perhaps other parts of Europe) in 2014 have not resulted in a groundswell of support across the entire alliance for the collective energy security policy preferences of the Eastern European members of NATO. Certainly Russia's invasion and annexation of Crimea in 2014 have made it more difficult for members of the Alliance such as Germany, France, and Italy to give Moscow the benefit of the doubt and deny that the Kremlin continues to employ energy as a political weapon.[21] However, the continuing lack of a real consensus across the entire alliance means that NATO's energy security agenda remains limited.

THE SILVER LINING

Ironically, even though the Alliance has made little progress in terms of expanding its energy security portfolio beyond operational energy security, it is in the rather limited realm of the latter where NATO has actually added some value in recent years and where it might continue to do so in the coming decade. However, in this rather limited area of overall energy security, the Alliance's efforts are really a work in progress, as NATO attempts to build a coherent agenda. In particular though, there have been two key developments for NATO to date.

The first significant development in terms of the Alliance's work in operational energy security is the creation of a Smart Energy Team (SENT), which consists of representatives from six NATO allies, including the United States, and two partner nations.[22] This effort was launched in late-2012 by NATO's Emerging Security Challenges Division, and is funded by the NATO science program. The team of experts examines promising energy-related technologies and helps to formulate standardization agreements, which ultimately promote interoperability among the military forces of the allies. For example, in February 2013, SENT visited an "energy camp" established by Defence Research and Development Canada to survey energy efficiency applications in cold weather environments.[23] The team is also examining, "more efficient energy solutions for cooling and heating tents, including adjustable load generators, heat pumps, floor heating, and materials for insulation and for storing generated energy and solar energy."[24] In the short run, SENT is looking primarily for high impact, low cost projects and applications in order to show political leaders within the Alliance that savings can be generated immediately. Ultimately though, SENT will develop a package of proposals for concrete Smart Defence projects and NATO science program activities.[25] In the meantime, their work helps to propagate operational energy security issues and to expose members of the alliance to potential smart energy solutions.

The second significant development in the Alliance's work on operational energy security has been the establishment of an Energy Security Centre of Excellence in Vilnius, Lithuania. Originally formed as an Energy Security Center operating under the Lithuanian Ministry of Foreign Affairs, the government of Lithuania offered the center as a contribution to NATO's efforts in energy security in 2012. In response, the North Atlantic Council approved the establishment of a NATO Energy Security Centre of Excellence (ENSEC COE) during its May 2012 Chicago summit—the center was then accredited in October 2012, and it officially opened in September 2013.[26]

At the ceremony marking its opening, NATO's Secretary General Anders Fogh Rasmussen implicitly recognized the ongoing debate among member states over the Alliance's role in energy security, and specifically the concerns some members have over the potential militarization of energy security: "I strongly believe that most resource issues will be settled by the power of the market, not by the power of guns. Energy security is not a call to arms."[27] Nevertheless, the Secretary General expressed his view that the ENSEC COE would add value to NATO's efforts by providing analyses on energy developments, creating new opportunities for training and education, and improving operational energy efficiency.

Since its opening, the ENSEC COE has been engaged in commissioning several studies on operational energy issues, developing an operational energy concept in conjunction with Allied Command Transformation in Norfolk, VA, and crafting training programs on operational energy security. The ENSEC COE also plays an important role as co-director (along with the Joint Environment Department of the Swedish Armed Forces) of NATO's SENT, mentioned earlier, its activities are governed by a steering committee comprised of Estonia, France, Italy, Latvia, Lithuania, and Turkey. Although not yet members of the steering committee, Sweden, the UK, and the United States are reportedly interested in joining as well.

So far, the ENSEC COE and SENT remain the only two significant accomplishments for NATO in the realm of energy security. Certainly the alliance deserves some credit for the positive role that Operation OCEAN SHIELD has played in safeguarding the transit of energy supplies, principally petroleum, in the Gulf of Aden and off the Horn of Africa. However, this mission, ongoing in various forms since late-2008, was not and still is not devoted to energy security per se. Instead, it began by focusing on the security of shipments under the auspices of the United Nations's (UN) World Food Programme, and today it is focused on combating piracy broadly, not on energy transit explicitly.

LESSONS TO BE LEARNED . . . AND APPLIED

The reason why NATO's success in the energy security realm has been largely limited to the two initiatives outlined previously, is because they both fit more squarely within NATO's traditional focus. That is, they both emphasize the operational efficiency and effectiveness of Alliance member state military forces. Herein lies the primary lesson to be learned from NATO's otherwise unsuccessful foray into energy security—when alliance-wide initiatives fit into NATO's traditional realm of the military and defense, progress is likely to be easier and the odds of substantial contributions to collective security increase. This means, for instance, that Alliance efforts to develop training courses on operational energy security issues offered in NATO schoolhouses are likely to meet with little resistance from member states and hence are more likely to succeed and ultimately have a positive impact.

This conclusion, as well as insights gleaned from observing NATO's efforts to date in the realm of energy security, leads to several recommendations about the way ahead both for NATO and for the United States as it seeks to leverage the Alliance. First, the United States, and the Department of Defense (DoD) in particular, should aggressively pursue increased collaboration through NATO on operational energy security because of the broad strategic benefits that accrue to the United States. As the United States has stated many times in various national security and defense strategies over the last decade or more, America prefers to fight in coalitions, and it prefers to have its closest, most capable allies in Europe as members of those coalitions.[28] If that continues to be the case—and it appears so, at least judging from the most recent of those strategies, the 2014 *Quadrennial Defense Review* (QDR) report[29]—then the United States will need partners that are not simply willing but also able to deploy and fight side-by-side with American forces. By collaborating on operational energy projects, exercises, and other activities with those partners through

NATO, the United States can help both itself and its partners reduce operational costs while increasing operational capacity and combat capability through greater energy efficiency. Ultimately, this will make it easier—that is, more affordable—for the political leaders of allied and partner countries to join in U.S.-led coalition operations as well as to lead such operations themselves.

Second, although the United States does more than other allies in terms of operational energy security research, development, testing, and procurement, there are indeed prospects for the U.S. military to learn more from its allies, and Washington should more aggressively pursue transatlantic technology transfer and development in operational energy. British development of intelligent power storage and management systems, Dutch development of photovoltaic solar panels and light-emitting diode lamps, and German work on hydrogen fuel cell technology all represent potential areas where the United States could stand to learn more about what the allies are developing and producing. In some instances, the U.S. military services have engaged foreign partners in cooperative research and development efforts, but there is only limited recognition of the importance or potential role of allies in operational energy security efforts in the DoD Operational Energy Strategy and the DoD Operational Energy Implementation Plan. The former merely acknowledges that the United States can learn from its allies just as American allies may learn from it, and the latter somewhat vaguely posits that the United States can use operational energy capabilities and technologies to "enhance partnerships" with allies and partners.[30] As for the more recently released "DoD Energy Policy," there is no reference whatsoever to U.S. military interaction with allies or partners.[31]

Third, Washington should strongly leverage the ENSEC COE as well as the Norfolk-based Allied Command Transformation to more vigorously promote interoperability in energy-efficient technologies, platforms, and systems. Working through and with NATO provides the United States with an echo chamber of sorts, a means of propagating and amplifying best practices and promising technologies. This will become increasingly important in the years ahead, as the Alliance will struggle to maintain interoperability in the absence of an operational requirement like the International Security Assistance Force.[32] NATO as a vehicle for testing and spreading operational energy security technologies and practices will make it easier for all of the allies, including the United States, to maintain operational and tactical interoperability moving forward.

Fourth, the United States should focus its operational energy security cooperation within NATO on those allies with larger militaries and larger deployable forces. NATO is after all an alliance of 28 countries, among which there are various levels of military capability. In an era of increasingly limited fiscal or budgetary resources, the United States must more shrewdly prioritize where and how it will expand those resources. The allies most interested in contributing to operational energy security efforts are those for which the costs of fuel are a significant deterrent to deploying their forces. Those member states that want to increase energy-related savings and reduce the logistical tail are more likely to be up to the task of carrying the burden in this issue area. For this reason, American efforts are more likely to result in success with these allies. Even among this group of allies though, military practitioners must be cognizant of what political scientists call two-level games—that is, the interaction between domestic and international politics. In some cases, domestic political, electoral, or economic considerations may complicate efforts to cooperate at the international level, through NATO, despite agreement among international interlocutors.

Finally, the United States should place increased effort on conducting demonstration events and exercises with its NATO allies. The reason is that what is otherwise a good news story—the coming end of the alliance's decade-long involvement in Afghanistan—presents member state militaries with a significant challenge in terms of having an operational requirement to spur innovation and drive change in operational energy security. The only way to make up for the lost impetus of extant operations is to exercise rigorously, and to include operational energy scenarios, or "injects," in the language of the military trainer, into those exercises. So far, if largely because of Russia's aggression against Ukraine in 2014, both NATO and the administration of President Barack Obama appear committed to increasing the scope and number of exercises and training events between the United States and its allies following the end of NATO's major combat role in Afghanistan. The critical question moving forward though is whether and how funding resources will be identified and sustained over time.

In sum, although NATO's attempt to take on an increased role in energy security has met with only limited success, there are compelling reasons for the United States to seek to undergird and leverage the Alliance's achievements to date. A North Atlantic alliance engaged in energy security can benefit collective security today as well as into the future, when circumstances compel a NATO-centered, coalition response to Western security. Focusing efforts where appropriate, remaining cognizant of domestic politics within member states, and not aiming too high in terms of objectives and goals will together yield positive results for both Washington and its allies.

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CHAPTER 17

THE FEASIBILITY OF SMALL MODULAR REACTORS FOR MILITARY INSTALLATIONS

Ronald Filadelfo

Even as the U.S. national defense posture is in transition, reorienting toward a more Pacific-based strategy and facing a period of declining budgets, climate change, energy, and their relations to our security and defense remain important issues for the Department of Defense (DoD). This chapter will briefly review how the United States arrived at this point, and how this subsequently led to a consideration of placing nuclear reactors on military installations. The chapter will then discuss the results of a recent Center for Naval Analyses (CNA) study on the feasibility of this concept, in terms of contribution to mission and economic viability.

CLIMATE CHANGE AND ENERGY ON THE DOD's AGENDA

Although the warfighting implications of energy use and supply have long been known to military planners, the emergence of climate change and energy as more strategic issues on DoD's agenda began just a few years ago. In the summer of 2006, when the fundamental existence of human-caused climate change was still being debated in the United States, CNA was the first to take a serious look at climate change implications from a national security perspective.[1] This was done by assembling a panel of respected recently retired military leaders who would have expertise in security issues in various parts of the world, be above partisan politics, and have credibility with Congress and with the American public.

A critical aspect of this effort was that it was not intended to weigh in on any scientific debate concerning climate change or its causes. The panel of military leaders, known as the Military Advisory Board, made very clear that they were not climate scientists and would not take any position on the science, the causes of, or the expected severity of climate changes. Rather, their position was as follows: If the predicted changes occur, this is how they would affect world geo-politics and thus the security interests of the United States. Therefore, they kept assumptions regarding the expected severity of climate change fairly general and did not tie their findings to any particular level of temperature change or sea level rise.

The military panel came up with five broad recommendations:

1. Climate change should be considered in U.S. national security planning.

2. The United States should make more of a commitment to greenhouse gas reductions and climate stability.

3. The United States should engage on the international level to help ensure that less developed nations will be prepared to cope with expected changes in climate.

4. DoD needs to look out for itself and assess the potential impacts of climate change— to include rising sea levels—on military installations worldwide.

5. And most importantly for the current discussion, DoD could serve as a test bed to help lead the way for national energy efficiency and development of alternative energy sources and a smart energy future for the country.

These have all been, for the most part, acted upon by the defense and national security communities—particularly the first recommendation, as evidenced by the inclusion of climate change and energy prominently into the subsequent *Quadrennial Defense Review*.[2] Following the CNA report, the National Intelligence Council released a National Intelligence Assessment on this same issue, and came to the same general conclusions with more specific findings, including the identification of specific countries that could potentially become unstable from climate change.

In 2007-08, a confluence of events, including the opening of a passage across the Arctic in the fall of 2007, and prominent studies, really thrust climate change front and center on DoD's agenda. At the same time, the United States began to realize dramatic increases in energy costs. In 2008, the price of oil rose to roughly $140 per barrel, and fuel prices became so high that the U.S. Navy wondered if it would have to cut back at sea training. Also in 2008, the Defense Science Board (DSB) put out a very influential— and blunt—report on DoD's energy posture.[3] Three of the DSB's findings particularly resonated throughout the Department:

1. DoD is very energy inefficient, particularly on the operational side, and the warfighting vulnerability this results in is often unappreciated.

2. DoD was largely unaware of the huge financial costs of its fossil fuel requirements in systems and platforms, and in general was not adequately considering it in procurement decisions.

3. DoD's shoreside installations were overly reliant on the country's very fragile electric grid.

All of this led to a 2010 Memorandum of Understanding (MOU) between DoD and the Department of Energy (DOE), to collaborate on research and explore ways to use military installations as test beds for development of new energy sources and technologies.[4] The goal of this agreement was twofold: to help DoD meet its energy challenges; and to consider the use of the innovation and buying power of DoD to help jump-start markets for new technologies. As noted in the MOU:

> DoD aims to speed innovative energy and conservation technologies from laboratories to military end users, and it uses military installations as a test bed to demonstrate and create a market for innovative energy efficiency and renewable energy technologies coming from the DOE labs and other sources.

With growing concerns about climate change and national fossil fuel use, with the idea of the military as an innovator and a test bed in leading the country toward a smart energy future, and with the military's own need to ensure a reliable energy source for military bases separate from the fragile grid, the stage was set for consideration of nuclear power for military installations.

CONGRESSIONAL TASKING TO DOD

Largely due to climate change concerns, but also for economic reasons, the last several years have seen a renewed interest in nuclear power in the United States. However, because large commercial scale gigawatt (GW)-sized plants require such large up-front investment, and face sometimes daunting licensing and siting hurdles that could easily take a decade or more to resolve—issues are outlined in greater detail in Jane Nakano's Chapter 8 in this volume—there is particular interest in small modular reactors (SMRs). In section 2845 of the 2010 National Defense Authorization Act (NDAA), Congress tasked DoD to study the feasibility of powering military bases with small modular reactors.[5] The belief was that military installations could serve as a test-bed for this technology and perhaps help jump-start an American SMR industry. Of course, DoD has also been investing in other energy sources like solar, wind, and geothermal, and faces various mandates and goals for use of renewables. However, in this case, Congress was specifically interested in trying to help jump-start a U.S. SMR industry, one in which the United States could possibly be a world leader.

The Center for Advanced Energy Studies of DOE's Idaho National Laboratory and several universities have studied the domestic economic impact of SMR manufacture and deployment.[6] Total economic benefit depends on the degree of market penetration of nuclear energy in general and of SMRs in particular, and it is therefore impossible to predict with any precision. However, that study concluded:

> The annual operation of each 100 MW SMR unit is estimated to create about 375 jobs and generate $107 million in sales, $68 million in value-added, $27 million in earnings (payroll), and $9 million in indirect business taxes.

So in response to the Congressional tasking, the Office of the Deputy Undersecretary of Defense, Installations and Environment (DUSD-I&E) asked CNA to conduct a study. This was to be a short duration study, overseen by a steering group consisting of representatives from DUSD-I&E, DOE, the Nuclear Regulatory Commission, DOE National Labs, and each of the military departments.

The purpose of the study was simply to determine whether DoD should be willing to further explore this idea and be willing to consider specific proposals. The study's purpose was not to state categorically whether DoD should or should not build an SMR, much less where to locate one if DoD should decide to do so. Much more information and study would be needed before those decisions could be made.

The CNA Feasibility Study.

In assessing the feasibility of SMRs to power military installations, an obvious first question was: How do the power outputs of these reactors fit the energy needs of military installations? Commercial plants are on the order of a gigawatt or more in output. SMRs generate between about 30 and 300 megawatts (MW), and as the term "modular" in the name implies, modules can be added to meet power demands as needed.

Figure 17-1 shows a distribution function for power demand of U.S. military installations. Specifically, it shows the plant size required, assuming a 90 percent capacity factor, to meet the energy demands of U.S. military installations based on average installation energy use for fiscal years 2008 and 2009. Overall, about 60 percent of the installations could be supported with a plant of about 20-MW, and 90 percent could be supported with a plant of 40-MW. Thus, SMRs are adequate in power output for the vast majority of U.S. military installations.

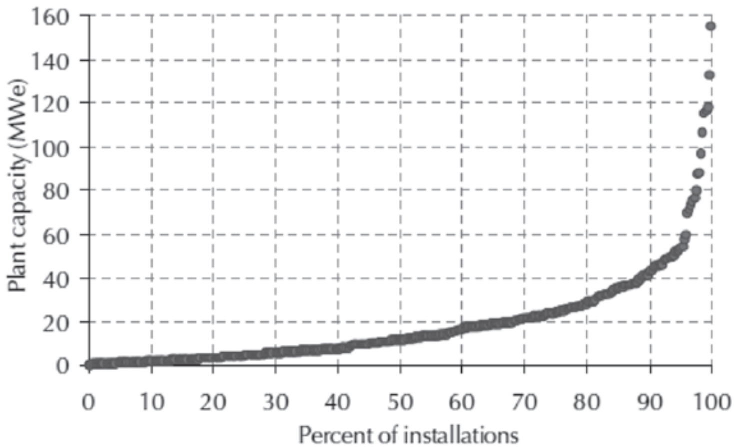

Figure 17-1. Plant Size Requirements for DoD Installations.

Given that these plants are the appropriate size to meet the needs of DoD installations, the feasibility analysis then focused on three questions: (1) Would an SMR contribute to the DoD mission? (2) What are the licensing issues and timelines? and, (3) Would an SMR be cost effective for a DoD installation?

Regarding contributions to the DoD mission, the issue is not primarily about the warfighting mission. Rather, it relates to supporting stateside installations, and helping DoD meet various energy and environmental goals. Using nuclear power from small modular reactors located on or near military installations would contribute to DoD missions by:

- Providing electric energy assurance for critical military facilities (more reliably at more stable cost);
- Helping DoD address mandates to reduce reliance on fossil fuels for electricity; and,

- Helping DoD address mandates to reduce greenhouse gas emissions.

Obviously, nuclear power will not help DoD with its mandates for renewable energy generation, such as the requirement to meet at least 20 percent of its energy demand with renewables by 2020. Similarly, SMRs will not necessarily help DoD fulfill its mandate to reduce overall energy use, specifically, to decrease its energy use per square foot of building space by 30 percent from 2003 levels, by 2015.

Safety, certification, and licensing are major issues that will need to be dealt with before any project can go forward. Whenever considering a nuclear reactor, safety is always the first concern. Commercial nuclear power has an excellent safety record in this country, and most evidence appears to indicate that SMRs are designed to be even safer. They are smaller, placed in the ground, and have many new passive safety features. Despite this, before the first of these can go forward, certification, and licensing issues have to be worked out, and that will take about 10 years. Even if it is agreed that this concept is feasible and worth exploring, finding a specific site will be very challenging, and consideration of impact on base function will also have to be addressed.

Cost effectiveness is by necessity a major part of any feasibility study. Because SMRs currently are not in operation, the first-of-a-kind expenses (FOAK) will be substantial, perhaps as high as $800 million. FOAK expenses include final detailed engineering for certification; resolving licensing issues; and manufacturing engineering, tooling, and facilities.[7] However, it is unlikely that a military installation taking on an SMR project will have to pay these costs. The envisioned model for this concept is that FOAK expenses will be paid by some combination of DOE, vendors, and direct congressional funding.

The CNA study calculated that if FOAK expenses are excluded, an SMR could produce electricity at a cost of about 8 cents per kilowatt hour (kWh). With FOAK included, the cost becomes over 20 cents per kWh. Although 8 cents per kWh is higher than the national average price industrial users pay for electricity, it could be cost effective in many areas. Figure 17-2 shows what the prices calculated above imply about ultimate cost effectiveness. The Industrial curve shows the distribution function for state average prices that industrial users pay for electricity. Prices in about 30 percent of states are more than 8 cents per kWh, which means that SMRs may be cost effective for many installations.

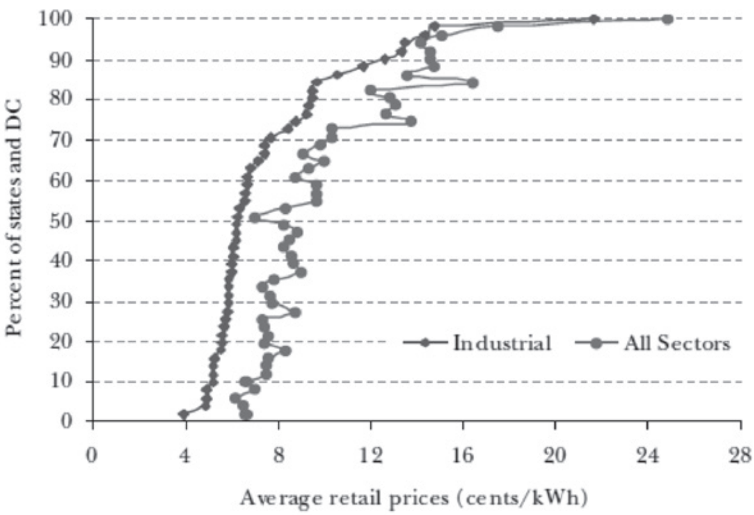

Figure 17-2: Distribution Function for Electricity Process in the 50 States and the District of Columbia, Industrial Users and all Sectors.

However, very few states show average prices greater than 20 cents per kWh, so an SMR project would generally not be cost effective if the installation had to pay FOAK costs. Therefore, economic viability depends on DoD not having to pay FOAK expenses. Further examination of the findings appeared to indicate that they are robust to any reasonable variation in input variables.

How do these prices compare to those of renewables, which DoD is also pursuing for its installations? CNA recently performed a study that looked at the economics of wind and solar photovoltaic (PV) energy at Department of Navy installations in the United States.[8] In that study, CNA used the National Renewable Energy Laboratory's System Advisor Model to calculate costs from these two sources at 87 stateside installations. In no cases, did solar PV have a cost as low as 8 cents, and at 12 installations, wind came in at this price or lower, suggesting the economics for SMR-generated electricity are generally favorable compared to renewables.

SUMMARY

As both DoD, and the United States as a whole, address energy challenges, it is generally believed that DoD can use its tradition of innovation and its large buying power to help lead the country toward energy efficiency and toward a sustainable energy future. In tasking DoD to examine the feasibility of siting small modular reactors to provide power to military installations, Congress appears to have an interest in jump starting a U.S. small modular reactor industry. To summarize the results of the feasibility study in terms of the three questions posed previously:

- SMRs could help DoD in terms of energy security for its installations, as well as with various energy and greenhouse gas reduction goals.
- Even if a decision is made to proceed with SMR deployment, it will take about 10 years before one of these could be producing electricity. There are many issues that remain to be worked out, including the effect a nuclear power plant could have on the function of the installation.
- Finally, an SMR could be cost effective for a DoD installation if some other entity picks up the FOAK costs.

Although these findings suggest that the SMR idea is worth examining further and perhaps entertaining specific proposals, they do not imply that DoD should build an SMR at a specific location. Many criteria need to be met before that can occur, and it remains to be determined if DoD will ever find a location that meets all the criteria. The feasibility study simply concluded, as was its tasking, that SMR deployment on military installations is worth further examination.

Of course, major potential obstacles also exist. Waste disposal is a major issue that remains to be solved before DoD, or the country as a whole, can make a serious commitment to nuclear power in any form, be it commercial-scale or small modular reactors. Security is sometimes mentioned as a benefit of locating an SMR on a military base. However, nuclear facilities already employ a great deal of security and access control, and although location on a military installation provides some additional security, in reality it is just another "fence line," and not a major consideration. Compatibility with installation missions is a major concern for DoD. For example, how far from a base housing complex will a nuclear facility have to be situated? Although nuclear facilities are not built adjacent to airports, would the same necessarily apply at military air stations? What about ordnance facilities, or ranges where ordnance is used?

Since completion of the feasibility study, DoD has not pursued any SMR projects, although the department has not ruled this out for the future. Meanwhile, DOE is partnering with the Tennessee Valley Authority (TVA) and Babcock & Wilcox mPower, Inc. (B&W) to undertake a project at the Clinch River site in Oak Ridge, with DOE paying about half of the design and licensing costs.[9] This will be a 180-MW installation, and could be operational by 2022. If completed, this would be the nation's first operational small modular reactor. This project is still in its early stages, and it is still far from certain that it will proceed to completion. B&W must still obtain Nuclear Regulatory Commission certification for its reactor design, which it hopes to have by 2016. At that point, the TVA will decide whether it wants to proceed with construction of the site. It is likely DoD will monitor the DOE-TVA project before moving on its own. Given this timeline, DoD is unlikely to move forward on SMRs for several years, at a minimum.

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