TOO MUCH ENERGY?
ASIA AT 2030

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Dan Blumenthal, Derek M. Scissors

Contributors:
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Key Findings

• Over the next 15 years, the US shale revolution and an end to the Chinese energy demand shock will, as compared to the last 15 years, be the two most important factors shaping global energy markets.

• The US political-economic system is proving resilient once again. The United States possesses natural resources, well-defined property rights, an open and competitive industrial structure, and deep capital markets—the best possible combination for innovation in energy. These factors catalyzed the ongoing US shale revolution.

• The American geostrategic position has also improved. While the US has enduring interests in the Persian Gulf—including countering terror groups and Iranian nuclear ambitions—it no longer needs the kind of enmeshed relationships it has had with major oil-producing states.

• Ridding itself of oil import dependency would free the US to pursue its interests in the Middle East without regard to offending dictatorships. Continued general interest in global oil-price stability will necessitate continued US involvement in the Middle East, but the US will have significantly more flexibility in responding to challenges there than it has in recent decades.

• China possesses natural resources but lacks the economic structure to properly exploit them. The state owns all oil and gas on Chinese land, meaning there are no incentives for entrepreneurs to explore. Competition in the energy sector is barred, Chinese capital markets are dysfunctional, and any innovation that does occur is not legally protected.

• Without fundamental economic reform, Chinese growth will stagnate; without energy sector reform, China's energy industry will remain inefficient and intensely dependent on imports. Genuine Chinese market reform would include enhanced property rights, industrial competition, and a partly privatized financial system, but these outcomes remain unlikely given the limited economic reform President Xi Jinping has been willing to implement thus far.

• While Chinese demand growth is diminishing, China's import share continues to rise. China's reliance on energy from the Middle East now far outstrips US reliance on Middle East energy. Beijing may become ensnared in supply arrangements, with all the consequent foreign policy distortions that Washington has suffered. China's geopolitical position will be tested.

• China may choose to create a formal alliance with a leading producer such as Russia (or Iraq), and Moscow may be getting desperate enough to meet Beijing's energy terms. Since both countries have revisionist political dreams, a genuine Sino-Russian alignment would pose a new set of geopolitical problems for the US.

• Russia will remain one of the world's top energy producers and exporters, but its energy future will hinge on several factors outside of Moscow's control, including Western energy sanctions and European regulations. Should Europe shift away from dependence on Russian energy, the Kremlin will feel more pressure to court China.

• Elsewhere, Saudi Arabia will maintain its status
as the top oil producer over the next 15 years. Iran and Iraq are the potential game changers in the Middle East. If either country can overcome its political challenges—a big “if”—a significant amount of additional oil could be turned out on the global market.
Access to affordable energy resources has long been an arbiter of economic growth and driver of geopolitical machinations. Examples from the 19th and 20th centuries abound. In the United States, the growth of oil production and, eventually, the Texas Oil Boom undergirded the Second Industrial Revolution and contributed to greater growth in East Coast oil-exporting cities. Across the Pacific, starting in the late 1800s, Japan’s resource limitations contributed to setting it on an imperial path. Some observers see China as facing the same limitations today. Most notably, through much of the 20th and into the 21st century, concerns about the free flow of oil drove the United States, the Soviet Union, and others to competition in the Middle East.

For the past three decades, concerns about energy security have focused primarily on the Middle East, which has faced unceasing threats to regional stability and is home to some of the world’s largest oil-exporting countries. The United States’ role in maintaining stability in the region has been generally welcomed but has also been very costly. At the same time, high oil prices came to be accepted as a matter of course, based on expectations of continued high demand and comparatively constrained supply.

But those expectations may not be borne out. In the latter half of 2014, crude oil prices plummeted, dropping some 40 percent between June and the end of the year. A supply glut, brought about in part by increased American energy production, and weak global demand saw oil priced below $60 per barrel, a five-year low. This crude oil shock has been a boon for consumers, the transport industry, and manufacturers, while hurting the bottom line of the world’s traditional energy producing countries, notably Russia and those in the Middle East.

“Shocks” are, by nature, transient. Prices may not remain low beyond the short term. Even so, plunging oil prices do point to questions about the global energy outlook over the long term, for uncertainties surround a number of issues bound to affect the energy security of the United States and its partners as well as the well-being of traditional energy producers. These uncertainties include

- Future oil and gas production in the United States, the Middle East, the Russian Federation, and China;
- Future energy demand in the world’s largest economies—notably in East Asia, the European Union, and the United States;
- Domestic energy policies in the United States, China, and high-volatility producers like Iraq; and
- Geopolitical factors, such as Iran and Russia sanctions.

Perhaps most noteworthy is the shale revolution, which is turning the United States into a major producer of both oil and natural gas seemingly overnight. In Asia, China’s thirst for energy may ease as its economic growth slows appreciably. Continuing tensions on the European periphery are raising questions about Russia’s future supply of energy to members of the European Union, while political instability around the Persian Gulf clouds the future of Iraq and Iran, major potential energy suppliers.

This report strives to shed light on these uncertainties with the aim of providing realistic scenarios for the global energy outlook to 2030. That time horizon
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is near enough to allow for reasonable confidence in
demand and supply projections but sufficiently distant
for geopolitical implications to play out. A 15-year time
horizon also minimizes the potential for multiple unex-
pected and extremely hard-to-predict developments.

A comprehensive description of the energy situa-
tion would require multiple volumes. In this report,
by taking a holistic approach, even though it cannot
be exhaustive, we aim to identify the driving factors
of American energy strategy. A better understanding
of how the energy market will evolve in the coming
years will enable Washington and its partners to better
tailor not only their economic and energy policies but
also their foreign and defense policies. To accomplish
that goal, the report is divided into three sections: four
country and regional energy outlooks (North America,
China, the Middle East, and Russia); a sketch of global
scenarios; and an analysis of geopolitical implications.

The energy outlooks for the United States and China
are most determinative. Both countries could drive
global net energy demand, and they are the world’s
central geopolitical actors. The Middle East, European
Union, and Russia matter, but just how important
they are will depend to a great degree on American and
Chinese behavior.

Each of these first four essays is organized along simi-
lar lines. First, the author describes the present contours
of the energy environment for the country or region at
hand. Then, the author discusses the primary factors
affecting that country’s net energy demand. Finally, the
author considers a number of scenarios for energy mov-
ing forward.

First, James Slutz discusses the biggest change in the
global energy environment in the 21st century thus far:
the new US energy outlook in the shale oil and gas era.
He notes that “the reversal of America’s energy fortunes
has taken place within an unprecedentedly short period
of time.” Only five years after shale oil and gas were
recognized as important sources of supply, the United
States in 2013 became the largest combined petroleum
and natural gas producer in the world. Looking forward,
Slutz sees increasing natural gas production, demand,
and exports on the one hand, and slowing demand for
oil along with increased oil production on the other.

Next, Derek Scissors addresses China’s energy out-
look. Because of its immense need for imported energy,
China will significantly affect the global energy mar-
ket in the coming years. China will be the world’s
largest importer of energy, coal, and oil out to 2030.
The natural resource endowment, current macroeco-
nomic trends, possible market reforms, and domestic
and international politics will all affect how Chinese
net demand develops in the coming years. Evaluating
these, Scissors lays out four possible scenarios for the
evolution of China’s energy sector. The four scenarios
illustrate the uncertainty in precisely how China will
shape global energy outcomes going forward. Nonethe-
less, the most likely outcome is that growth in Chinese
net energy demand will slow considerably.

Sara Vakhshouri next discusses the Middle East
energy outlook. Saudi Arabia will remain a major
energy producer over our timeframe, while Iran and
Iraq are potential game changers in the region. Both are
blessed with significant resource endowments but also
beset by challenges to their capacities to produce and
export energy. Iran faces sanctions on its exports and
limited access to foreign capital, making it difficult for
the country to upgrade its production. Iraq, meanwhile,
has lost control of large swaths of territory to Islamic
State militants and now faces a lengthy rebuilding pro-
cess, at best. Energy-sector development is also limited
by ongoing disputes between Baghdad and the Kurdish
regional government. If either Iran or Iraq can overcome
its challenges—a big “if”—a significant amount of oil
could be turned out on the global market.

The final regional outlook looks at the future devel-
opment of Russia’s energy sector. Andreas Goldthau
argues “Russia will remain one of the world’s top energy
producers and exporters, but energy sector develop-
ments crucially hinge on several factors it cannot influ-
ence: Western energy sanctions, international market
developments, EU market regulation, and European
decarbonization policies.” These factors are likely to
suppress the export markets for Russian oil or gas or
both. The promise of East Asian markets for Russian
energy remains notional but could be a boon should
Russia’s “Eastern Strategy” bear fruit.

Having examined the major countries and regions
likely to affect net demand, the report next distills
regional scenarios into global ones. Scissors lays out
global scenarios that consider success or failure for Amer-
ican shale, major shifts in Russian and Middle Eastern
energy exports, Chinese economic malaise, global macroeconomic performance, and the potential globalization of the shale revolution. Scenarios are ranked in order of probability, with the most likely scenario seeing American net energy demand moving to zero while global macroeconomic activity remains restrained.

These global scenarios set the stage for the report’s concluding chapter on geopolitical implications. Dan Blumenthal argues that developments primarily in China and the United States, and to a lesser extent in Europe and the Middle East, could lead to new challenges to the US-led liberal international order and will affect America’s ability to defend that order. That order, Blumenthal argues, is open to all countries and benefits those that participate.

Aside from the United States, China has perhaps been the order’s greatest beneficiary. Deng Xiaoping’s market reforms in the 1970s enabled China, for the first time, to take advantage of it. As Blumenthal writes, “China is now a major economic player and benefits from US global primacy,” with Washington providing “the international security that China is not yet able to ensure on its own.”

Energy security has been a central pillar in maintaining the liberal order. Stable supplies of oil, in particular, have supported the expansion of prosperity across the globe and reduced incentives for interstate conflict. The United States has ensured that security by championing a global market for oil, preventing hostile forces from dominating the Persian Gulf and its energy resources, and guaranteeing security of global sea lines.

Yet even as China has enjoyed the fruits of these US-provided public goods, Chinese leaders do not always see the liberal order in such a positive light and appear intent on revising it to their own liking. The People’s Republic, moreover, increasingly has the wherewithal not only to challenge that order but also to go toe-to-toe with the United States in certain areas. Russia and Iran do not project to present the same sort of global challenge as does China, though they are capable of causing local disruptions to peace and stability and apparently aim to dominate their own regions.

As a result of these challenges, global energy security is increasingly at risk. At the same time, the global energy order is changing. Over the past two decades, Chinese economic growth has presented a major demand shock to the system, and it is now the world’s largest energy importer. As China has grown wealthier, moreover, it has become more intent on providing for its own energy security rather than relying on public goods historically provided by the United States. At the same time, the United States is poised to become a net exporter of oil and gas.

Shifts in energy dynamics are likely to affect how the United States interacts with its allies; how the United States and China interact with each other; and how the United States and China each engage with the Middle East, Russia, and other traditional energy suppliers. Will the United States continue to keep the Persian Gulf out of the hands of hostile powers? How much will it care about stability in the region? How will China’s perceptions of its interests in the Middle East change? Will Beijing consider a direct role in ensuring stability there? What are the prospects for Sino-Russian economic and security ties as Euro-Russian ties fray?

Nearly every country around the globe can be expected to reexamine energy policies in the coming years as the Organization of the Petroleum Exporting Countries’ domination of the market fades. Because energy is so important to economic well-being and national security, governments will reassess their economic, foreign, and security policies as well. A fundamental realignment of national security strategies, diplomatic ties, and energy relationships is in the offing. This report aims to illuminate the contours of that realignment and provide insight to policymakers tackling a new energy world.
The US Energy Outlook

James A. Slutz

The reversal of America’s energy fortunes has taken place within an unprecedentedly short period of time: although oil and natural gas production from shale was only first recognized as an important source of supply in 2008, by 2013 the United States had become the largest combined petroleum and natural gas producer in the world. A newly discovered offshore oil field requires around 10 years to develop, yet in just 5 years America’s declining petroleum production of the previous 40 years was reversed. This energy landscape upheaval is an astonishing change in a very short time period.

Over the past few years, new oil and natural gas discoveries have been made in places such as Ohio, Pennsylvania, and North Dakota. North Dakota has become the second-largest oil-producing state in the US, behind only Texas, while Pennsylvania is becoming a leading natural gas producer. Across the country, the growth in oil and natural gas production, and the attendant effects on job creation and tax revenue, have been remarkable. (See table 1.)

To illustrate the magnitude of this impact, we need only look at five years of natural gas projections from the US Energy Information Administration (EIA). In 2007, the EIA projected that by 2030 the US would be importing more than 20 percent of its natural gas supplies (see figure 1). Only five years later, the EIA projected that by 2022, the US would be a net natural gas exporter. (See figure 2.)

Figures 1 and 2 not only illustrate the magnitude of resource potential, but they also show the inability to accurately forecast future energy trends during a period of technological change. It is difficult to find a precedent for any change of this scale in US energy outlooks, but clearly we are in an era of abundant natural gas resources and increased oil production.

The latest EIA long-term energy outlook to 2040 paints an even more bullish US energy future, with dramatically growing energy supplies. Among the EIA’s projections:

- US energy output will grow faster than consumption during the next 20 years;
- Total US energy self-sufficiency will rise from about 8 percent to well above 90 percent by 2035 in the

<table>
<thead>
<tr>
<th>Table 1</th>
<th>GROWTH OF US PETROLEUM SUPPLY AND ECONOMIC IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas production growth (2008–13)</td>
<td>28%</td>
</tr>
<tr>
<td>Crude oil production growth (2008–13)</td>
<td>55%</td>
</tr>
<tr>
<td>New jobs attributed to petroleum production (through 2012)</td>
<td>2.125 million</td>
</tr>
<tr>
<td>New federal, state, and local tax revenue (through 2012)</td>
<td>$74 billion</td>
</tr>
</tbody>
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**Figure 1**  
Net US Imports of Natural Gas by Source, 1990–2030

![Graph showing net US imports of natural gas by source from 1990 to 2030.](attachment:figure1.png)

Source: US Energy Information Administration

**Figure 2**  
Total US Natural Gas Production, Consumption, and Net Imports, 1990–2035

![Graph showing total US natural gas production, consumption, and net imports from 1990 to 2035.](attachment:figure2.png)

Source: US Energy Information Administration
reference case (which assumes current conditions), and under some scenarios the US will become a net energy exporter during that time frame;

- Production of US crude oil and other liquids (for example, natural gas liquids or condensates) will rise steadily during the next 10 years;

- The US is projected to become a net natural gas exporter by the early 2020s because of new liquid natural gas (LNG) projects and trade with Canada and Mexico; and

- US carbon dioxide emissions peaked in 2005 and will continue to decline through 2040, primarily because natural gas replaces coal for power generation.¹

For nearly 40 years, US energy policy has been formulated in an atmosphere of scarcity, characterized by fear of rising energy costs, of relying on imported oil, and of running out of energy. Policy created in this environment inevitably limits options.

This hand-wringing over energy policy would lead one to think that the US is running out of energy. But the facts are that the US is the world’s largest natural gas producer, second-largest coal producer, second-largest oil producer, and largest geothermal-energy producer.

In addition to the actual energy it produces, the US is a leader in energy technology. This technology capability has been instrumental in continuing to grow US energy supply—both the actual volume of energy and the improvements in energy efficiency—which allows the country to gain more productive capacity from every British thermal unit of energy.

The Shale Revolution

It is the shale revolution that has led to this stunning reversal in America’s energy fortunes. That revolution is the culmination of the work of a committed visionary, George P. Mitchell. Geologists have long known that the US shale formations contain hydrocarbons. In fact, they are known to be the source rock, or origin, of oil and natural gas that has accumulated in conventional oil- and gas-bearing geologic zones.

Mitchell was determined to create a technological path to commercial production of all the natural gas trapped in the shale. He began drilling shale gas wells in the Barnett formation around Dallas, Texas, in 1984. After many years and many attempts, Mitchell succeeded in effectively applying hydraulic fracturing to the shale formations. The real breakthrough in shale gas production came from applying both horizontal drilling and multistage hydraulic fracturing, which resulted in more wide-scale shale gas development beginning around 2005.

Shale oil and gas development is both similar to and different from conventional oil and gas drilling. It is similar in that it uses advanced petroleum engineering and information technology to access difficult-to-reach resources. The oil and gas industry is one of the most high-tech in the world. It takes a combination of advanced materials, supercomputing, and sophisticated communications to drill two miles deep, turn and drill horizontally another mile or more, and still keep the drill bit inside a vertical interval of just a few feet. (See figure 3.)

The oil and gas industry has made these developments look easy. However, shale oil and gas production is a high-cost exploration-and-development activity. Where shale oil and gas development differs from conventional production is that success with shale is critically tied to managing costs and maximizing productivity. Operation efficiency is absolutely critical to continued investment. A key element of cost management is effective planning of not just one well, but also the entire drilling and production site. An industry measure of effective planning for a company is monitoring drilling rig utilization in terms of length drilled per unit of time. The industry has dramatically reduced drilling time through technology and improved management.

Integral to the development of the US shale revolution is the legal and commercial environment. America’s oil and gas industry dates back 150 years, from the first well drilled in Pennsylvania in 1869. The subsequent decades have seen hundreds of thousands of wells drilled nationwide, providing a rich geologic history as a base for exploring for shale oil and gas development. In addition, the US land ownership structure, where individuals own the subsurface minerals, has also
been recognized as a key enabler of the shale revolution. This legal and commercial environment provided the following key supporting factors:

- A mineral ownership structure that incentivized technology development and expedited resource commercialization;

- Available geologic information that identified potential shale zones; and

- Existing industry equipment and capacity, which minimized capital costs in the early stages of shale development.

In addition to these influences, the US market pricing system—and the existing pipeline and other oil and gas transportation networks—provided a transparent outlet for production. All of these factors helped launch the US shale oil and gas industry and continue to support growing oil and natural gas production.

Shale oil and gas plays (groups of fields) have been identified and are being developed across wide areas of the country. (Figure 4 shows the extensive accumulation of shale oil and natural gas reservoirs.) New shale resource opportunities are still being identified. While the development tends to be concentrated in specific portions of each shale basin, the resource potential is huge, with many of the plays covering extensive areas.

Estimates of recoverable shale oil and gas resources continue to grow. The EIA currently estimates US shale gas resources between 665 and 1,161 trillion cubic feet (Tcf) of technically recoverable resources. While shale oil and gas production is in the early stage of development, and long-term production data have yet to be accumulated, the EIA has stated that there is a greater upside than downside uncertainty in oil and natural gas production.2

In short, looking to 2030 the US energy outlook is transitioning from demand focused to supply focused, with implications for the US and the international energy market. An exploration of the factors driving these changes follows.

**Energy Demand Forecast to 2030: A Changing Energy Mix**

The dramatic changes in US oil and natural gas production are changing the country’s energy mix. The scale and speed of change make it difficult to assess trends
and to project the makeup of the long-term energy mix. Therefore, while it is useful to look at models and forecasts, identifying drivers of change is equally valuable.

Natural-Gas Demand Growth. The most pronounced change is the growing role of natural gas in the overall energy portfolio. Growing natural gas supplies from shale formations have resulted in dramatically lower gas prices, at one-quarter to one-third the cost in other regions of the world. This is shifting demand for US gas in three important ways.

First, lower prices have resulted in significant growth in demand for natural-gas-fired power generation and, second, in major new industrial expansion in energy-intensive industries. Third, production is projected to exceed domestic demand, paving the way for exports. While much attention is paid to the natural gas export regulatory environment, market forces will eventually prove greater than regulation, and the market will determine the level of exports.

Power Generation. The EIA projects that within the natural gas category, the greatest growth will occur among the various fuels that make up the power-generation energy mix. It also projects that by 2035 natural gas will surpass coal as America’s largest source of energy for electricity generation. Natural gas, it turns out, is an attractive fuel for new generating capacity.
Over the past few years, the switch from coal to natural gas for power generation has been driven by natural gas prices, which have become more competitive than coal. Federal and state policies, which discourage new coal plants, have added further pressure to expand natural gas as a fuel for power generation. Considering recent proposed rules from the US Environmental Protection Agency to regulate carbon emissions, this trend looks likely to continue. (Figure 5 illustrates the growing role of natural gas in the power sector.) It is difficult to see a scenario that would change this path.

**Energy-Intensive Industries.** The EIA’s *Annual Energy Outlook 2014* projects significant growth in the use of natural gas in the manufacturing sector. Energy-intensive manufacturers—such as those working in chemicals, petroleum refining, aluminum, glass, and cement—are investing in new, more efficient facilities to cash in on competitive energy prices. The availability of low-cost natural gas, specifically ethane, has resulted in plans for at least 97 new chemical industry projects valued at $71.7 billion. This investment is expected to directly or indirectly result in 537,000 new jobs in the chemical industry and another 1.2 million new jobs in construction. In a report released in September 2013, IHS projected that lower natural gas prices would increase industrial production 2.8 percent by 2015 and 3.9 percent by 2025.

Some of the most energy-intensive businesses are chemical manufacturers. They use natural gas as both a feedstock and heating source to create their products. These businesses also provide the fundamental building blocks for other products, including consumer and commercial goods, agriculture and health care needs, and other critical portions of the supply chain. Making these products requires large amounts of energy, primarily natural gas and gas products, such as ethane.

Throughout the 1990s and early 2000s, energy-intensive manufacturing businesses were closing facilities in the US because of higher natural gas prices. In 2007, the National Association of Manufacturers reported that higher raw-material costs and concern over short supply, if left unaddressed, would result in 25 percent of manufacturers shifting 32 percent of their production abroad. This fairly recent instance of high natural gas prices shows the direct link not just to energy-intensive manufacturing but also to the industries that use these critical intermediary products to create finished goods in industries classified as less energy intensive.
Because of the large energy input that energy-intensive industries need to produce their offerings, a small difference in cost can create a significant competitive advantage. North America now has some of the most attractive prices for natural gas and natural gas liquids in the world. Therefore, energy-intensive businesses, such as chemical manufacturing, are seeking opportunities to invest and grow in the US. Take the following examples:

- In December 2012, South African company Sasol announced plans to invest at least $16 billion to build an ethane cracker and gas-to-liquids plant in Louisiana. The facility will create 7,000 jobs during the construction phase and more than 1,200 permanent jobs to operate the plant.

- Dow Chemical has announced plans to construct an ethylene cracker south of Houston. The $1.7 billion investment will create 150 permanent jobs.

- Methanex Corporation, a Canadian company, is relocating two methanol operations from Chile to Geismar, Louisiana. The first plant, expected to begin operations in 2014, will add 150 permanent jobs; the second facility, 35.

- In Iowa, Orascom Construction Industries, an Egyptian company, is building a natural-gas-based fertilizer plant, the first large-scale fertilizer plant built in the US in 25 years. The facility will create 2,500 construction jobs over three years.

Petroleum refining is another energy-intensive process. Manufacturing gasoline, diesel, and other products provides an example of the impact of competitive energy supply and prices. Converting crude oil to usable products requires energy to distill the various products, and hydrogen to change the chemistry of some hydrocarbons into other usable products. The energy and hydrogen come primarily from natural gas. To make each barrel of refined product requires 500 to 800 cubic feet of natural gas per barrel of crude oil, although the precise amount of gas used depends on the type of oil being refined. Typically, heavier crude oils require a greater amount of natural gas because of the need for more hydrogen during processing.

Natural Gas Exports. There are currently 26 LNG export applications pending with the US Department of Energy. The department has already approved exports to free-trade agreement (FTA) countries, and the current debate now concerns exports to non-FTA countries. Based on US law, natural gas exports to countries that have an FTA with the US are considered to be in the public interest. For countries without an FTA, the application includes a more detailed process in which the government must determine that the application is in the public interest. While a consensus appears to be emerging that some level of natural gas exports are positive for the US economy, the key issue is whether the market or the government is most effective at determining the level of exports.

How the natural gas export issue is resolved will be critical to determining the level of investment, not just in export terminals but also in the long-term development of natural gas resources. Historically, markets have been most effective in facilitating the development of new energy supplies and meeting demand. When the US government has constrained demand through limiting natural gas uses, such as through the Powerplant and Industrial Fuel Use Act of 1978, the result has been shortages, not surplus and lower prices. Government action to limit trade is likely to have the same result.

In May 2014, the Department of Energy announced new rules to change the order of export-permit processing. The prior system provided that applications are processed in the order they are received. The new process requires that the Federal Energy Regulatory Commission (FERC) process be completed before an export authorization is granted. The FERC process requires completing detailed engineering work and environment-impact analysis, which cost tens of millions of dollars. The intent is to ensure that those projects with the greatest likelihood of being commercially viable are moved to first in the queue. Some see the change as increasing investment risk, since such a significant expenditure is required before obtaining the export authorization. In the old system, the export authorization was issued conditionally upon FERC approval.
The Value of a Natural Gas Advantage in the Refining Industry

Valero Energy is the world’s largest independent refining company, with 13 refineries in the US. One of Valero’s refineries, the Three Rivers Refinery in Texas, was slated for possible sale in 2008 because the facility was only marginally profitable. Yet, shale oil and natural gas have changed the prospects for the refinery and the people working there. Crude oil from the Eagle Ford Shale formation, and lower natural gas prices, have saved $665,000 per day and raised profits by 400 percent. Once a marginal asset, the Three Rivers Refinery is now a valuable facility.1

The Eagle Ford Shale, in the refinery’s backyard, has seen oil production increase from 352 barrels per day in 2008 to more than 600,000 barrels per day in 2013. The growth in US natural gas production has pushed prices down by almost half from the 2008 price. Both of these developments have greatly benefited the Three Rivers Refinery. Lower natural gas prices have saved Valero more than $1 billion annually since 2008.

In 2012, US refineries used a little more than 1 billion Mcf (natural gas is measured in units of 1,000 cubic feet, or Mcf) for processing crude oil into gasoline, diesel fuel, and other products.2 As a comparison, an average US home uses about 70 Mcf of natural gas per year.3 The amount of natural gas used by refineries would serve approximately 14.6 million average-sized homes for a year (more single-family homes than in New York, Ohio, and California combined).

America’s refining businesses have a significant competitive advantage over foreign refiners because of natural gas prices. If we assume a natural gas price of $4.00 per Mcf in the US, then the cost to a refinery is $2.00 to $3.20 for enough gas to refine the equivalent of a barrel of oil. If the refinery is in Rotterdam where gas prices are about $11.00 per Mcf, then the cost per barrel of oil equivalent is $5.50 to $8.80. In Asian countries relying on LNG imports, refiners face a cost of $16.00 per Mcf for their natural gas input, which results in the cost per barrel rising to between $8.00 and $12.80.4

To understand the extent of the US price advantage, it is useful to note that the margin per barrel of refined product has historically been around $3.00 a barrel. As a result, current natural gas prices in the US have greatly improved the global competitiveness of US refineries compared to those in Europe and Asia.

While this analysis is a simple review of one component of a complex business involving many more variables, it shows the impact of competitive natural gas prices on one industry. It is not just about making oil refining, an industry with historically narrow margins, more profitable. The refinery’s competitive advantage results in running its manufacturing facilities at greater capacity, which increases domestic fuel supplies. The excess production can also be exported, increasing economic output for the country.

In 2011, the US became a net exporter of refined products for the first time since 1949, reversing decades of being a net refined-product importer. Refined product exports in 2011 were the second-highest value of all exported products, with a total value of $111.1 billion, second only to automobiles.5 The petroleum refining industry is making a real and measurable difference in increasing US manufacturing exports, in part because of abundant natural gas.

The US will remain a region of competitive natural gas prices, in part because the physical cost of shipping LNG to other regions will naturally limit exports even if all policy barriers are removed. The growing demand from energy-intensive industries will continue.

Notes

4. The natural gas prices used in this example were based on 2013 data from Bloomberg.
As of September 2014, the Department of Energy had approved nine projects, representing approximately 17 billion cubic feet per day of natural gas, for export to non-FTA countries. This is out of a total of more than 50 billion cubic feet per day of export approvals for FTA countries, which includes South Korea, one of the largest global LNG consumers. Again, while the regulatory process is important, market conditions will ultimately be the deciding factor in the capacity of export terminals and amount of LNG exported, because a greater volume of gas has been approved for export than the market can absorb (particularly in the near to medium term). In addition, the inclusion of South Korea as an FTA country means that exports to the second-largest LNG market are not subject to the politics of the export approval process, since they are by law in the public interest.

The Annual Energy Outlook 2014 projects that the US will become a net natural gas exporter before 2020 and anticipates that exports could be 18 percent of supply by 2040. The vast majority of this projected export growth (88 percent) should occur by 2030, and Asia is projected to be the primary market for LNG exports from the US. Although Europe is also a LNG importer, the higher Asian natural gas prices support shipments from the US and are more attractive for the significant infrastructure investments required in the US to support exports. Natural gas exports to Mexico travel by pipeline and therefore do not require the higher cost structure of LNG liquefaction and shipping.

In figure 6, declining Canadian natural gas imports and increasing exports drive net natural gas imports. Pipeline exports of natural gas to Mexico and LNG shipments both grow and are equally important in the 2030–40 timeframe, as shown in figure 7.

Oil Demand. While natural-gas demand will continue to grow in the coming decades, the same is not true for oil. Yet even as the domestic oil demand remains flat or
declines through 2030, oil production and exports are set to increase.

The US transportation sector almost exclusively uses oil and the liquid fuels made from it. Representing 71 percent of crude-oil demand, the US transportation sector is the most important crude-oil user. A primary component of the liquid-fuels supply is used in Light Duty Vehicles, or passenger cars. Regulatory changes requiring higher fuel efficiency, and changes in demographics and driving patterns, are resulting in forecasts of lower liquid fuel demand. The variation in the level of demand is projected using changes in vehicle miles traveled (VMT). Figure 8 illustrates the anticipated decline, which primarily occurs in the 2015–30 time period.

Growing crude-oil production in the US combined with flat and projected declining demand is reducing the amount of crude-oil imports. An added factor is changing crude-oil quality in US production. Natural crude oils differ in their makeup, with varying hydrocarbon components resulting in oil that requires different refining processes. The different crude oils have varying technical criteria but are commonly referred to as light or heavy depending on shorter or longer hydrocarbon molecules, and sweet or sour depending on whether they contain sulfur compounds.

The US refinery complex was largely built to process heavier crude oils. The new shale oil production favors lighter crude oils. This disconnect in refining infrastructure, new production, and projected declining oil demand provides an opportunity for imports and exports. For example, the heavier Canadian oil sands crude oil is suited for processing in US refineries, while the more valuable (and excess) lighter shale oil can secure greater value as an export product. In addition, excess production of refined products can be exported as an important manufactured product.

Crude-oil exports are overseen by the US Department of Commerce. The US does not currently export crude oil, except to Canada. It does, however, export refined products, of which it is a significant global supplier. As stated earlier, the US refineries are currently designed to process heavy crudes, but the

Figure 7
North American Natural Gas Trade and LNG Exports

Source: US Energy Information Administration
ever-increasing production from shale oil reservoirs (such as the Bakken shale) is lighter and sweeter.

Given the current refinery base in the US, it is likely to be technically and economically advantageous for the US to continue to import and process heavy, sour crude and export lighter, high-value crudes from new production. This will require revising the crude-oil export authorization system, which was developed from the standpoint of oil scarcity and declining production.

In a June 2014 decision, the Department of Commerce confirmed that processed condensate (very light crude oil) can be exported as a refined product and is not subject to the export ban. The requirement is that the condensate be processed in a midstream facility, not on the lease. While seen as an affirmation of existing laws and regulations, it is also a positive step toward opening the market to crude-oil exports. A fully functioning market, rather than government restrictions, is needed to ensure that the most effective crude-oil qualities are matched with existing refinery configurations.

However, the future of US oil production is less certain than the natural gas production potential detailed previously. Figure 9 highlights the variability in export potential depending on future crude-oil production. Under the high-production scenario, the US would become a net crude-oil exporter before 2040.

**Other Energy Sources: Coal, Nuclear, and Renewables.** The primary US energy sources other than oil and natural gas are coal, nuclear, and renewables. With the exception of ethanol and other liquid renewables, these are used primarily for power generation. But the fact that shale natural gas is rapidly growing to be the largest share of the fuel mix for power generation has affected the demand projections for these other energy sources. Overall, although the rate of electricity demand growth is projected to slow, the total amount of electricity demanded will continue to increase. The new electricity capacity will primarily be from natural gas and renewables.

As shown in figure 10, in the EIA’s reference case
the growth in natural-gas-fired generation is replacing coal, as discussed earlier. Meanwhile, nuclear energy capacity is projected to remain flat, with new additions replacing retirements. However, the EIA’s projections assume that most of the plant retirements will be in the 2030–40 timeframe, so in the near term there will be little change in nuclear power generation. In sensitivity cases where nuclear power retirements accelerate, nuclear power is replaced by growth in natural gas and renewable generation capacity. Again, the majority of this impact is beyond 2030.

Power generation from renewables continues to grow. The EIA’s analysis indicates that most renewable power growth over the next 10 years will be driven by government policy requirements, but as natural gas prices increase and capital costs for renewable generation decline, renewable generation will become more competitive. The EIA projects that renewables will account for 16 percent of total electricity generation by 2040.\textsuperscript{10}

**Net Energy Demand Scenarios**

There are numerous independent factors affecting energy demand and production forecasts out to 2030. Even so, it is useful to consider future scenarios in which the current state of oil and gas production in the US remains unchanged, is higher than expected, or lower than expected. The following scenarios are illustrative, not definitive.

**Baseline Scenario: The EIA Reference Case.** The baseline case is the current state of oil and natural gas production in the US. The US oil and gas production decline has been reversed, a major change from the past several decades. While a major shift from the past, this scenario does not fully realize the shale oil and natural gas potential. With a long-term natural gas price of $6.00 per Mcf or lower, the US moves to be a natural gas exporter, with up to 15 percent of natural gas production exported in 2030. Oil production grows,
and US import reliance is reduced but not eliminated. Natural gas becomes the dominant fuel for power generation, because of competitive natural gas prices and supported by policies that discourage coal use.

High-Production Scenario. The baseline case is built on existing well-production data. Given the limited information from relatively new shale oil and natural gas extraction, there is a high probability that the EIA’s reference case underestimates oil and natural gas production potential. A high-production case is significantly driven by greater estimated ultimate recovery (EUR). In addition, technology advances continue to improve recovery efficiencies. A slightly larger rate of growth driven by technology will greatly increase recovery effectiveness, since a single-digit percentage of the in-place resource is currently extracted.

In the EIA’s high-production case, EUR is estimated to be 50 percent higher, and the technology factor is increased by 1 percent. The resulting projections result in a gas price in the range of $4.00 to $5.00 per Mcf, and significantly higher exports—approximately 50 percent higher than in the baseline case. These higher export volumes, priced on a gas market basis (Henry Hub), can be the key driver of a global natural gas market. In addition, lower gas prices facilitate even greater industrial growth. Oil production rises to a point that imports greatly decline by 2030 and continue to decline until the US becomes a net oil exporter before 2040.

Low-Production Scenario. Based on production history, a low-production scenario is far less likely than a high-production scenario. An environmental event could result in greater regulatory requirements, which would increase well construction and production costs. The EIA does not model this outcome but does model a case with lower ultimate recovery, which would have the same impact of constraining production. The low-production case results in gas prices in the $8.00-per-Mcf range in 2030. This scenario would increase costs to a level that would constrain natural gas exports to about one-half of the volume under a baseline case. While a higher price would also reduce projected industrial growth, natural gas prices in this

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**Figure 10**

**New Power Generation Primarily from Natural Gas and Renewables**

![Graph of new power generation from 2013-15 to 2036-40, showing a significant shift towards natural gas and renewables.](source: US Energy Information Administration)
low-production scenario would still be competitive compared to economies relying on LNG for their natural gas supply. Under a low oil-production scenario, US oil imports are again rising by 2030.

**Energy Supply Forecast to 2030: The Production Outlook**

The US has the 12th-largest oil reserves in the world, but that should not lead to an undervaluation of the impact of growing shale oil and natural gas production. As noted at the beginning of this chapter, the US is the world’s largest natural gas producer and second-largest oil producer. Because of growing unconventional oil production, the International Energy Agency forecasts that the US will overtake Saudi Arabia in oil production by 2020. This is a remarkable change given that oil production declined every year from 1985 to 2008. Likewise, natural gas production has experienced impressive growth. As recently as 2007, the EIA predicted that by 2030 the US would import 20 percent of its natural gas needs through LNG. But in 2014, the EIA projected that the US would be a net gas exporter before 2020. The production of unconventional oil and gas has created a new paradigm of US energy abundance.

**Natural Gas Production.** Natural gas production is projected to increase and exceed domestic consumption over the 2030–40 period. Natural gas from shale formations is expected to increase from 40 to more than 53 percent of natural gas supply in 2040. The second-highest growth area is gas from tight formations (rocks with very low permeability). A number of studies (by the EIA, Potential Gas Committee, National Petroleum Council, ICF International, and others) have estimated the shale gas resource base. The common element among these estimates has been that America’s total amount of available natural gas has increased over time. While most estimate recoverable resources in the range of 2,000 Tcf, some now exceed 3,000. Figure 11 shows the EIA’s projection of the growing shale gas component of the US energy production outlook.

One of the key reasons for these differences in estimates is the anticipated effect of technology on improving the technical and economic recovery of the resource.
In a 2011 study of natural gas in the US, the Massachusetts Institute of Technology (MIT) evaluated the effect of technology on expanding the resource base. Figure 12 shows the findings of that analysis.

The MIT evaluation demonstrates that extensive resources exist and can be recovered at well-development costs below $6.00 per Mcf. Figure 12 also illustrates that advancing technology may dramatically reduce the cost of production and increase the amount of recoverable natural gas.

According to the EIA’s Annual Energy Outlook 2014, natural gas prices are projected at less than $6.00 per Mcf through 2030. The EIA projection indicates a continuous rise in natural gas prices above $6.00 in the 2030–40 timeframe. This is the reference case; in a higher-production case, EIA assumes greater resources and greater technological innovation, which result in greater supply and correspondingly lower prices. Figure 13 shows the EIA natural gas price forecast in the reference case.

Looking at the historical portion of figure 13, one can see how higher prices encouraged technological advances, which increased supply and thus led to lower prices. Specifically, the increasing natural gas prices from 2004 to 2008 provided a market signal to the industry to invest in technology that brought shale natural gas to market. Initially, this gas was more expensive to produce, but as the cost of production dropped and the amount of production increased, natural gas prices declined to the low point in 2012. Low natural gas prices have spurred demand, causing prices to increase modestly.
Crude Oil. Growing US production of crude oil and natural gas liquids is an even more recent phenomenon than the rapidly expanding natural gas supply. Crude-oil production hit a low point of 4.96 million barrels per day (mbd) in 2008. In 2013, because of shale oil production, crude-oil and liquids production reached 7.72 mbd, a 55 percent increase from 2008. This represents a historic turnaround in production. The data on tight or shale oil are even more dramatic, rising from less than 1 mbd in 2010 to more than 3 mbd in the second half of 2013.

The future growth and sustainability of these unconventional oil resources depend on factors such as well-production decline, lifespan, drainage areas, geologic extent, and technological improvement, both in areas currently being drilled and in areas yet to be drilled. Reliable future projections will depend on data that will take years to accumulate and will vary from region to region. To evaluate variations that may affect the reliability of forecasting future production of shale resources, EIA’s crude-oil projection evaluated high and low production cases along with the reference case.

The methodology for evaluating the high and low cases reflects the greater uncertainty inherent in higher versus lower production. In other words, production lower than the reference case is not likely, but production higher than the reference case is quite likely, based on historical resource projections. However, limited information on production and well performance creates some uncertainty in estimating future production. Figure 14 illustrates the potential for higher crude-oil production based on geologic factors, increased resource recovery, and technical innovation.

One of the factors that will determine the amount of long-term production is price. Unlike natural gas, crude oil will continue to be priced on the global market. While there are many benefits to expanding domestic crude-oil production, crude-oil prices will continue to be set based on global markets, because crude oil is a fungible commodity that is relatively

![Figure 13: Natural Gas Prices Projected to Increase as Cost of Production Rises](image-url)
easy to transport and store. Natural gas is much more expensive, difficult to store, and difficult to transport long distances. Therefore, natural gas markets will remain largely regional.

**Key Drivers of Shale Oil and Natural Gas Production Sustainability**

Although oil and natural gas extracted from shale are playing important roles in America’s shift to energy abundance, there are genuine questions about the sustainability of their production. Shale as a significant source of oil and gas supply is, after all, a relatively new phenomenon. It is worth exploring how the current conditions fostering production may develop in the coming years.

Currently, technical, environmental and societal, and infrastructure factors are most affecting shale production sustainability in the US. The future development of each factor is uncertain, meaning so is the future of shale oil and gas production.

**Technical Factors.** The shale oil and natural gas resource base in the US is very large. The technology to unlock the resource from the shale rocks has been a sea change for the oil and natural gas industry. However, much work has yet to be done to continue the pace of development, including:

- Understanding the unique characteristics of each shale play;
- Conducting additional research into and continuing to develop drilling and hydraulic fracturing technology to improve efficiency and recovery;
- Ongoing investment to maintain shale production in the face of steep decline rates (decline rates of 50 percent or more in the first year);
• Continuing to develop improvement and cost-control systems to maintain return on investment in drilling programs, particularly to justify expansion into more prospective areas; and

• Using technology development to reduce the environmental and social impacts of shale oil and gas production.

The importance of continuing technological innovation is illustrated by contrasting the ultimate recovery of resources from conventional reservoirs with those from shale reservoirs. In conventional reservoirs, primary production typically results in 15 to 25 percent recovery of the oil or natural gas. In shale oil and gas extraction, the recovery percentage is in the single digits. Therefore, the remaining resource still available for extraction with advancing technology is very high. An additional 3 to 4 percent recovery of the in-place resource would double the technically recoverable resource—a huge increase in the discovered shale oil and gas. Technology development will play a great role in expanding the resource base.

Environmental and Societal Factors. While changes in demand can affect gas availability in the short term, long-term projections depend most importantly on supply. Supply potential is particularly relevant when the resource base is very large, such as with shale gas in the US. The issues with perhaps the most potential to slow the rate of natural gas development are those related to environmental tradeoffs and the broader social license to operate.

The process of exploring, drilling, and extracting oil and natural gas has significant environmental impacts. These effects are manageable, and long-term harm to the ecosystem can be prevented with a proactive and comprehensive approach. Effective environmental protection requires advance planning and operational processes designed to protect ground and surface waters, minimize land impacts, and manage methane and other air releases. Effective environmental stewardship is critical for maintaining a social license to operate, or for the public’s and communities’ acceptance of and support for industry operations. Social license is not defined by law, but by community standards.

Maintaining a company’s social license is also essential to effective long-term corporate financial performance, as a number of organizations, such as the Principles for Responsible Investment Association, are advocating environmental and social measurements to be considered alongside traditional financial performance in decisions by equity investors. In addition, major banks are now requiring a minimum level of environmental performance as part of their lending terms.

There are many aspects of environmental protection. The primary environmental impacts common to all shale oil and natural gas development include ground water, surface land and water, land disturbance, and air emissions. A relatively new issue of concern is induced seismicity, which has been associated with waste-disposal wells in a few instances.

Public and community impacts of shale oil and gas development include not only environmental tradeoffs but also the specific effects on the quality of life of residents in the vicinity of the oil and gas activity. Some of the primary public and community impacts are related to traffic, construction activity, and industrialization or commercialization of rural areas. Whether the residents consider these impacts significant varies from region to region. Not surprisingly, in those areas with a long history of oil and gas development, the impact is seen as less problematic.

Industry, government, and other organizations are making progress by reducing the adverse environmental and social tradeoffs of oil and gas development. Industry and state regulatory agencies have moved quickly to address concerns regarding hydraulic fracturing. Regulations and practices regarding ground and surface water protection and land use have been implemented. Air-quality protections are improving. Research to understand induced seismicity is underway. While more remains to be done, organizations that involve multistakeholder participation are addressing these issues in a way that builds public confidence.

The regulatory structure for overseeing oil and gas regulation is largely in place. Many states have increased staff and resources to ensure effective implementation, although an effective performance-measurement system would prove useful. Several regional best-management practice groups are under development. These best-management practice systems...
will provide a process for cataloging effective new technologies to address environmental and social issues, setting the stage for raising standards and reducing tradeoffs in the future.

**Infrastructure Factors.** Infrastructure includes all of the facilities necessary to bring shale oil and gas to market. These include pipelines, rail cars and terminals, midstream processing facilities, and regional gathering systems. In 2013, the industry invested $89.6 billion in midstream infrastructure projects. In a recent study, IHS estimated that the industry will continue to make significant annual capital investments in midstream and downstream facilities in the $80 billion range through 2020.14

Building the infrastructure to connect production facilities to markets is part of the business. Sometimes there is a time lag between drilling wells and marketing product, because of the need to first confirm the value of resources in an area before investing in the pipeline and other infrastructure to connect the area to markets. A concern for both producers and midstream facility operators is that permitting time for new facilities could slow down the infrastructure development process and in turn slow oil and gas production development.

So far, infrastructure permitting does not appear to be affecting production. But anecdotal information about pipeline permitting delays suggests that vigilance is required so that infrastructure investments can be made in a timely fashion. The most notable example is the Keystone XL pipeline, which has been pending approval for more than five years. Should this length of delay become the normal practice, investment in infrastructure would be greatly impacted and would slow resource development.

**Conclusion**

The US energy environment is increasingly marked by energy abundance, with the future outlook transitioning from demand focused to supply focused. There are uncertainties regarding the scope of the change, but not the direction. US oil and natural gas production will continue to grow. As stated by the EIA, the US energy supply picture has greater upside than downside uncertainty. In simple terms, US domestic energy production is highly likely to grow and is more likely to grow at rates higher than the reference case.

**Notes**

3. Ibid.
The Chinese Energy Outlook

Derek M. Scissors

The People’s Republic of China (PRC) will be the largest national energy importer over the 2015–30 time frame and most likely the largest importer of both coal and oil individually. It is already the largest total energy consumer, largest generator of power, largest coal producer and consumer, and biggest alternative-energy spender.

That China matters a good deal to the global energy market is plain, but the reverse is not entirely true: the key factors determining the size and composition of the Chinese energy sector are unlikely to be global energy supply and prices. Thanks to its huge foreign-exchange reserves, the PRC is fairly price insensitive as a global buyer. And as a large economy, its own policies will over the long term be the primary driver of net energy demand and its components.

The critical element of those policies is whether Beijing will undertake pro-competition reform, both in its energy sector and across its economy. Without fundamental economic reform, Chinese growth will stagnate; without energy reform, its energy industry will remain inefficient and intensely import dependent.1 While energy and broader reform are linked, one could conceivably occur without the other.

A comprehensive reform path including both economics and energy seems to be what most observers are assuming, and would lead to strong expansion in energy consumption, production, and imports. At this point, the single most likely path remains weak or absent reform, with the result that China’s energy consumption and production growth is far below potential. But the path remains dependent on foreign energy supplies.

China’s Current Energy Sector

China’s energy sector presently has the following main features:

1) Inadequate local resources;
2) Slowing but still notable consumption growth;
3) High coal dependence;
4) Increasing import dependence; and
5) Heavy spending, especially on alternatives to fossil fuels.

Contrary to the situation for some Middle Eastern countries, there are extensive and frequently updated descriptions of the PRC’s energy situation. Chinese energy statistics are quoted in a variety of places but ultimately stem from Chinese sources, as foreigners are not permitted to collect independent measurements. Different entities—the National Bureau of Statistics (NBS), National Development and Reform Commission (NDRC), National Energy Administration and its predecessors, and industry associations—use different methods and tap different samples, providing a range of numbers.

In terms of reserves, the PRC has the third-largest recoverable coal reserves, at approximately 13 percent of the world total. Its shale reserves are widely quoted as the world’s largest, but this is not a useful figure since so little of the reserves has been proven commercially viable.2 Its nonshale oil and gas reserves are not important globally.

Initial estimates show that China’s primary energy consumption rose roughly 4 percent in 2013 to 2.85 billion tons of oil equivalent (the amount of energy
released by burning one ton of crude oil). Coal predominates, accounting for at least 66 percent of energy consumption.\(^3\) Oil accounts for 18 percent, hydropower (water power) 7 percent, gas 6 percent, and nuclear and wind about 1.5 percent each. Electricity demand in particular climbed 5.3 percent in the first half of 2014, slowing from the previous year. Nearly 80 percent of electric power comes from coal, 16 percent from water, 2 percent from nuclear, nearly 2 percent from wind, and 1 percent from solar.\(^4\)

China accounts for almost half of global coal consumption. Domestic coal production inched up 1 percent to 3.7 billion tons in 2013 and slipped 2 percent in the first half of 2014 to 1.85 billion tons. Coal imports rose 13 percent to 327 million tons in 2013.\(^5\) Precise coal-consumption figures vary among the NDRC, Ministry of Industry and Information Technology, and China Coal Association but can be roughly calculated using production and imports.

China has 24.4 billion barrels of proven oil reserves and was the world’s fourth-largest producer of oil and liquids in 2013, at 4.5 million barrels per day (mbd), which is far behind the top three. Oil consumption in 2013 was 10.7 mbd.\(^6\) There are data discrepancies, but import dependence is between 53 and 58 percent and rising. The General Administration of Customs puts 2013 oil imports at 282 million tons, a 4 percent increase. Saudi Arabia was the top supplier, with a 19 percent share; Angola was second, at 14 percent; and non-Saudi Middle East suppliers combined for about 35 percent. The share of this last group rose in the first eight months of 2014 while Saudi Arabia’s share fell.

Dependence on gas imports is about 32 percent and also rising. Imports rose by one-quarter in 2013, past 55 billion cubic meters, while domestic production climbed 9 percent to almost 113 billion cubic meters. Total consumption rose 14 percent but remains below the ambitious targets set in the mid-2000s, largely because of price controls and other elements of the domestic energy regime that are discouraging both consumption and production.\(^7\)

The non–fossil fuel share of energy use approached 10 percent in 2013, rising almost half a percentage point. Hydropower production, by far the biggest component, rose 7 percent to 789 billion kilowatt hours (kwh). Wind power production stood at 125

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Figure 1

**Electricity Production (Billion Kilowatt Hours)**

billion kwh, a 33 percent increase, though data may be compromised by political demands for rapid gains in this area. Nuclear power generated 111 billion kwh and is likely to rise quickly after a pause caused by the Fukushima Daiichi tragedy. While solar power generation has grown rapidly and the PRC produces the majority of the world’s panels, solar still constitutes a negligible portion of total power generation.

Domestic investment in the energy sector was approximately $470 billion in 2013. Growth rates varied wildly among sectors, declining outright in coal while soaring in gas. There are a variety of alternative-energy spending estimates, depending on the inclusion of hydro and nuclear power, but spending appears to have fallen from $65–$68 billion in 2012 to $54–$61 billion in 2013. The PRC also spent close to $30 billion on extractive overseas energy investments in 2013. Chinese oil firms produce about 2 mbd at overseas wells.

**Energy and Economic Variables**

The central factors that could affect China’s energy sector in the next 15 years are:

1) Current macroeconomic trends;

2) Possible macroeconomic disruption and improvement from broad market-favoring reform;

3) Domestic and international political changes;

4) The national resource endowment; and

5) Reform within the energy sector.

Most forecasts for 2002–08 Chinese energy use proved far too conservative. One factor was unexpectedly durable economic growth; another was the surprise adoption of an energy-intensive development model. According to official data, coal production fell for two consecutive years, to 880 million tons in 2000. But by the end of 2009, it was 2.96 billion tons.

Looking forward, weaker-than-anticipated economic growth may now produce the opposite effect: overly high energy-use forecasts. Successful economic reform would boost growth but would also shift away from the current energy-intensive development model, to some extent cutting into energy demand growth. In addition, there has been a change in the GDP–energy consumption relationship globally and, more recently, in the PRC, with GDP gains becoming less energy intensive. (China adds the twist that the GDP-energy relationship shifted in late 2008, almost certainly because GDP was being exaggerated for political reasons.)

While Chinese data quality is uneven, it is clear that economic growth has slowed. And the government seems to have recognized, belatedly, that a renewed reform commitment is needed. However, the much-touted third plenum in Fall 2013 has few accomplishments to show to date, and announced economic and energy targets should not be treated as credible unless effective policy implementation is well underway.

In principle, reform could speed up the inevitable shift away from heavy industry that has bred high energy use over the past decade. Less emphasis on construction and related sectors—such as steel and cement—means less urgent need for coal.

In terms of specific changes, there has been some movement in the financial sector, and the operation of capital markets can be extremely important to raising energy production. Presently, however, China’s energy sector faces few limits on access to capital. Nor is that likely to change with reform, given pressure to produce more at home because of heavy dependence on imports.

Capital-market reform will more likely alter industry winners and losers. Commercially oriented financial institutions would see sectors differently than the NDRC, cutting financial subsidization and oversupply. This means comparatively less coal use as oversupplied industries such as steel and real estate are cut back. In that scenario, consumer lending would rise (for example, car purchases), boosting oil and gas.

Within the energy sector, alternative energy is being more heavily subsidized than other sources and, following financial sector reform, would fade in importance unless preferential policies were adopted outside of finance. In combination with more competition being permitted (see the Energy Variables section), capital-market reform would also help elevate private firms at the expense of state monopolists.
Another often-cited variable affecting the energy outlook is urbanization. Analysts sometimes confuse the urbanization that occurs because of greater opportunities created by reform with state-directed urbanization. For now, the state option is not being exercised. Furthermore, market-driven urbanization is a ways off and its role is contingent on other factors.

Blocking both market- and state-led urbanization is the timetable for the unification of urban and rural registration in terms of land ownership and available benefits. At present, rural residents cannot freely move to and establish formal residence in Chinese cities, which is necessary for access to local schools and other benefits. Unified registration is not supposed to be completed until 2020, and the impact on energy consumption will take several years beyond that to materialize. Even then, the impact of freer labor movement on energy production will remain limited unless more commercial competition is permitted, specifically in energy.

Sharper land-ownership rights in rural areas are potentially much more important. The shale boom has occurred in the US well in advance of everywhere else, chiefly because of deep-seated and well-defined American land rights: landowners own the mineral resources, not just the right to build. Granting such rights in the PRC would be transformative, first in agriculture but ultimately in energy as well, as rural land in China is still owned by the state and rented to citizens. Unfortunately, reforms are aimed at protecting rural landholders from predatory behavior by local governments, not at granting true ownership. These reforms would mark an advance in social and political terms, but not in the economic or energy spheres.

It follows that while the success of broad economic reform matters enormously, on its own it is not especially important to net energy demand through 2030. The two paths for the economy are the excessively energy-intensive path it has been on since 2002, with progressively slower growth, and a reform path that sees disruption followed by an acceleration of growth that is less energy intensive. What truly distinguishes the two economic paths is the composition of energy use.
Energy Variables

The relevant energy-specific variables are China’s resource endowment and state intervention in industry structure, price controls, and subsidization. Resource endowment is most often discussed in terms of physical resources, but there is also an important financial component. Official foreign-exchange reserves hit $4 trillion in mid-2014 and there are hundreds of billions of dollars more at state banks. This means that the inadequacy of Chinese oil and coal reserves is important to the world but not to China. The PRC may not have enough coal or oil, but reserves mean it can easily afford to add a huge bill for new coal imports to its already huge bill for oil imports.

Hydropower has been heavily developed and has limited potential for further growth. Spending on alternative energy will certainly continue but will be constrained by explosive growth in domestic debt and a poor commercial track record. The rapid-growth phase for wind power may have ended, and solar remains a tiny industry. Nuclear power can achieve the goal of a doubled share of Chinese energy consumption, but that share would still amount to only 4 percent.

That leaves shale. In theory, shale could transform proven reserves in the PRC as it has in the US, offering China a much larger domestic fossil fuel base to draw on. The timing of this transformation of course depends on prices, but also on international technology development, the structure of the energy industry, and basic property rights. An expansion of proven reserves in the form of viable shale could start at almost any time with the right policy changes. Alternatively, stable energy prices and lack of internal reform could mean that targets continue to go unmet and shale production is minor through 2030.

There is a role for state action in energy, such as in higher-standard building codes. But the US boom was not driven by the government or even Exxon or Chevron. Instead it was small, private firms (some of which have now become sizable) competing freely.

Political Forces

An end to the Communist Party’s power monopoly over the next 15 years is not impossible but is quite unlikely. Similarly, truly disruptive international political changes, such as major wars, are unlikely for China through 2030. The main role for politics is therefore to shape economic and energy reform decisions.

China’s dependence on fossil fuel imports leaves it vulnerable to developments in the Middle East and tensions over maritime transit in the South China Sea, through which most energy imports pass. An extended disruption in imports from certain sources would lead to changes in the energy mix. Less dramatic and more positive, China benefits from being more business oriented than most countries, willing to set aside worries about the influence of multinationals and security differences if high-value commercial goals are achievable. Beijing also has no qualms with the nuclear or coal industries.

At home, a purge initiated by Communist Party General Secretary Xi Jinping—the “anticorruption” campaign—has impinged considerably on energy. Lack of transparency means that both the true objectives and the status of the campaign cannot be verified, but it may serve as a prelude to the breakup of China National Petroleum Corporation (CNPC) or Sinopec (or even both of them). CNPC especially has been implicated in corruption investigations, whatever their true motive. This could enhance competition in the energy sector, although it is more probable that the breakup would be managed to ensure continuing state dominance of energy.

Notes

At the moment, the Chinese energy sector is entirely incompatible with such a development.

In late 2006, the State Council formalized the requirement of absolute state dominance over energy. This is not mitigated by vague talk of reform, frequent administrative shuffling, or selling minority stakes in a single subsidiary to a mix of investors. There will be many government claims of further energy sector reform in the next 15 years, but all that matters is how much genuine commercial competition will be allowed.

Present industry structure prohibits competition. While the state giants have many subsidiaries, there are two huge state-owned onshore oil and gas companies (CNPC and Sinopec), one offshore monopoly (China National Offshore Oil Corporation), and just a few small firms. The three state majors control about 95 percent of oil and gas output and more than 70 percent of refining. There are a large number of coal miners, but the majority of production is state controlled and Beijing seeks to consolidate on a noncommercial basis, with a goal of 10 or fewer prominent state-owned enterprises (SOEs).

The power sector has a state grid monopoly split into two regional firms, plus five dominant state-owned power-generating companies accounting for 88 percent of generating capacity. Hydropower has already been consolidated and is entirely state controlled through China Three Gorges Corporation, Power Construction Corporation, and China Energy Engineering. The same is true with China General Nuclear and China National Nuclear Corporations. There has been private participation in wind and solar but it faded as industry conditions deteriorated, with the survivors either national generators or supported by local governments.

The failure to develop shale resources is a concrete illustration of the problem. Because the NDRC permits so little competition, there is little incentive to innovate domestically. Foreign firms are being allowed to partner with SOEs, which could bring much-needed technology. If competition remains heavily suppressed, however, then the adaptation of foreign technology to the Chinese market will be slow. Within the 2015–30 time horizon, this same dampening could apply to other energy technologies. Without commercial competition, China cannot innovate and will be forced to try to copy.

More market participants would improve energy efficiency and thus reduce net energy demand. But
even allowing substantial private participation could have only limited benefits if price controls remain. Price caps in electricity and heating, intended to benefit consumers, have long distorted the market. They principally encourage overuse of cheaper, more easily available coal while inhibiting more expensive natural gas production and imports.30

The NDRC insists that it is conducting reform by changing the nature of its energy price controls, but this merely reinforces the unwillingness to allow supply and demand to determine the price. According to Xinhua, the current round of “reform” puts off market prices indefinitely: “The third and final step will be a new, uniform price system by 2015 before eventually allowing energy prices to be decided by the market itself.”31

Along with price controls, financial subsidies of various kinds also undermine market prices. Annual energy subsidies easily exceed $100 billion. Artificially low power and heating prices create pressure for higher subsidies, especially for relatively expensive options, such as renewables. Such subsidies warp commercial competition into political competition over who is to be favored more. They also breed overcapacity.32

Concentrated industry structure, price controls, and subsidies all promote inefficiency and push net energy demand higher than it should be. Effective reform would spur innovation and quickly and sustainably increase production, thus lowering net energy demand. But there is little sign of that as yet.

Scenarios

In light of the economic and energy variables, the four possible scenarios are simple to characterize:

1) The status quo of no major economic or energy reform;

2) Effective economic reform but continued state dominance of energy;

3) Ineffective economic reform but substantial erosion of state dominance of energy; or

4) Effective economic and energy reform.

The present status of the energy sector and the nature of proposed reforms can be used to generate a quantitative sketch for each scenario. This is a set of illustrations, not a comprehensive or coherent model. Most important, prices are not derived. In the two energy reform scenarios, Chinese prices are assumed to converge to world prices (to European prices for gas). World oil prices are assumed to rise modestly, coal prices to decline in real terms, and (European) gas prices to be essentially flat. Where there is no energy reform, prices are endogenous along with factors such as industry structure and subsidies. In all scenarios, China is price insensitive because of its huge foreign currency reserves. Stockpiling is also ignored.

The scenarios show considerably more variability in energy consumption, production, and imports than benchmark forecasts such as those offered by BP or the US Energy Information Administration, which appear to assume successful Chinese economic and energy reform.33 Energy consumption growth is depressed in two scenarios (in one it is outrun by production). Green (non–fossil fuel) energy does relatively better when there is less reform—though its absolute use is still higher with reform—because it is unlikely, at market prices, to be competitive with fossil fuels for most of the forecast horizon. Note that in all scenarios, absolute figures are mildly understated for the sake of comparability. The percentage changes are more important.

Scenario 1: Status Quo. The status quo scenario is the most likely, with a probability of about one in three. Talk of economic and energy reform has not been accompanied by serious action. If that continues, the driving forces in the energy mix will remain largely unchanged. By 2030, changes will appear minor in comparison to China’s recent record (although they would be considerable for many countries). Most important, China will fall far short of the energy consumption range established by the benchmark forecasts.

The International Energy Agency projects annual average real GDP growth at approximately 5.5 percent between 2015 and 2030.34 This is the lowest yet published by the major energy forecasters and still too high for the scenario of no major economic reform. True GDP growth here, as opposed to what the official GDP results will be, is about 3.8 percent.35 Without energy
reform, energy per unit of GDP declines, but not as quickly as the government plans. These factors account for slow energy consumption. In particular, China may not become the world’s largest oil consumer.

Continued government intervention allows green-energy production to expand comparatively quickly. The increment to energy production thus almost matches the increment to consumption, capping import dependence. The growth of coal imports slows considerably and China, while still by far the global leader, becomes less dominant in world coal production and consumption. Oil and gas imports both expand, but their volumes are at the low end of industry expectations.

In this scenario, China’s energy needs are manageable and it will prefer lower cost to safer supply because the economy cannot easily afford a price premium for a decade or more. The available producer with the lowest cost is Saudi Arabia. It would require important additional developments for Iraq or Iran, for example, to qualify as China’s top partner.

Scenario 2: Only Economic Reform. The economic-reform-only scenario is the third most likely, with a probability of about one in four. Energy is considered by China and others to be strategic, or in need of more state control than almost any other sector.\(^{36}\) It is thus possible that broad economic reform will be implemented but energy will be exempted. Reforms in labor, finance, and most of the state sector still sustain higher economic growth, with GDP at something close to the IEA’s 5.5 percent annual average.

Energy demand is boosted accordingly, but such changes, especially in the state sector, also alter the

<table>
<thead>
<tr>
<th>Table 1: Approximate State of Play, 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy production</td>
</tr>
<tr>
<td>Net energy imports</td>
</tr>
<tr>
<td>Primary energy supplied</td>
</tr>
<tr>
<td>Electricity production</td>
</tr>
<tr>
<td>Thermal</td>
</tr>
<tr>
<td>Hydro</td>
</tr>
<tr>
<td>Wind</td>
</tr>
<tr>
<td>Nuclear</td>
</tr>
<tr>
<td>Electricity consumption</td>
</tr>
<tr>
<td>Coal and lignite production</td>
</tr>
<tr>
<td>Net coal and lignite imports</td>
</tr>
<tr>
<td>Coal and lignite consumption</td>
</tr>
<tr>
<td>Oil and liquids production</td>
</tr>
<tr>
<td>Net oil and liquids imports</td>
</tr>
<tr>
<td>Oil and liquids consumption</td>
</tr>
<tr>
<td>Natural gas production</td>
</tr>
<tr>
<td>Net natural gas imports</td>
</tr>
<tr>
<td>Natural gas consumption</td>
</tr>
</tbody>
</table>

Notes: These numbers understate actual results for 2013 but are used for the sake of comparability. Discrepancies among demand, supply, and trade are accounted for by claimed changes in stocks.
### Table 2
Status Quo Scenario Forecast

<table>
<thead>
<tr>
<th></th>
<th>2013 Approximation</th>
<th>2030</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy production (ktoe)</td>
<td>2,582,854</td>
<td>3,287,973</td>
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<td>Energy consumption (ktoe)</td>
<td>3,012,770</td>
<td>3,747,886</td>
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<tr>
<td>Electricity output, thermal share</td>
<td>78.0</td>
<td>61.6</td>
<td>–21</td>
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<tr>
<td>Electricity output, other share</td>
<td>22.0</td>
<td>38.4</td>
<td>+75</td>
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<tr>
<td>Coal production (kilotons)</td>
<td>3,577,107</td>
<td>3,956,280</td>
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<tr>
<td>Coal consumption (kilotons)</td>
<td>3,587,947</td>
<td>4,025,677</td>
<td>+12.2</td>
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<tr>
<td>Oil production (kilotons)</td>
<td>212,911</td>
<td>232,499</td>
<td>+9.2</td>
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<tr>
<td>Oil consumption (kilotons)</td>
<td>483,713</td>
<td>696,063</td>
<td>+43.9</td>
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<tr>
<td>Gas production (mcm)</td>
<td>116,361</td>
<td>208,635</td>
<td>+79.3</td>
</tr>
<tr>
<td>Gas consumption (mcm)</td>
<td>160,215</td>
<td>344,296</td>
<td>+115</td>
</tr>
</tbody>
</table>

Source: Author’s calculations

Note: Energy production and consumption is in kilotons of oil equivalent (ktoe) and gas production and consumption is in million cubic meters (mcm).

### Table 3
Economic-Reform-Only Scenario Forecast

<table>
<thead>
<tr>
<th></th>
<th>2013 Approximation</th>
<th>2030</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
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<td>Energy production (ktoe)</td>
<td>2,582,854</td>
<td>3,486,853</td>
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<tr>
<td>Energy consumption (ktoe)</td>
<td>3,012,770</td>
<td>4,540,240</td>
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<td>Electricity output, thermal share</td>
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<td>69.3</td>
<td>–11</td>
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<tr>
<td>Electricity output, other share</td>
<td>22.0</td>
<td>30.7</td>
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<td>4,049,285</td>
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<td>4,449,054</td>
<td>+24.0</td>
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<td>Oil production (kilotons)</td>
<td>212,911</td>
<td>254,003</td>
<td>+19.3</td>
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<td>Oil consumption (kilotons)</td>
<td>483,713</td>
<td>816,991</td>
<td>+68.9</td>
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<tr>
<td>Gas production (mcm)</td>
<td>116,361</td>
<td>238,540</td>
<td>+105</td>
</tr>
<tr>
<td>Gas consumption (mcm)</td>
<td>160,215</td>
<td>485,451</td>
<td>+203</td>
</tr>
</tbody>
</table>

Source: Author’s calculations

Note: Energy production and consumption is in kilotons of oil equivalent (ktoe) and gas production and consumption is in million cubic meters (mcm).
energy-intensive development model. The pace of energy consumption gains thus continue to ease. Domestic production responds to some extent to ongoing demand growth (and a generally richer economy), but lack of energy reform means that the gap between consumption and production widens considerably. This necessitates more use of fossil fuels, which in turn means relatively less importance for green energy and greater import dependence. Coal imports are at a consistently high level, straining global capacity, while the volume of oil and gas imports approach or match industry expectations.

Here, the weakness of the energy sector and the strength of the economy cause a repeat of Chinese behavior over the previous 15 years, only on a larger scale. China is interested in all partners, especially those less connected to the world market, such as Russia. This also includes small energy players such as Colombia.

**Scenario Three: Only Energy Reform.** The energy-reform-only scenario is the least likely, with a probability of about 1 in 10. China has had a political focus on energy since 2011, and the sector is now the leading target of the anticorruption campaign. Economic reform could stumble, meaning the development model stays largely unchanged, and yet the energy sector is reformed for political reasons. Most likely, industry structure would change to encourage less concentration and thus less political influence. Gross subsidies would also be reduced but price controls may remain in place.

These steps would boost competition and increase efficiency, causing strong energy production gains. Energy reform also boosts the economy, though obviously to a lesser extent than economic reform would. Average annual GDP growth is therefore in the 4 to 5 percent range, and energy consumption expands at a decent clip. Energy reform means that the most cost-effective sources of energy outperform, which in China’s case is coal. High levels of coal production are sustained over the forecast period, limiting both coal imports and green energy use. Increased efficiency would also serve to cap oil and gas imports.

This scenario promotes an energy policy of convenience. China will be able to choose among foreign oil suppliers on the basis of a variety of factors, not simply

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Energy-Reform Only-Scenario Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013 Approximation</td>
</tr>
<tr>
<td>Energy production (ktoe)</td>
<td>2,582,854</td>
</tr>
<tr>
<td>Energy consumption (ktoe)</td>
<td>3,012,770</td>
</tr>
<tr>
<td>Electricity output, thermal share</td>
<td>78.0</td>
</tr>
<tr>
<td>Electricity output, other share</td>
<td>22.0</td>
</tr>
<tr>
<td>Coal production (kilotons)</td>
<td>3,577,107</td>
</tr>
<tr>
<td>Coal consumption (kilotons)</td>
<td>3,587,947</td>
</tr>
<tr>
<td>Oil production (kilotons)</td>
<td>212,911</td>
</tr>
<tr>
<td>Oil consumption (kilotons)</td>
<td>483,713</td>
</tr>
<tr>
<td>Gas production (mcm)</td>
<td>116,361</td>
</tr>
<tr>
<td>Gas consumption (mcm)</td>
<td>160,215</td>
</tr>
</tbody>
</table>

Source: Author’s calculations
Note: Energy production and consumption is in kilotons of oil equivalent (ktoe) and gas production and consumption is in million cubic meters (mcm).
their production efficiency, supply stability, and ease of transport. Under these conditions it is likely that China will look to favor longstanding partners such as Angola and the United Arab Emirates.

**Scenario Four: Comprehensive Reform.** The comprehensive reform scenario is the second most likely, with a probability of almost one in three. In it, the anticorruption campaign turns out to be a prelude to both economic and energy sector reform, which starts in earnest in 2016. Reforms extend to land rights, the entire state sector, and labor and finance. Economic growth is healthier and, less important, GDP gains average better than 6 percent annually. This is the scenario most frequently adopted by Chinese scholars.\(^{37}\)

Energy demand is boosted by rapid expansion but also checked by a changed development model and lower energy intensity. Greater efficiency helps energy production rapidly expand.

The combination of high demand and supply-side market reforms extend fossil fuel use at the expense of green energy, although the absolute amount of green energy produced and its share in electricity output still rise. China continues to account for half of the global coal industry, becomes the world’s biggest oil consumer, and sees rapid gains in both gas production and consumption. This is the scenario where both supply and demand forces induce notable shale development. Gross imports are quite large across all fossil fuels, but import dependence is kept in check by the vibrant domestic energy sector.

China’s absolute need for energy is large, but its energy dependence is contained. This is a scenario where China engages with many energy players but has the flexibility to avoid the especially troublesome ones, one such as Venezuela. Smaller but relatively stable partners, such as Oman, could help substitute for the troublemakers.

**Conclusion**

The four previously described scenarios help demonstrate the extent of uncertainty. If economic and energy reforms are implemented, the only question is when they will occur within the forecast horizon.

### Table 5
**Comprehensive Reform Scenario Forecast**

<table>
<thead>
<tr>
<th></th>
<th>2013 Approximation</th>
<th>2030</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy production (ktoe)</td>
<td>2,582,854</td>
<td>3,927,801</td>
<td>+52.1</td>
</tr>
<tr>
<td>Energy consumption (ktoe)</td>
<td>3,012,770</td>
<td>4,940,942</td>
<td>+64.0</td>
</tr>
<tr>
<td>Electricity output, thermal share</td>
<td>78.0</td>
<td>73.7</td>
<td>–6</td>
</tr>
<tr>
<td>Electricity output, other share</td>
<td>22.0</td>
<td>26.3</td>
<td>+20</td>
</tr>
<tr>
<td>Coal production (kilotons)</td>
<td>3,577,107</td>
<td>4,310,414</td>
<td>+20.5</td>
</tr>
<tr>
<td>Coal consumption (kilotons)</td>
<td>3,587,947</td>
<td>4,653,242</td>
<td>+29.3</td>
</tr>
<tr>
<td>Oil production (kilotons)</td>
<td>212,911</td>
<td>301,695</td>
<td>+41.7</td>
</tr>
<tr>
<td>Oil consumption (kilotons)</td>
<td>483,713</td>
<td>876,488</td>
<td>+81.2</td>
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<tr>
<td>Gas production (mcm)</td>
<td>116,361</td>
<td>297,884</td>
<td>+156</td>
</tr>
<tr>
<td>Gas consumption (mcm)</td>
<td>160,215</td>
<td>543,129</td>
<td>+239</td>
</tr>
</tbody>
</table>

Source: Author’s calculations

Note: Energy production and consumption is in kilotons of oil equivalent (ktoe) and gas production and consumption is in million cubic meters (mcm).
The nature of the energy development path is fairly easy to anticipate; some variant of scenario four will play out. But reforms have not yet been implemented and, in the case of energy, have not even been clearly presented. The impact of reform failure has not been sufficiently examined.

China is already in the same league as the US, while Saudi Arabia in shaping global energy outcomes and has the potential to become an even bigger factor. The uncertainty surrounding the PRC’s energy sector is thus second only to uncertainty regarding the Middle East’s global importance.

Notes


6. US Energy Information Administration, China.


11. World Bank, “GDP per Unit of Energy Use (Constant 2011 PPP $ per Kg of Oil Equivalent),” http://data.worldbank.org/indicator/EG.GDP.PUSE.KO.PP.KD.


15. Chen Zhi, “Analyst Sees Industrial Overcapacity Last


23. Zhou et al., *China’s Energy and Emissions Outlook to 2050*.


35. GDP does not properly represent economic growth but is used here for the sake of simplicity. Recall also that official figures can be manipulated at any time for political reasons.


The Middle East Energy Outlook

Sara Vakhshouri

Technological developments and the recent shale revolution in North America have significantly changed the global energy landscape. The United States, once seen as the major market for oil and gas exporters, is now expected to outstrip Saudi Arabia in oil production and surpass Qatar and Australia in liquefied natural gas (LNG) exports. Overall US oil production could reach its historic high level of 9.6 million barrels per day (mbd) in 2015, last achieved in 1970. US tight oil production may surge to 5 mbd by 2017.

This remarkable rise in unconventional production raises concerns about the possible implications for the long-standing producing countries and regions, particularly members of the Organization of the Petroleum Exporting Countries (OPEC) and the Middle East. There is also concern as to the effect tight oil and gas will have on global prices and whether oversupply in the market may continue in the long term.

This chapter is devoted to the future of energy supply and demand in the Middle East—the impact of tight resources on the region’s producers and their export markets, the future role of OPEC in the global market, “game changers” in the Middle East, and challenges to Middle Eastern countries’ abilities to meet future production targets.

Middle East Energy Outlook to 2030 (Baseline Scenario)

The baseline energy outlook scenario for this chapter is based on the BP Energy Outlook 2030, the International Energy Agency’s World Energy Outlook, and IEA’s New Policies Scenario. Global proven oil reserves are estimated at 1.5 trillion barrels. About 73 percent of these resources are located in OPEC countries, 52 percent in the Persian Gulf, and another 14 percent in North America. US proven oil reserves are said to account for only 2 percent of global reserves.2 Persian Gulf producers are expected to maintain their supply share in the market, but the region needs significant investment in its energy sector if this is to hold true. The shale oil and gas production surge in North America means that Asian imports from the Middle East must rise considerably to offset it.

In addition, a surge is expected in energy intensity and domestic consumption in the Middle East, mainly because of population growth and energy waste. The region’s energy consumption growth in the next decade is estimated to surpass the growth rate in industrialized regions, with inefficiency and price subsidies contributing significantly to this increase.

Middle East Energy Production. The Middle East’s low-cost oil will help the region to maintain its central role in the market, and if non-OPEC production starts to dive, perhaps by the mid-2020s, the region will again be responsible for most of the supply increase in the global oil market.3

- Middle Eastern energy production is expected to grow 33 percent by 2030.
- The liquids production from this region will increase by 12 mbd by 2030.
- Oil and gas will maintain their dominance in energy production, growing 19 percent and 68 percent, respectively.4
The Middle East will maintain its global market share as a large energy exporter, and it is expected that its overall oil and gas exports will rise 10 percent by 2030. Oil will account for 90 percent of the region’s total energy exports by 2030.

To achieve its ambitious production capacity and production growth targets, however, the Middle East requires substantial amounts of investment. The IEA estimates that the region needs $3.7 trillion of investment in its energy sector, including in renewable energy, to maintain its production and global market share through 2035.

Middle East Energy Consumption. Population growth is the primary driver of increasing energy consumption in the region. Energy waste, encouraged by subsidies and delays in reform programs (except in Iran), also contributes to energy demand growth in industry, transportation, power, and household use.

Predictions for energy consumption are as follows:

- Energy production growth will accelerate. Even so, the share of the region’s supply in the global market will remain at 14 percent. This is because the region’s energy consumption will rise 65 percent by 2030.

- The Middle East’s global share of energy consumption will increase from 6 percent in 2011 to 7 percent over the next two decades, with a 4 mbd increase by 2030.

- Energy consumption per capita in OPEC member nations is 75 percent more than the non-OECD average, limiting export growth of oil and gas from these countries.

- Oil’s share in the region’s overall consumption mix will drop from 49 to 42 percent by 2030. The share of natural gas will rise from 49 to 55 percent. Fossil fuels’ share in the region’s consumption mix will remain at about 98 percent.

- The power-generation and transportation sectors will be responsible for most energy consumption growth. Energy demand in the power and transportation sectors will rise by 58 and 63 percent, respectively.

- Oil’s share in the transportation sector will drop from 94 to 90 percent by 2030, while the share of gas in this sector will surge from 6 to 10 percent. Gas’s share in power generation will increase from 61 to 74 percent by 2030, while oil’s share will plunge from 33 to 17 percent.

- The growth of the petrochemical industry in the major energy-producing countries, like Saudi Arabia and Iran, and the subsidized price of gas, a primary feedstock for these factories, are major contributors to industry’s energy demand increase.

The Middle East’s Game Changers: Saudi Arabia, Iraq, and Iran

Saudi Arabia, Iran, and Iraq are the biggest energy players in the region, boasting large and easily extractable reserves. Saudi Arabia, with its significant spare capacity, for many years has been the swing producer and has played a crucial role in balancing supply and demand during major disruptions. Iraq and Iran both have ambitions to raise their production capacities well above current levels.

In the baseline scenario, Iraq and Iran are the only Middle Eastern producers that sustain significant production growth in this region. Their substantial amount of proven reserves, low costs of production and of maintenance are the key factors for production growth in these countries. Even so, both countries face major internal and external challenges to increasing their contributions to market supply.

Saudi Arabia. Saudi Arabia has the world’s largest proven oil reserves, largest petroleum liquid production, and greatest exports. Saudi Arabia’s oil production capacity is around 12 mbd, but the kingdom acts as a swing producer, largely producing according to market needs, and is currently generating 10 mbd. Oil is responsible for 90 percent of Saudi gross domestic product.
Developing the natural gas sector is now a priority, as it reached its targeted oil production capacity in 2009. Increasing natural gas production capacity will allow the country to reduce oil consumption in its power-generating sector and will improve margins in petrochemicals because of cheaper feedstock. Riyadh has set a goal of reducing the share of fossil fuels in its electricity sector by at least 50 percent by 2020 to free oil and natural gas production for export and use in petrochemicals.

The main driving forces that could affect Saudi Arabia's energy production growth and export capacity are excessive domestic energy consumption because of subsidies and domestic stability and the relative security of its oil fields.

**Domestic Consumption.** Historically high oil prices, the associated economic growth, and high energy price subsidies have turned Saudi Arabia into the biggest energy-consuming country in the Middle East. In 2012, Saudi Arabia consumed 3 mbd of oil. Iran, by comparison, consumed only 1.7 mbd that year. Oil is consumed mostly in the transportation sector and is used as feedstock for power generators. Saudi officials have warned that if the bullish growth of domestic oil consumption continues, the country could lose 3 mbd of crude oil exports by the end of 2020.7

**Stability and Security.** Pipelines, refineries, and energy export facilities have historically been targets for terrorists. In 2006, al Qaeda called for renewed attacks against the country's energy facilities. Iran and Saudi Arabia are now at loggerheads over the future of Iraq and other vital issues. To secure its oil revenues, Riyadh has enhanced physical security at export facilities and is developing alternative export facilities and routes in more secure areas of the country.

**Looking Ahead.** In the baseline scenario, Riyadh does not further boost oil production capacity before 2030, as a supply shortage, especially considering North America's tight oil resources, is unlikely. Instead, the kingdom has focused on natural gas. It has 288 trillion cubic feet (Tcf) of proven natural gas reserves, the fifth largest after Russia, Iran, Qatar, and the US. Domestic natural gas consumption is expected to rise to 3.5 Tcf per year by 2030, almost double consumption in 2011. It is estimated that natural gas production in this country will be adequate for only domestic needs, leaving no export capacity.8

**Iraq.** Iraq has the fifth-largest proven oil reserves, after Saudi Arabia, Venezuela, Canada, and Iran. Yet up to 90 percent of its resources are unexplored, mainly because of years of war and sanctions. Production costs in Iraq might be among the lowest in the world, but its production has never exceeded 4 mbd. Only recently has Iraq begun a very ambitious development plan to boost oil production.

Although Iraq does not have a legal framework governing investment in its energy sector, the Iraqi oil minister signed a number of long-term contracts with international oil investors between 2008 and 2010. The investment contracts are for development of more than 60 billion barrels from existing oil fields and also from explored but undeveloped fields. If all these contracts were to have been completed successfully, Iraqi oil production capacity, in theory, would have increased to about 12 mbd by 2017: three times higher than its production of around 3 mbd in 2012 and equal to that of Saudi Arabia.9 The contracts, however, have already been renegotiated for a more modest production target of 9.5 mbd by 2017.

The influential factors for Iraqi oil production and export capacity growth are: (1) lack of a legal framework for investment, (2) insufficient infrastructure, (3) need for electricity, (4) need for water and natural gas reinjection to oil fields, (5) domestic rivalry between the Iraqi government and the Kurdistan Regional Government (KRG), and (6) attacks by radical Sunni group Islamic State of Iraq and Syria (ISIS).

**Lack of a Legal Framework for Investment.** Internal political conflicts, in particular between the central government in Baghdad and the Kurdistan regional government, have largely prevented the country from passing a uniform hydrocarbons law. A proposed hydrocarbons law, a legal framework in which investors can work and invest, was put forward in 2008 but has not yet received final confirmation in the Iraqi parliament, let alone ratification by the president.
Insufficient Infrastructure. According to Iraqi officials, the country requires $30 billion of investment in energy infrastructure every year. Limited facilities for storing, refining, transporting, and exporting provide many obstacles to production of oil. The functioning of Iraqi export facilities and pipelines in the north has been limited by sabotage, and southern facilities are currently running at maximum capacity. Disagreements between the central government and the KRG have slowed infrastructure investment, in particular preventing the country’s pipeline capacity from growing.

Water and Natural Gas Reinjection. To boost oil well pressure and thus production from old fields, Iraq needs to reinject water and natural gas into the wells. Although Iraqi fields have associated gas, no infrastructure is in place to capture this gas for reinjection. Instead, the gas is being flared. Water is another source for boosting well pressure. It is estimated that Iraq needs to reinject 10 to 15 mbd of seawater at the cost of $10 billion into its oil wells reach its 2017 targets. The water reinjection project has been renegotiated and delayed many times.

Need for Electricity. Current electricity-generation capacity is insufficient for developing the hydrocarbon industry and increasing oil production. The need for remodeled and expanded power-generation capacity and efficiency is a major obstacle. Plans for increasing power-generating capacity by 20 gigawatts by 2015 have been delayed.

Baghdad vs. KRG. The Iraqi central government has been in many disputes with the KRG over the expansion of the energy industry and oil production. The KRG passed its own hydrocarbons law in 2007, but Baghdad continues to insist that energy companies must sign contracts with the national government. Baghdad also decreed that the KRG could not export its own crude oil; only the national government can. The KRG has challenged the Iraqi government by signing investment contracts with international companies and export agreements with foreign customers; prior to the Islamic State offensive, it was exporting 250,000 barrels per day. The KRG has plans to increase its direct exports to 1 mbd by 2015 and 2 mbd by 2019.

ISIS Attacks and Turmoil in Iraq. The recent ISIS attacks have threatened the short- and long-term prospects of Iraqi oil production and the future of its energy industry in general. On June 21, 2014, Iraq’s largest refinery, at Baiji, succumbed to ISIS. The Baiji refinery has a capacity of 320,000 barrels of oil per day and previously supplied one-third of Iraq’s domestic fuel use. Even though the refinery helps supply domestic demand, its seizure pushed Brent oil prices to a nine-month high and raised serious questions about the flow of energy exports from Iraq. The expansion of ISIS attacks could affect short-term supplies and might also significantly alter long-term production plans. Before the current turmoil, Iraq’s production was forecast by independent observers to double in the coming decades, reaching 9 mbd by 2035. Now, however, most major oil investors have pulled their staff out of Iraq. Any further political instability—or, worse, additional attacks on Iraq’s energy infrastructure—could undermine the rosy projections.

Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>2.3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2017</td>
<td>5</td>
<td>6.5</td>
<td>13</td>
</tr>
<tr>
<td>2020</td>
<td>6</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>2030</td>
<td>8</td>
<td>9</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: 2012 figure is actual.
Looking Ahead. The IS offensive has transformed the dilemma facing the Iraqi energy industry. Assuming it addresses the aforementioned obstacles, if the Iraqi government succeeds in maintaining its governing authority and reestablishing security, its oil production could still reach 9 mbd by 2030 (table 1). The current turmoil, however, has raised many questions and doubts about the future of the Iraqi oil industry.

Iran. Iran has the world’s fourth-largest proven oil reserves after Saudi Arabia, Venezuela, and Canada. It also possesses the second-largest natural gas reserves after Russia. Iran produced 3.2 mbd of oil and 5.6 Tcf of natural gas in 2013 and is among the top five global oil and gas producers.

On the export side, however, Iran’s share of oil exports in the global market has plummeted since 2012. And even with extensive natural gas resources, the country has never held more than 1 percent of the global gas market. The Iranian energy industry faces significant obstacles, featuring lack of investment and limited access to needed technology as a result of international sanctions and high domestic energy consumption and mismanagement of energy resources.

Domestic Consumption. Iran’s excessive domestic energy consumption is mainly a result of price subsidies and low efficiency. Although the government in January 2010 introduced an energy subsidy reform plan to reduce the price subsidies for petroleum, natural gas, and electricity, it still has a long way to go to achieve its goal. In 2012, Iran consumed 9.6 quadrillion British thermal units of energy, of which oil and gas accounted for almost 98 percent. Domestic consumption increased 60 percent from 2002 to 2012 and is expected to continue increasing to 2030.

Sanctions. Since late 2011, new international sanctions have targeted oil exports and derivative income. Prior to this, Iran was producing above 4 mbd and had a production capacity of about 4.5 mbd; its exports were approximately 2.5 mbd. But the production and export of crude oil dropped dramatically in 2012 because of low storage capacity and transportation and insurance sanctions. In 2013, crude oil production fell to about 2.7 mbd of crude oil. Out of this 2.7 mbd, Iran consumed about 1.5–1.7 mbd domestically. According to the petroleum minister, current oil production capacity is likely in the range of 3.5–3.7 mbd.

In April 2013, crude oil and condensate exports dropped to their lowest level in the past 26 years. In 2012, average daily export of crude oil and condensate declined 40 percent, from 2.5 mbd in 2011 to about 1.5 mbd in 2012. Because of the substantial drop in exports and a lack of sufficient storage capacity, Iran was forced to reduce its crude oil and condensate production by 17 percent. Iran was OPEC’s second-largest producer of crude in 2012. But for some months, its production fell below Iraqi levels for the first time since 1989.

The drop in production was not simply due to recent sanctions on oil exports. Sanctions on investment in the energy industry date back to 1979. These sanctions have had a significant long-term toll on its infrastructure and, crucially, have denied the industry access to adequate investment and foreign technology. The country’s oil wells are mostly in the second half of their lives and are facing continued natural depletion of their production capacity at the rate of 8 to 11 percent annually as well a low average recovery factor rate of 20 to 25 percent. (Low recovery factor rates have held since 1979.)

As a result of international pressure, nearly all international oil companies (IOCs) have halted their activities in Iran since 2012. In the past three years, with the exception of Chinese and Russian companies, no IOCs have shown interest in newly introduced exploration and development blocks in this country. As a result, there has not been any actual production from a new oil field since 2007.

Natural gas production has also slowed down in the past few years because of sanctions. Iran has 1,193 Tcf of natural gas proven reserves and 17 percent of global natural gas proven reserves. The natural gas exploration success rate is 79 percent, compared to the world average success rate of 30–35 percent. In 2012, Iran produced 8.2 Tcf of natural gas, a 3 percent increase over 2011. However, substantial domestic gas consumption of 5.5 Tcf and the need to reinject 1 Tcf of natural gas into oil fields to maintain oil production in 2012 prevented any significant exports.

Looking Ahead. Under its new president, Hassan Rouhani, Iran has recently modified its upstream investment
regulations to attract international investors. It is also engaging in international negotiations over its nuclear program with the hope of thinning sanctions on its oil production. Nevertheless, even if Iran reaches an agreement with the international community, it is not expected that the broad set of sanctions will be wholly and immediately removed.

If the sanctions ease, it could take only about 90 days for Iran to regain its 2011 production of 3.5 mbd. However, it will take extensive and significant investment and access to foreign technology to go much beyond this. Because of the lack of foreign investment and technology, aging oil fields, production capacity depletion, and general mismanagement, Iran's crude oil capacity is not expected to exceed 4.5 mbd to 5 mbd in the next decade; capacity could reach 5.5 mbd only in 2030. The most optimistic scenario is that Iran does gain access to international investment and technology and pushes its oil production capacity above 6 mbd by 2030, matching its pre-1979 high. Nonetheless, it is more likely that Iran will increase its oil production capacity to not more than 5.5 mbd, even if it does gain access to foreign investment and technology, and instead focus more on producing natural gas. This is due mainly to the lower demand for oil in the market, US shale oil production, and higher competition to increase and secure global market share among the major oil producers.

To reduce natural gas consumption and expand production, just as with oil, Iran will have to reduce subsidies and attract more foreign investment and technology by both changing investment regulations and cooperating with the P5+1 nations (United States, Russia, China, United Kingdom, France, and Germany) to reduce sanctions. Iran's natural gas exports, however, are much less likely to compete seriously in the global market, as exporting its gas via pipeline to its neighboring countries is more practical and economically beneficial.

How the Shale Revolution Affects Middle Eastern Energy Markets

North America's unconventional oil and gas production could affect Middle Eastern producers in three primary ways: by undercutting oil prices, reducing US imports from the region, and stoking more intense competition in the energy market.

Oil Price Impacts on the Middle East. As mentioned earlier in this chapter, new technologies and the accessibility of unconventional energy resources have completely rewritten most supply predictions made during the past decade. Contrary to projections made just a few years ago, global energy production is growing faster than global demand. This shift has already had a steep impact on prices. (Factors besides North America's tight oil production could soften global oil prices. One is lower demand growth because of lower economic growth in regions such as the European Union.)

Tight oil production had a delayed effect on global oil prices because of supply interruptions in major oil-producing countries such as Libya and Iran. In 2012, tight oil production added 847,000 barrels per day to US crude oil output, but this did not lead to a significant price drop. Thus far, the “tight oil revolution” has been solely a US phenomenon and has not proved easily replicable in other countries. Nonetheless, the market could face the prospect of oversupply.

Any sustained downward price movement would undoubtedly have a significant effect on Middle Eastern energy producers. This is primarily a result of their fiscal dependency on oil revenue. For instance, Saudi Arabia, the country with the world's largest conventional oil reserves (almost 266 billion barrels), depends strongly on oil revenue. In 2011, petroleum exports generated 90 percent of government revenue. In 2012, tight oil production added 347,000 barrels per day to US crude oil output, but this did not lead to a significant price drop. Thus far, the “tight oil revolution” has been solely a US phenomenon and has not proved easily replicable in other countries. Nonetheless, the market could face the prospect of oversupply.

Kuwait is another example. With crude oil production of 2.9 mbd and exports of 2 mbd, petroleum exports accounted for 93 percent of Kuwait's export revenue and 95 percent of its fiscal income. The dip in prices means less revenue for Middle Eastern oil producers, with concomitant effects on their economies, social spending, and possibly political stability.

Balancing against this a bit, domestic energy prices in these countries are highly subsidized. With a decline in market energy prices, the subsidies provided in both the power sector and transportation could be allowed to drop.

In any case, tight oil supply may ultimately affect global oil prices only within a narrow band. Beneath
a certain oil price, tight oil supplies could drop significantly. OPEC members highly dependent on oil revenue, so they could also try to limit their production to offset potential oversupply in the market.

**US Crude Oil Imports from the Middle East.** US imports of crude oil and natural gas have shrunk because of gas and oil production from shale formations. The tight liquid production increase from the Bakken and Eagle Ford shale basins in North Dakota and Texas over the past five years was, in fact, equal to Iraq’s current production. The Bakken shale formation itself could provide crude equivalent to that of a major Persian Gulf oil-producing country.²²

To understand the impact of American tight oil production on US imports from the Middle East, consider the specifications of the crude oil used as feedstock in domestic refineries. As discussed in the first chapter, American refineries are mostly refining heavy, sour crude oil, while US domestic tight crude is mostly light and sweet. As a result, the US will remain dependent on heavy crude oil imports from the Middle East. Indeed, Middle Eastern exports to the US, particularly from Saudi Arabia and Kuwait, have actually increased. This will likely continue unless and until the policy limitations on Canadian production from oil sands, with 20 to 21 degrees of American Petroleum Institute (API) gravity, are lifted. Even then, Canadian oil sands may not be price competitive. (Venezuela has traditionally been a major supplier of heavy crude to the US, but Venezuela does not presently have the capacity to serve both the US and its increasing orientation to Asian markets.)

Even under a scenario in which Canadian oil sand crude flows to the US market, Middle Eastern supplies will still play a notable role. Saudi Arabia has a refinery capacity of 1 million barrels a day within the US proper. Moreover, Saudi Aramco has a 50 percent share of Motiva Port Arthur refinery in Texas (Royal Dutch Shell owns the other 50 percent), which has the largest capacity to produce gasoline and diesel in the US.²³

**Natural Gas.** In 2012, shale gas production in Pennsylvania alone was equal to the total natural gas exports of Qatar, the second-largest natural gas exporter in the world.²⁴ Current evidence suggests that US LNG exports will eclipse those of both Qatar and Australia by 2017, the world’s largest exporters at present. America’s LNG pricing and volume of exports will attract the Middle East’s traditional customers. Ironically, the Middle East could conceivably become a major market for American LNG. The United States could supply some portion of natural-gas demand in Kuwait and the United Arab Emirates, especially given that Iran’s natural gas exports are negligible.²⁵

**Refined Petroleum Product Exports.** US refined products are now aggressively competing with their Middle Eastern counterparts, particularly in the European market. In 2008, the US exported around 1.6 million barrels of refined petroleum products. This number grew to more than 2.7 million barrels a day in 2013.²⁶

**Petrochemical Exports.** The domestic price of US shale gas is a sizable advantage for US gas-based petrochemical manufacturers over those operating in the Middle East. Most of the gas-based petrochemical producers in the Middle East lack enough gas as a feedstock for their factories. Saudi Arabia is using liquid petroleum gas and naphtha as a petrochemical feedstock to offset the shortage of natural gas. The US has a long-term advantage over the Middle East in the gas-based petrochemical industry.

**Tight Oil and the Future of OPEC**

Many have speculated about the future of the role of unconventional oil and gas and their downward effect on energy prices. Over the past few years, US tight oil production was the major reason that global oil markets did not react significantly to supply disruptions resulting from turmoil in Libya, Syria, and Iraq or international sanctions levied on Iran.

The Islamic Revolution in Iran, various conflicts in Iraq, the Libyan civil war, and other events show that after supply disruptions resulting from war or political unrest, production capacity does not quickly recover.
In these cases, production capacity has still not reached previous peaks. Iran, for example, produced approximately 6 mbd before the 1979 revolution but has failed to surpass 4 mbd since. History indicates these countries cannot reach production capacity targets as quickly as they may plan.

Moreover, OPEC members in the long term are facing severe challenges thanks to their rapid energy consumption growth, which results from low domestic energy prices and growing populations. This growing domestic energy demand, coupled with reduction in production capacity in some member countries, will constrain OPEC’s supply in the long term.

**OPEC Production.** In theory, any excess market supply could create a significant challenge for OPEC producers and their economies. However, as mentioned earlier, many uncertainties and challenges could impede production revamps in Iran, Iraq, and perhaps elsewhere.

If these countries do not achieve their ambitious production targets, OPEC will not need to address major excess supply in the market. On the other hand, should the market see excess supply because of US tight oil or recovery in Iran and Iraq, OPEC would need to reduce its supply. Maintaining a long-term price level between $80 and $100 per barrel is crucial for OPEC members’ fiscal revenues and overall economies.

Closer to the end of our forecast horizon, the story could be different: the IEA anticipates US tight oil production to plateau starting in the mid-2020s and eventually taper off. The Energy Information Administration (EIA) projects that US crude oil production will peak at 9.6 mbd in 2019 and decline to approximately 7.5 mbd in 2040. Should those projections hold, OPEC would again have the option of increasing its own production.

**Price Standard.** Tight oil production is extremely sensitive to global oil prices. Unlike with conventional oil wells, there is need for near-constant drilling of oil wells in unconventional formations to maintain production and offset quickly declining production from older wells. An oil price range of $70–80 per barrel may be the minimum level at which most tight oil production is economically viable. If crude oil prices stay below $70 per barrel, current US tight oil production could drop 20 percent within 90 days. This, in turn, will drive prices up. This creates a price range within which both conventional and unconventional oil supplies could remain in balance.

### Scenarios for Middle East Oil Production to 2030

Scenarios for Middle Eastern oil production out to 2030 reveal the region’s three game-changing countries. Iran and Iraq will be the major contributors to the Middle Eastern oil production growth by 2030. As I mentioned earlier, Saudi Arabia does not have any specific plan or ambition to increase its production capacity.

The baseline scenario I have described involves very high production. Under the baseline scenario, (1) Iraq is not under ISIS attack, and investment in its energy sectors continues without a major interruption; (2) Iranian sanctions are eased; and (3) contemporary oil prices will not remain low. Sustained low crude prices reduce the incentive to invest and cause OPEC members to rethink efforts to increase their oil production.

The lower production scenarios to 2030 can be summarized as (1) Iranian sanctions ease, and Iraq remains in turmoil; (2) Iran’s production remains limited by international sanctions, and Iraq stabilizes; and (3) the status quo holds in both Iran and Iraq, with each unable to increase its output as predicted. These scenarios are described here and summarized in table 2.

**Scenario 1: Iran and Iraq both overcome their major challenges, but global prices remain low for an extended period.** Under this scenario, Iran reaches an agreement with the P5+1 nations, and sanctions on its energy industry consequently ease. With access to international investment and technology, Iran could fairly quickly increase its oil production to a range of 4.5–5 mbd and could eventually reach 6 mbd, matching its pre-1979 high.

In Iraq, ISIS is defeated, paving the way for international investors to reenter. However, Iraq likely cannot achieve an oil production level of 8 mbd, which was the 2030 forecast prior to ISIS’s assault. Damage to its
energy infrastructure, concerns about new threats, and stalled international investment could all delay Iraqi oil production growth. If Iraq succeeds in overcoming ISIS attacks quickly, we should expect oil output of up 7 mbd by 2030.

Scenario 2: Iran’s production grows; Iraq remains in turmoil. Here, Iran’s oil production grows as hoped—short-term production of 4.5–5 mbd in the next decade and longer-term production of 6 mbd. However, Iraq continues to suffer ISIS attacks in the short term, and its production range will be between 4.5 and 6 mbd by 2030.

Scenario 3: Iraq’s production grows; Iran remains under sanctions. Under this scenario, Iraq will have oil output of 6–7 mbd by 2030. Iran fails to reach to an agreement with the P5+1 nations, and sanctions are extended. Production will range between just 4 and 4.5 mbd by 2030.

Scenario 4: Iran’s and Iraq’s production both suffer in the long term. Under this scenario, production in each country is hampered by long-term challenges. Investments in Iraq and Iran are delayed because of lack of security and international sanctions, respectively. The combined production of Iraq and Iran by 2030 could reach 9–10 mbd, versus an expected projection of 13–14 mbd in the baseline scenario.

Conclusion

OPEC countries have 73 percent of the global proven conventional oil reserves, and their production growth will trend upward by 2030 according to the baseline scenario. OPEC is expected to maintain its central role in the market in the next two decades, perhaps balancing greater production elsewhere by reducing its crude oil supplies out to 2020. From 2020 until 2030, US oil production is expected to taper off, whereas OPEC production and supply in the market could grow. Contrary to general perceptions, US imports from the Middle East not only will continue but even may rise in the short term. The main reason for this is that American tight oil is light and sweet, whereas most US refineries are designed to refine heavy and sour crude oil.

Nonetheless, the Middle East faces challenges in both the short and long term. US LNG exports are intensifying competition for regional gas exports. US-refined products will compete with Middle Eastern products. US companies will have an advantage in gas-based petrochemical production compared to Middle Eastern factories.

The surge in energy supplies and slower global growth is obviously driving prices down. This will particularly affect Middle Eastern oil producers, whose economies and national budgets depend highly on oil revenue. In the long term, growth in domestic energy consumption because of population growth and energy

### Table 2

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Iran</th>
<th>Iraq</th>
</tr>
</thead>
<tbody>
<tr>
<td>High case (Baseline Scenario)</td>
<td>5.5–6 mbd</td>
<td>8 mbd</td>
</tr>
<tr>
<td>Scenario 1: Iran and Iraq both overcome their major challenges, but global prices remain low for an extended period.</td>
<td>4.5–5.5 mbd</td>
<td>6–7 mbd</td>
</tr>
<tr>
<td>Scenario 2: Iran’s production grows; Iraq remains in turmoil.</td>
<td>4.5–5.5 mbd</td>
<td>5–6 mbd</td>
</tr>
<tr>
<td>Scenario 3: Iraq’s production grows; Iran remains under sanctions.</td>
<td>4–4.5 mbd</td>
<td>6–7 mbd</td>
</tr>
<tr>
<td>Scenario 4: Iran’s and Iraq’s production both suffer in the long term.</td>
<td>4–4.5 mbd</td>
<td>5–6 mbd</td>
</tr>
</tbody>
</table>

Source: BP Energy Outlook 2030.
waste poses a significant threat to Middle East export capacity and fiscal revenue. The top producers will be Iraq, Iran, and Saudi Arabia, but the first two have many sizable challenges to reaching their ambitious production targets.

Notes


8. Ibid.

9. Ibid.

10. Ibid.

11. BP, BP Energy Outlook 2030.

12. Ibid.


15. Ibid.

16. Ibid.


23. Saudi Arabia has a refinery capacity of around 2 mbd outside of its country, not only in the United States but also in Japan, China, the Philippines, and South Korea. This refinery capacity is through the kingdom’s joint venture and investments in refineries that are designed to process Saudi Arabia’s crude oil as feedstock.


25. Fesharaki, “Is the US a Rising Energy Superpower?”


29. Ibid.
Russia's economy is hydrocarbon-driven. The energy sector will remain decisive for the development of the Russian economy going forward as well as a key source of government income, today amounting to some 52 percent of Russian federal revenues. State ownership in strategic sectors, notably oil and gas, will remain the dominant pattern in Russian economic governance, meaning that the Russian economy will modernize, but only slowly.

Russia will remain one of the world's top energy producers and exporters, but energy-sector developments crucially hinge on several factors it cannot influence: Western energy sanctions, international market developments, European Union (EU) market regulation, and European decarbonization policies. These factors are likely to impact the baseline scenario for Russia laid out by the International Energy Agency’s (IEA’s) World Energy Outlook 2013, which arguably is the best-case scenario for Russia out to 2030. Several worst-case scenarios emerge, with varying degrees of negative effects on Russian oil and gas output. Upward effects may materialize only if Russia’s Eastern Strategy works and compensates for the losses in traditional markets.

Baseline Scenario

The baseline scenario for this analysis is the IEA’s World Energy Outlook 2013 and its New Policies Scenario.¹ This scenario assumes that national and international policies pertaining to the energy sector will be implemented as announced and take effect on current demand and supply trajectories.

According to this baseline scenario, Russia will remain a prime energy producer and consumer out to 2030. Russia’s oil production will fall to 9.6 million barrels per day (mbd) in 2030, down from today’s 10.7 mbd, which is mainly a function of aging oil fields in western Siberia. This puts the country behind the United States (9.2 mbd in 2012 and 11.5 mbd in 2030) and Saudi Arabia (11.7 mbd in 2012 and 11.4 mbd in 2030).

Russian gas production sees growth mainly driven by Asian demand amid stagnating European import needs. Output is expected to reach 757 billion cubic meters (bcm) in 2030, up from 673 bcm in 2011. (This compares to 649 bcm of US output in 2011 and 807 bcm of projected output for 2030.) In terms of coal, Russia’s output slightly rises from 257 million tonnes of coal equivalent (Mtce) in 2011 to 261 Mtce in 2030. This puts Russia among the top 10 global coal producers, but compared to China (2.605 Mtce in 2011, 2.871 Mtce in 2030) or the US (766 Mtce in 2011, 674 Mtce in 2030) its output remains midsized. Until 2030, the country’s overall energy demand will grow from 718 million tonnes of oil equivalent (Mtoe) to 806 Mtoe. Oil consumption will remain almost stable (145 Mtoe/2.8 mbd), whereas gas demand will increase from 391 Mtoe (or 422 bcm) to 430 Mtoe (464 bcm). Coal consumption will almost remain flat, rising from 116 Mtoe (or 179 Mtce) to 120 Mtoe (185 Mtce).

Main Assumptions

I assume no dynamics arising from development and structure of the Russian economy, ownership structures of the Russian oil and gas industry, energy intensity of Russia’s economy, climate change policies or deep shifts in the incumbent Russian energy mix, or international
oil price slumps. These assumptions can be explained as follows:

- With the natural resources sector accounting for 19 percent of Russian gross domestic product, the energy industry has traditionally been the main determinant of economic dynamics in Russia. Because the energy sector is so crucial for the Russian economy and the country’s political leadership, we assume energy-sector dynamics influence the development of the Russian economy going forward, not vice versa.

- While the Russian economy features a growing service sector and a historically strong manufacturing sector, economic growth is driven by large-scale investment projects, which tend to be state-driven and funded by energy revenues. This makes it unlikely that deep structural shifts in the economy will occur in the short to medium term. Absent the development of a vibrant domestic information technology sector and a sizable and internationally competitive financial service industry, prevalent energy consumption patterns in the Russian domestic economy are likely to persist.

- State ownership in strategic sectors, notably oil and gas, will remain the dominant pattern in Russian economic governance. In oil, a sector privatized in the 1990s, state companies Rosneft, Gazprom Neft, and Slavneft have come to control around 50 percent of production again. In gas, Gazprom makes up for the bulk of domestic output (though rival companies such as Novatek have managed to gain some 27 percent market share). Foreign companies will be allowed to participate in upstream projects and supply capital and technology, but Russian state-owned corporations will retain the majority share in these projects. Oil and gas export licenses remain in the hands of state companies, too. In line with a decade-long trend, property rights likely will not tilt toward greater private ownership, but instead the energy sector will remain under state control or steering.

- Energy-efficiency gains will occur but will not free up significant additional energy volumes for export. Russian energy intensity stands at 2.7 times the EU-27 average, which makes it a very energy-inefficient economy. An economy of $2.1 trillion, Russia consumes 422 bcm of natural gas per year, which compares to 436 bcm of EU-27 demand, a $18.5 trillion economy. As the World Bank estimates, Russia could save up to 45 percent of its total primary energy demand, or some 240 billion cubic meters of natural gas and 43 million tons of oil, through energy conservation.

In light of this, the draft of the new Russian energy strategy prominently highlights the goal of increasing energy efficiency. However, the degree to which Russian energy intensity decreases is a direct function of investment going into energy efficiency measures. Investment, in turn, depends on the development of the Russian economy as a whole. If the country thrives, assets will be replaced, the economic structure will modernize, and improvements in energy efficiency will likely occur as a result. Energy efficiency is therefore not assumed to be a driving force of Russia’s energy-sector developments. Instead, it is regarded as a function of broader developments of the Russian economy and its modernization pathways.

- Climate change policies will not significantly change Russia’s carbon intensity. Russia has signed and ratified the Kyoto Protocol, but the country has profited from generous emission targets related to the fact that the carbon targets were benchmarked against the 1990 baseline year. This, essentially, has so far exempted Russia, currently the world’s fifth-largest emitter of greenhouse gases, from having to adopt serious climate policies. In 2011, Russia announced that it would not participate in the second commitment period of the protocol. Russia has also not signaled participation in post-Kyoto targets. In light of this track record, I do not expect significant impact on the energy sector stemming from carbon policies, regardless of the results of the 2015 Conference of Parties negotiations.
• The previous assumption is also in line with the draft of the new Russian energy strategy, which suggests Russia foster the production of coal for domestic energy use, with a view to increasing its share in electricity production. Still, domestic Russian demand will only modestly affect coal production. Export growth of the Russian coal sector—Russia has the world’s second-largest coal reserves after the United States—can be assumed to be a function of demand trends in Asia and is represented in the baseline scenario. There are also natural limits to export growth, given the long distances to market from the main sites of production in Siberia’s Kuznetsk Basin.

• The development of new domestic Russian reserves presupposes sustainably high crude prices. This holds true for both the Russian oil and gas sectors (because of the prevalent oil price link). Short of significant tax breaks (which have been granted already for projects on the Yamal Peninsula and other “hard-to-develop” fields), faltering oil prices will eat into the profitability of new projects. Arguably, the ability of the Russian state to lower the fiscal burden on the domestic energy sector is limited, as the budget will likely need prices of above $110 per barrel to break even, which exposes Russia to significant risks stemming from international oil price fluctuations. Still, this analysis assumes the current IEA baseline scenario projections—oil prices stand at $121 per barrel in real terms by 2030, and periods of very low prices are brief. Sustained deviations from this projection would obviously harm the Russian economy further.

**Energy Sanctions: Scope and Duration.** Energy sanctions have emerged as a major risk factor for the Russian energy sector. More to the point, the scope and duration of the sanctions might affect the Russian energy sector’s ability to maintain production as projected and replace aging fields. With political tensions remaining high between Moscow, Washington, and Brussels going forward, Western policies targeting the Russian energy and financial sector will have negative effects, particularly on Russian oil output and the industry’s overall performance. If sustained over the longer term, the effects of retaliatory Western policies in response to continued Russian assertiveness could be significant, limiting Russian access to foreign technology, financing, and markets.

Russia’s official strategy for overcoming the prevailing “technological backlog”—the fact that Russian energy industry is not on par with its international competitors when it comes to both technical sophistication and managerial skills is based on technology partnerships with international partners, notably Western companies. The main idea is to move the sector from “resource-based to resource-innovative development” along the entire energy value chain, thus making the resource sector both the source and a driving force of product and process innovation in other sectors of the economy. Unconventional drilling techniques would allow Russia to slow declines in output rates and tap promising light tight oil (LTO) reserves, such as the Bazhenov Formation.

Foreign know-how will also be needed to manage complex ventures such as liquefied natural gas (LNG) projects and Arctic offshore fields (for example, Yamal, Shotokman, and Sakhalin). It is particularly those “hard-to-recover” assets whose development will strongly hinge on joint ventures with Western majors and the support of high-tech service companies such as Baker Hughes, Halliburton, and Schlumberger. As Western sanctions target precisely the technology transfer needed for Russia’s energy-sector modernization, the latter will slow down if not stall. Exploration and production (E&P) in crucial new reserves will be affected, too, likely leading to their postponement.

The Russian energy sector, moreover, requires not only foreign technology and technical know-how, but also sizable investment to replace aging oil fields.
in Western Siberia (such as the important Samotlor Field), to offset declining gas output in the Tyumen region (notably its giant fields of Medvezhe, Yamburgskoe, and Urengoiskoe), and to develop new fields in the Far East or the Arctic. In the IEA’s baseline scenario, cumulative investment needs amount to some $849 billion in oil and $1.016 billion in natural gas until 2035, the bulk of which will need to go into upstream development.\(^8\) This implies that, short of foreign investment, a significant—and possibly unsustainably high—share of overall domestic investment will need to go into the energy sector to meet these goals. (The IEA estimates up to $40 billion per year in oil and $49 billion in gas.) Because of ongoing tensions between Russia and the West, whether the necessary investment volumes will indeed materialize is, therefore, questionable.

Moreover, because of Western energy sanctions, state-owned energy companies—representing the bulk of Russian oil and gas production and investment—are increasingly deprived of refinancing options in European and US capital markets. Exacerbating this, sanctions now also target Russia’s financial industry and may eventually bar the country from crucial international systems such as the Society for Worldwide Interbank Financial Telecommunication (SWIFT). Sanctions will not only make it difficult for the Russian energy industry to optimally fund the companies’ investment, affecting the economic viability of these projects, but also divert investment away from E&P into developing the domestic skills and technology needed for complex projects independent of the international energy industry. Possibly, although this is highly speculative, these efforts might even trigger consolidating effects in the Russian energy industry, further diminishing the role of private companies in the sector, decreasing its international competitiveness, and delaying necessary energy-sector reforms.

Finally, ongoing tensions and resulting sanctions pose a threat to Russian exports. Some 80 percent of Russian crude oil exports are sold to Europe, as is 75 percent of exported Russian gas. Gazprom holds the Russian gas export monopoly on Europe and has concluded long term takeoff agreements with EU domestic utilities. State-owned Transneft controls exports of European oil exports. Both commodities are exported mainly through pipelines, which makes it difficult for Russia to seek alternative export opportunities in the short to medium term. In the highly unlikely, but still possible, case that European leaders decide to fully sanction Russian oil and gas exports, the Russian energy sector will see highly disruptive effects.

**International Energy Market Developments: Trade Patterns and Pricing.** A second set of risks for the Russian energy industry stems from international market developments, more precisely from the challenges arising from emerging competition in natural gas and from deteriorating conditions in established key markets, notably Europe. In fact, the draft version of Russia’s new “Energy Strategy to 2035” mentions “tightening competition on foreign energy markets” as the prime external energy challenge for the Russian energy sector.\(^9\) This growing competition manifests itself in risks to the Russian energy sector in two ways.

First, Russia faces rapidly growing competition in natural gas markets, which is driven primarily by expanding global LNG supply coupled with surging unconventional gas production in the United States (essentially eliminating the United States as an export market for LNG producers). In the baseline scenario, global LNG trade will increase by some 210 bcm through 2035, with Qatar and Australia driving supply. The United States is forecasted to add 50 bcm to global LNG supply by 2020 and 75 bcm by 2035. This contrasts with up to 250 bcm of potential American gas exports, which could theoretically materialize should the Federal Energy Regulatory Commission approve pending applications. Russia has already seen planned LNG exports from the Shtokman project to the US market falter in the face of domestic North American gas supply growth.

Surging US LNG supplies beyond the baseline scenario would likely put an additional dent into Russia’s incumbent markets in Europe and potential export markets in Asia. In a softening post-2008 European market environment, additional LNG volumes have already caused Gazprom to lose market shares in defense of the incumbent pricing model. Although most of the prospective additional US LNG supply will go to Asia, it will still further weaken Russia’s position in Europe, Gazprom’s most important exports market.
Second, Russia faces growing pressure on its traditional gas pricing model, which pegs the gas price to a substitute, mostly oil. This is partly because European consumers have started to push for greater spot indexation of gas prices, eroding the model that traditionally secured profits for Gazprom. Gazprom reluctantly adjusted prices in 2010 (introducing spot components into the pricing mechanism) and lost revenue as a result.

More important, possibly, the prospect of future US LNG exports raises the question of which pricing model will dominate supply contracts to Asia and elsewhere. A likely model will entail a strong link to Henry Hub in the US, which, given the potentially large US LNG market share, would make US spot prices an international marker and clearly put additional pressure on the oil-pegged pricing model characterizing long-term contracts (LTCs) with Russia. About half of European gas contracts are still long-term and oil-indexed. This share will decrease if US LNG exports are expanded rapidly and once current contracts expire, starting in 2020.

**EU Energy Market Regulation and Energy Choices.** A third set of risks for the Russian energy sector relates to EU market regulation and European energy choices. These risks center on EU decarbonization policies, EU competition policies, and supply infrastructure and policies.

Trade relations between Russia and the European Union are asymmetric: while the EU mainly exports high-value-added products eastward, its main imports from Russia consist of oil (63 percent of the total import value) and gas (9 percent). Changes in EU fossil fuel consumption therefore directly affect Russian energy export volumes and hence revenues, as do energy choices more broadly. For instance, the drop in European gas demand of 5.6 percent in 2009 forced Gazprom to cut production and translated into an annual 8.8 percent drop in Russian gas exports to Europe. Overall production dropped by 16 percent that year.

Risk stems particularly from environmental policies (notably the EU’s “20-20-20” decarbonization goals, aimed at reducing Europe’s carbon emissions by 20 percent while increasing energy efficiency by 20 percent and achieving a 20 percent share of renewables by 2020) coupled with imported coal’s remaining cost-competitive with gas out to 2020 and beyond. Essentially, current EU policies favor renewable energy sources (RES) while failing to cap coal consumption, thus squeezing gas out of the merit order. Consequently, Europe remains the largest export market in Russia’s draft energy strategy but already features less prominently.

The EU has also moved toward injecting more competition into the European energy sector. The 2007 Third Energy Package now requires unbundling production from infrastructure and sales and thus deeply affects existing gas market structures. The European Commission has also started antitrust investigations against Gazprom on the grounds of illegal resale clauses, denial of third-party infrastructure access, and discriminatory pricing practices. The EU has further put pressure on natural gas LTCs and prevalent oil indexation. Although they will take effect only slowly, these moves might lead to a fundamental change in Gazprom’s business practices in Europe, which have so far relied on market partitioning, destination clauses, and differentiated pricing schemes.

Third, EU internal market regulations extend to external infrastructure projects. Russia’s South Stream, the planned 63 bcm pipeline circumventing Ukraine, first was put on hold by EU authorities because of violations of EU competition rules and eventually abandoned by Gazprom in December 2014. South Stream has been a key element in Russia’s strategy to lock in European market shares, and its failure will force Gazprom to fundamentally rethink its export strategy going forward. By contrast, the commission has granted exemptions from Third Energy Package provisions for the 16 bcm Trans-Atlantic Pipeline, a rival project and part of the EU-sponsored Southern Corridor.

Finally, while the EU moves toward further liberalizing its domestic market, it may also develop a more coherent external energy policy, notably with a view to uniting its purchasing power behind a consumer monopsony. The new European Council president, Donald Tusk, is likely to push this project, which European leaders have already endorsed. A united 450 bcm import market, the world’s largest, will have the means to coerce external suppliers such as Gazprom into more favorable pricing and supply deals.
Scenarios for Russian Supply Trends

These three sets of risks suggest that Russian supply might at best develop as projected in the baseline scenario. In other words, the baseline scenario is likely to become the best case absent long-term sanctions hitting the Russian energy sector, persisting international market pressures, and European markets destroying gas demand by turning toward RES and coal. The worst case consists in various combinations of the three sets of risks I have discussed. Cascading upward in terms of impact, these may look as follows.

Scenario 1: EU Demand Destruction. The “EU demand destruction” scenario assumes that risks primarily stem from European pro-RES policies. It assumes that energy sanctions will not remain in place and that international market developments will drive changes in pricing and trade patterns as assumed in the baseline case. In this scenario, European demand for Russian gas will stagnate rather than increase, European demand for Russian gas stabilizes at current levels of 167.2 bcm, and projected demand for additional Russian production capacity does not materialize. A reasonable proxy for the supply impact is the difference between projected and current European import volumes from Russia. Although European gas demand is projected to remain flat in the baseline case, the EU is set to import some 140 bcm more in 2035 than it does today because of falling indigenous production. Assuming that Russia’s import share stays roughly where it is today—30 percent—the additional call on Russian gas would be around 42 bcm. This compares with 135 bcm of additional production capacity that the IEA projects for Russia throughout 2035 in its baseline scenario. In other words, in an EU demand destruction scenario, about 31 percent of Russian additional production will not materialize.17

A rough but reasonable proxy for the impact of lasting sanctions is Russia’s projected future liquid fuel production other than conventional crude (LTO, natural gas liquids, and other unconventional oil). These represent important potential additions to Russia’s oil balance, and their development requires Western technology and capital. Russian unconventional oil production amounts to roughly 1.5 mbd out to 2035, according to IEA projections, and is crucially needed to at least partially offset declining conventional crude output (which is projected to fall by some 2.8 mbd out to 2035). Sanctions would prevent these 1.5 mbd from materializing. The impact would therefore amount to 14 percent of Russian oil output compared to 2012 production levels and 16 percent compared to projected 2035 production levels.

As a reaction, Russia’s energy industry will seek to further strengthen ties with Asian consumers, with a view to sustaining the necessary financing for enhancing recovery rates from existing fields and for new upstream projects. The May 2014 30-year 38 bcm per year gas deal between Russia and China hints at the possible pattern that could emerge: Russian investment in developing new fields (in this case, Gazprom’s pledge to put down $55 billion) will be matched by upfront payments on the part of the customer (in this case, CNPC’s prepayment of $25 billion). Some of the assumed production losses will therefore be made up by Asian investment. It is, however, questionable whether the technology required for hard-to-recover reserves will become available through joint ventures with Asian producers.

Scenario 2: Sanctions. The “sanctions” case assumes that Western policies targeting the Russian energy sector will be broad in scope (including financial and technology-related areas) and long-term. In this scenario, European demand for Russian energy and international market developments are assumed to remain as in the baseline case. Sanctions will likely target primarily the oil industry, for its crucial role as a cash cow for the Russian state budget. (Thirty-seven percent of Russian state revenues stem from oil sales, compared to 7 percent from gas sales.)

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In case of a full-fledged embargo on Russian energy, the short-term effect is of the magnitude of the volumes sold to Europe. These are 4.5 mbd in oil (75 percent of Russia’s total oil exports) and 167 bcm in gas (roughly 60 percent of Russia’s gas exports). While, at least in the case of oil, a globalized market will help Russia accommodate trade disruptions in the longer term, the damage to the Russian energy industry (and the state budget) is likely to be deep. As I have highlighted, a full-fledged embargo is a highly unlikely scenario, notably because of the hostile—and possibly belligerent—Russian reaction such a move would trigger.

**Scenario 3: Sanctions and EU Demand Destruction.** The “sanctions and EU demand destruction” case assumes that Western policies targeting the Russian energy sector will be broad in scope and long-term and will combine with risks stemming from European pro-RES policies and a flawed European Emissions Trading System. The effect is a combination of the previous two scenarios (a possible negative supply impact of 1.5 mbd in oil and of 42 bcm in gas).

**Scenario 4: Doomsday.** This last scenario represents the worst case: Western oil sanctions remain in place, European gas demand destruction continues, EU competition policies force Russia into a new business model, and international market developments further undermine Russian market presence. In this case, Russian oil and gas supply will not only be affected as described in Scenario 3. The gas sector will also suffer from additional LNG volumes made available on international markets (notably if US LNG export volumes exceed projected levels), which will foster spot pricing and put competitive pressure on incumbent oil-linked LTCs. EU competition policies could then be the proverbial straw that breaks the camel’s back. This will affect Russia’s export outlook both in Europe and Asia.

Expiring LTCs will allow Europeans to push for a shift away from the oil-price peg in the medium term (after 2020). Given regulatory pressure from the EU, Russia will likely also lose its ability to partition European markets and to exclusively service them through Russia-controlled pipelines. Both factors will increase gas-on-gas competition in Europe, which will eat further into already-squeezed margins in the gas sector. Unless Russia gives up its insistence on the traditional LTC model, its exports to its traditional home market will drop. Alternatively, Russia will have to accept losses in revenues to retain market shares, and the outcome of this choice remains uncertain.

In terms of volumes, all Russian gas can be affected by regulatory and pricing pressure. In other words, 167 bcm of current volumes imported from Russia are theoretically threatened by a new pricing regime. The more the EU moves toward unified gas purchasing (the Tusk initiative), increases regulatory pressure on existing LTC contracts, and enforces Third Energy Package provisions on market competition, the higher the additional risk in this regard. If Russia decides to resist changes in the pricing structure—Gazprom has hinted that it would not further compromise in pricing disputes—the company will suffer from losses in export volumes to Europe.

It is hard to estimate the magnitude of the additional Russian export contraction related to Gazprom potentially resisting international pricing pressures and EU regulation. The 2009 drop in exports may serve as a possible indicator. It reflects competitive pressure arising from additional LNG, admittedly during times of economic crisis but absent additional pro-competition measures on behalf of the EU. On that basis, the estimate is a contraction in exports to Europe of around 10 percent or 17 bcm in 2012 terms.

In this scenario, Russia will entirely be at the mercy of Asian markets. Both oil and gas sector prospects will depend on strategic partnerships with Asian companies, with a view to funding and possibly technology. Since Russian LNG projects are costly and generally run late (likely to be exacerbated by sanctions), Russia will need to turn primarily to Asian consumers by putting in place additional pipeline infrastructure. Yet Asian markets will only soak up additional gas volumes (exceeding the baseline scenario) at acceptable (read, close to European) prices. China will also ask for shares in Russian upstream assets, a request that has so far been refused by Russia. In addition, domestic Chinese natural gas production (notably in shale) as well as supplies secured from Caspian sources and LNG contracts will determine the degree to which Asia will bail out Russia in times of trouble. The jury is out on whether Russia’s Eastern Strategy (which aims to diversify energy
exports toward emerging Asian economies), so forcefully celebrated in the wake of the May 2014 $400 billion China-Russia gas deal, will eventually work.

In all, this analysis suggests results are skewed toward several low-side scenarios with varying degrees of negative effects on Russian oil and gas output. It is important to note that the estimates on supply impacts are very rough proxies and ignore several other (notably domestic) factors that could affect Russian energy production. Therefore, they are at best an indication of the potential scope and magnitude of supply outcomes but should not be regarded as absolutely indicative. Table 1 summarizes these five scenarios (including the best case) and contrasts their potential supply impact.

**Notes**

6. Ibid., “Technological Gap.”


Net Energy Demand Scenarios, 2015–30

Derek M. Scissors

There are common factors across the globe that will drive net energy demand over time:

1) Energy resource endowment;
2) Macroeconomic development and growth;
3) Resource ownership rights;
4) The competitive structure of the energy industry;
5) The functioning of capital markets; and
6) Domestic and international politics.

Over our 2015–30 forecast horizon, these factors vary in importance by region. Most of the world’s major energy producers are in the Middle East, while the biggest net energy consumers are China and the European Union (EU). The United States is swinging from consumer to producer. Among truly powerful shifts in the energy landscape, the most likely involve American shale development, supply shocks in the Middle East, Chinese reform, and the EU-Russia energy relationship. Tables 1–4 summarize the probability of different energy outcomes in various key countries and regions and indicate which factors will be involved.

While tables 1–4 feature the major energy players, these are not the only ones. Venezuela, for example, has the potential to be a global top-five oil exporter. On the demand side, Indian economic growth and Japanese energy mix changes have the potential to affect the global market.

However, the improvements needed in Venezuela would be so time consuming as to limit their impact within our forecast horizon, even if they did occur.

Table 1

<table>
<thead>
<tr>
<th>US Scenario</th>
<th>Highest probability</th>
<th>Middle probability</th>
<th>Lowest probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• High output driven by greater ultimate recovery, since only a small amount of in-place resource is extracted</td>
<td>• US oil import dependence is narrowed but not eliminated.</td>
<td>• An environmental setback leads to harsh regulations and lowers ultimate recovery.</td>
</tr>
<tr>
<td></td>
<td>• Lower prices, higher exports, and a global gas market</td>
<td>• Gas prices rise moderately and the US becomes a gas exporter.</td>
<td>• Gas prices rise to near world levels and exports become minor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gas becomes dominant in power generation, displacing coal.</td>
<td>• Oil imports eventually rise again.</td>
</tr>
</tbody>
</table>

Key factors

• Endowment
• Domestic politics
On the demand side, India could matter somewhat sooner, but the country could also become more energy sufficient, such that the global impact would be minor. Policy decisions have already considerably altered Japan’s energy mix and would have to be extreme to affect the global market going forward. We therefore treat the rest of the world as a group. (See table 5.) Our analysis can be extended to other countries or regions if events warrant.

Global Scenarios

The country- and region-specific scenarios can be combined to produce global scenarios. It is certainly true that multiple country or regional scenarios can occur simultaneously, such as Middle East output expansion simultaneous with Chinese domestic reform. For ease of presentation and understanding, however, I present the global scenarios according to their primary

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**Table 2**

**Middle East Scenario**

| Highest probability | • Only either Iraq or Iran is able to overcome production limits.  
|                     | • Net regional output rises, but not sharply enough to affect the global market. |
| Middle probability  | • Iraq overcomes its internal obstacles and Iran overcomes its external obstacles.  
|                     | • Regional oil output rises significantly and sustainably, competing more sharply with American shale. |
| Low probability     | • Neither Iraq nor Iran is able to scale up output to what should be sustainable levels.  
|                     | • Region continues to be a source of upward price pressure, aside from occasional Saudi actions. |
| Key factors         | • Capital markets  
|                     | • Domestic politics |

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**Table 3**

**China Scenario**

| Highest probability | • The status quo holds and both energy production and, especially, consumption grow far slower than state or private forecasters anticipate. |
| Middle-high probability | • Both economic and energy reform occur relatively early in the forecast horizon.  
|                     | • Demand and domestic production soar simultaneously, checking net demand. |
| Middle-low probability | • Economic reform occurs but energy is largely exempted.  
|                     | • China grows and needs more energy but cannot produce it at home.  
|                     | • Imports jump. |
| Lowest probability   | • Energy reform is advanced for political reasons, even while economic reform fails.  
|                     | • Near-self-sufficiency results in some areas of energy. |
| Key factors          | • Structure of industry  
|                     | • Property rights |
feature—for example, the effect of American shale. The scenarios are presented in descending order according to their estimated probability.

**Scenario One: Status Quo Variant.** The obvious global outcome to bet on is the combination of all the high-probability country and regional scenarios. This essentially consists of US net energy demand falling toward zero, and mixed, at best, production results elsewhere, a variant of what has been occurring over the past few years.

Global macroeconomic activity remains subdued due to structural weakness. Net energy demand is thus restrained both economically and by higher American supply. Downward pressure on global energy prices continues and less-competitive fossil fuel exporters, such as Brazil, are only regional players. The world moves toward a unified, dollar-denominated gas

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**Table 4**

**RUSSIA–EUROPEAN UNION SCENARIO**

<table>
<thead>
<tr>
<th>Probability</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest probability</td>
<td>• European energy demand stagnates, harming Russian gas production incentives.</td>
</tr>
<tr>
<td></td>
<td>• Some Russian output pushed onto the global market.</td>
</tr>
<tr>
<td>Middle-high probability</td>
<td>• Sanctions on Russia remain in force for the bulk of the forecast horizon.</td>
</tr>
<tr>
<td></td>
<td>• Disincentive and diversion effects as in highest-probability case, affecting oil in particular.</td>
</tr>
<tr>
<td>Middle-low probability</td>
<td>• EU demand weakness and sustained sanctions blast gross Russian oil and gas output.</td>
</tr>
<tr>
<td></td>
<td>• Some excess output sent onto the global market.</td>
</tr>
<tr>
<td>Lowest probability</td>
<td>• The EU changes domestic and external policies.</td>
</tr>
<tr>
<td></td>
<td>• The previous International Energy Agency (IEA) baseline holds with regard to greater EU imports from Russia and higher Russian energy output generally.</td>
</tr>
</tbody>
</table>

**Key factors**

• International politics
• Macroeconomics

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**Table 5**

**SCENARIO FOR THE REST OF THE WORLD**

<table>
<thead>
<tr>
<th>Probability</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher probability</td>
<td>• Net demand follows its trend since the financial crisis: slow growth and downward pressure on prices.</td>
</tr>
<tr>
<td></td>
<td>• Episodes of volatility chiefly due to spurts of above-trend macroeconomic growth in the top importers, such as India</td>
</tr>
<tr>
<td>Lower probability</td>
<td>• Net demand returns to its faster pre-2008 pace, with upward price pressure.</td>
</tr>
<tr>
<td></td>
<td>• Scattered episodes of price weakness from periodic global economic weakness and responsive supply growth in slack producers such as Venezuela</td>
</tr>
</tbody>
</table>

**Key factors**

• Macroeconomics
• Property rights
market, driven by domestic US natural gas prices in the range of $5 per thousand cubic feet, and substantial exports. Alternative energy becomes less cost competitive. Only scattered countries learn from the American example on property rights and competitive industry, making shale competitiveness a major shift but not a revolutionary one.

It is important to note that combining a set of high-probability outcomes does not necessarily lead to a high-probability outcome. This status quo variant is the single most likely path for the global energy market, but the chances of it occurring are clearly less than 50 percent.

Scenario Two: Political Glut. The Russian Federation is a major oil producer, Iraq is a potentially major oil producer, and Iran is less significant. Nonetheless, the parallels between sanctions decisions on Iran and on Russia are obvious. And multinationals’ hesitation to intensify development of Iraq’s huge reserves is similar in nature.

In this scenario, these concerns are mitigated. European and Middle Eastern politics and responsive capital flows combine to dump oil onto the world market, keeping crude prices below $100. The EU cuts its fossil fuel demand for domestic political reasons, declines Russian supply, or both. The security environment in Iraq improves, Iran sanctions are lifted, or both. Combined Russian, Iraqi, and Iranian oil production approaches 23 million barrels per day (mbd), and additional oil thus appears on the world market. The November 2014 output increase by Saudi Arabia also presages this scenario.

Energy prices drop, led by oil. There is a demand response and increased economic growth, but the supply effect is stronger. Higher-cost oil producers such as Algeria are forced out of the global market. Outside of a few countries, the share of alternative energy stagnates. Suppliers compete to form privileged relationships with major consumption countries—chiefly, Russia courting China and perhaps certain Middle Eastern countries courting the EU.

Each constellation of changes in the EU, Russia, Iraq, and Iran is quite unlikely, but there are multiple paths to scenario two. Moderate diversion of Russian energy from the EU combined with Iraqi stability, for example, would be enough.

Scenario Three: World Macroeconomic Rebound. While energy is obviously connected to economic growth, it is not the most important driver in most cases. Here, better fiscal and monetary policy in the advanced economies and, especially, market reform in emerging economies, such as China and India, boost global growth beyond the anticipated, unimpressive trajectory.

Prices of all types of energy rise. Crude oil prices head back toward $140. There is a supply response but it is not sufficient to offset the demand push. Higher-cost production, such as from Canadian oil sands, benefits disproportionately. Alternative energy thrives in absolute terms (its share of energy consumption will continue to vary by country). There is pressure for global energy-market integration, with the most economically dynamic areas of the world having the most weight. This is only one possible shift away from the status quo path, and the shift is a reasonably likely one.

Scenario Four: Demand Drag. Here, slow economic growth creates the opposite energy environment as scenario three. China’s rapid expansion drove net energy demand higher, faster than anyone had predicted, for a decade. Chinese economic stagnation would not only directly hurt energy demand, but it would also indirectly hurt demand by weakening partner economies. Oil prices only slowly return to $100.

Chinese coal imports nearly disappear and gas imports are 60 percent of the (bullish) IEA projection. Oil imports rise very slowly from current levels. Global energy prices therefore drop, led by coal. Responsive energy supply cuts occur but are limited by revenue dependence for major exporters such as Russia. Both American and Chinese net energy demand is weak for an extended period.

This triggers a bloodbath among coal and gas exporters as higher-cost production is forced out of the market, and those on the margin compete over long-term sales contracts and infrastructure financing. Alternative energy struggles. This scenario is also only one shift away from the status quo path, and reasonably likely.

There is a larger drop in probability to the next group of scenarios than there is successively between the first four.
Scenario Five: Political Peril. This scenario is the opposite of scenario two. There is no production breakout from Iran and, especially, Iraq, or such a breakout is offset by Saudi cutbacks. Adding to the vulnerability of global supply, the EU halts or reverses its present course of destruction of fossil fuels demand and ties up more Russian output. Russia is satisfied with this outcome and fails to make needed energy investments.

Combined Russian, Iraqi, and Iranian oil output is 17 mbd. The result is higher energy prices, led by oil, but no pressure for global integration. This means a good deal more volatility. The Russia-EU tie-up and weakness in the Middle East sends high-demand countries hurrying to find secure suppliers, including among high-cost producers. National oil companies become more prominent to limit instability. China in particular would invest even more heavily in Venezuela, plus in some East African countries. Alternative energy programs would be large and widespread.

This is a somewhat unlikely outcome, as it requires a chain of negative events to constitute a true departure from the status quo path in Europe and the Middle East.

Scenario Six: Shale Fail. The US private sector’s capacity to sustain a shale expansion to or past 2030 is convincing. However, such an expansion may eventually require more intensive or extensive drilling that generates political pressure to curb property rights. American shale production is thus capped (perhaps extending its lifespan beyond the forecast horizon) and anticipation of heavy downward pressure on energy prices turns out to be mistaken. The US remains a top-five energy importer, and net demand begins to grow again by the 2020s.

US gas prices are at or above $8 per gallon, causing exports to be geographically limited by transport costs. The global gas market is stillborn, with only a few countries fully integrating into the North American market. Energy trade remains vulnerable to shocks, and national alternative energy programs grow in size and popularity. This scenario requires only one change from the status quo path, but that change is highly unlikely.

Scenario Seven: Global Shale Revolution. In this scenario, US supply growth proves irresistible to other large energy users. The countries disband or limit their national oil companies and encourage competition to develop shale in their energy industries. Private-property rights are sharpened to a considerable extent.

Production diffuses and energy trade shrinks dramatically, particularly if it requires high-cost transport. Oil prices stay below $100, and global gas prices move to present American levels. Alternative energy is strangled. The Organization of the Petroleum Exporting Countries essentially falls apart, with only Saudi Arabia and perhaps Iraq able to maintain high levels of output. There is, over the forecast horizon, less and less need for a global oil market. This is worth considering as an extreme case, but requires a series of unlikely events where countries from Argentina to China move urgently and effectively on energy reform.
China, the United States, and the Geopolitics of Energy

Dan Blumenthal

Over the next 15 years, the United States and People’s Republic of China (PRC) will be the prime players in international energy markets. According to Jim Slutz, the US will likely have a positive net energy demand profile, while Derek Scissors concludes that the PRC’s profile will be relatively negative. US energy production and exports will increase, while China will have a difficult time matching production with growing demand in the absence of economic and energy reform. However, China’s energy consumption growth rate will be tempered by a slowing economic growth rate.

The two countries will not only be the prime movers in the energy market, but also the most important economic and geopolitical players over the next 15 years. The nature of the Sino-American relationship will be the major determinant of geopolitics and, therefore, of the future course of the energy security system.

The other major producers considered in this report—Russia, Iran, and Iraq—have oil and gas reserves that could enable them to put significant amounts of additional energy on the world market. But they face serious challenges in doing so. As Andreas Goldthau argues, the Russian energy sector is constrained by Western sanctions and the potential decarbonization of its major market, the European Union. Similarly, Sara Vakhshouri shows that Iranian production is constrained by international sanctions and the attendant lack of investment in production capabilities. Iraq has a potential oil output of anywhere from 6 to 8 million barrels per day. However, the ISIS attacks and Iraq’s general lack of domestic stability and coherence make significant new output very questionable.

Even if Russia, Iran, and Iraq could optimize their production, they would still be secondary energy and geopolitical players. They simply do not have the economic size or political wherewithal to compete with the US or China. In the rosiest scenario for these three nations, they would be regional players whose status is enhanced by their energy relationships with the US and China. Given their revisionist tendencies, Iran and Russia could play a larger role in the energy markets if (1) they ramp up energy production, (2) find new buyers, or (3) decide to cooperate with a China that has decided to pose a more serious geopolitical revisionist challenge to the US.

Ultimately, the US and China will determine the course of geopolitics, economics, and energy markets. Since the energy order is a subset of the larger American-dominated world order (liberal order), there are two essential questions for the future of energy: Will the PRC continue to accept, however grudgingly, the world order in most of its dimensions? Or will Beijing more aggressively try to reshape it in accordance with its own perceived evolving interests? For the US, the main strategic question is whether it will devote the economic and diplomatic resources necessary to maintain its prime position in international politics and thus preserve the liberal order it helped create.

The net demand profile of each country will affect this larger set of geopolitical questions in two ways. First, net energy demand impacts each country’s national wealth and hard and soft power (production capacity is a reflection of a country’s economic and energy system, or energy-economic model). Second, net energy demand affects each country’s relationships with key suppliers and purchasers, which in turn influences the military force posture and strategic relationships of each country.

For example, during the past 15 years, the world’s main energy story has been the massive growth of the Chinese economy and consequent Chinese-led energy
demand shock. China’s increased energy demand required a foreign and energy policy of going out: Chinese state-owned energy companies scoured the world for energy resources, mostly in the Persian Gulf and Africa.

To support this energy strategy, the Chinese government subsidized its energy companies by forming diplomatic relations with supplier nations and by tasking the People’s Liberation Army with so-called “new historic missions,” including developing maritime capabilities to protect Chinese energy interests overseas.

The PRC also hedged against overreliance on energy transported by sea by building pipelines and expanding diplomatic relationships on the Asian continent. China’s net energy-demand profile—a move toward more dependence on imports—had substantial geopolitical implications. While it did not undo the international system, it introduced a more competitive dynamic.

The new energy story is twofold. First, the US is becoming a major energy producer and exporter. While this development will not lessen US interest in a low and stable oil price derived on the global market, it will change the nature of America’s relationship with existing suppliers and new purchasers. Second, China’s economy is stagnating and its relative external demand is slowing.

These changes will also impact geopolitics in ways further explored in this chapter. For example, China could develop relatively greater interest in a preferential or even strategic relationship with Iran, Iraq, or Russia. The US may be less interested in bilateral energy and strategic relationships that it has had with countries such as Saudi Arabia. But it will have an overall interest in stability in the Middle East, a region with great potential to affect oil prices.

In this chapter I will explore the connection between the international political-economic system and the international energy system, addressing the current state of those systems, impact of Chinese demand shock, and future changes to the international and energy order that are potential consequences of changes in net energy demand in China and the US. Finally, I examine how changes in the two countries’ net energy demand will affect their relations with each other and major energy producers.

The US Liberal Order and the Energy Security System

The international energy system is a subset of the larger world order. The British and Americans created the modern international political-economic system after World War II, establishing an open and liberal international economic system bolstered by liberal international laws and institutions that encouraged democratic governance. The US has had a maximalist view of its security needs—it needed a liberal order to allow the US way of life to flourish. A US preponderance of power ensured that this system was defended.

The order needed constant refining and flexibility to include emerging powers such as China. Aside from the US, the PRC may be the greatest beneficiary of this liberal economic system. Deng Xiaoping’s market reforms in the 1970s launched what the Economist called “the most dynamic burst of wealth creation in human history.” China is now a major economic player and benefits from US global primacy: Washington provides the international security that China is not yet able to ensure on its own.

The international energy system reflects US preferences and interests. In the aftermath of World War II, the US encouraged a free market in energy, the oil market globalized, and transactions were conducted in US dollars. The US Navy guarantees the maritime commons through which oil is brought to the market. It also guarantees the security of most of the main oil producers. Thus, oil supply in particular reflects the main elements of the liberal order: a well-functioning international market policed by the US through both force and diplomacy.

But on several occasions in the latter half of the 20th century, the market failed for geopolitical reasons, evidencing the need for a preponderance of US power. For example, since the 1970s—which saw Saddam Hussein’s rise to power in Iraq, the Iranian Revolution, and the Soviet invasion of Afghanistan—the US has based its energy security policy on the Carter Doctrine, which President Jimmy Carter announced in 1980:

The region [the Persian Gulf] which is now threatened by Soviet troops in Afghanistan is of great strategic importance: It contains more than two-thirds
of the world’s exportable oil. The Soviet effort to dominate Afghanistan has brought Soviet military forces to within 300 miles of the Indian Ocean and close to the Straits of Hormuz, a waterway through which most of the world’s oil must flow. Let our position be absolutely clear: An attempt by any outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States of America, and such an assault will be repelled by any means necessary, including military force.\(^2\)

The manifestation of the Carter Doctrine was the creation of US Central Command to oversee military operations in the Gulf, effectively making it an American lake. Washington took responsibility for stability there and for keeping open choke points, such as the Strait of Hormuz, through which oil flowed throughout the world. Washington also developed very intense relationships with Gulf suppliers, who strongly influenced how the US developed its Middle East policies. As China’s demand for Gulf energy increased, it became dependent on US implementation of the Carter Doctrine for its own energy security.

China’s Demand Shock and Its Geopolitical Consequences

Since the end of the Cold War, the greatest energy system change has been the massive growth of the Chinese economy and the energy demand shock it created. As Scissors writes earlier in this report, over the last decade China had to rapidly feed its voracious new energy demand. Because of its highly inefficient industrial and regulatory structure, China’s energy sector could not produce enough and has become increasingly dependent on imports.

China’s oil import dependence is between 53 and 58 percent and rising, with most imports coming from the Middle East. China is dependent on imports for about 32 percent of its natural gas. Australia, Qatar, Malaysia, and Indonesia are China’s largest maritime liquid natural gas suppliers, while Turkmenistan, Uzbekistan, Kazakhstan, and Burma provide natural gas to the PRC via pipelines.

Protecting Overseas Energy Interests. This energy profile, combined with the competitive security dynamic in Sino-American relations, has been a key driver of China’s energy and national security strategies. China has developed new commercial and diplomatic relationships with major suppliers, particularly in the Gulf and Africa. In turn, Beijing grew concerned about supply disruptions along the long maritime expanse from Africa to China’s eastern seaboard. It feared terrorism, pirates, and political instability, but most of all it feared that the US and its allies could cut off China’s energy supply in the event of a downturn in Sino-American relations.

Reflecting this concern, in 2004 then–president Hu Jintao famously identified the Malacca dilemma, or the fact that most of China’s energy imports passed through one choke point: the Malacca Strait. Once through the strait, oil tankers bound for China then pass into the South China Sea, home to increasingly heated maritime territorial rows.

The PRC has little control over the security of its imports through these straits, choke points, and seas and has only one coastline that houses its ports and harbors. That coastline faces US allies and partners in Japan, Korea, Taiwan, the Philippines, and the relatively hostile and potentially US-aligning Vietnam. While revanchist historical claims, nationalism, and the potential of future energy production play a role in China’s assertive behavior in the South and East China Seas, China’s reliance on these seas to transport energy and export goods is probably the most important factor driving its more aggressive posture.

China’s answer to the vexing problem of protecting its energy supply has been threefold: (1) a more robust maritime military and diplomatic posture (new historic missions); (2) the state flagging of maritime commercial vessels and, more broadly, the use of international law; and (3) the development of diplomatic relations with and construction of pipelines from gas- and oil-producing countries in Central Asia.

The New Historic Missions. The People’s Liberation Army Navy (PLAN) has been implementing the new historic missions in three ways: (1) a naval task force deployed in the Gulf of Aden since 2008; (2) the development of military forces able to project power into
both the South China Sea and Indian Ocean, through which most of China's imported energy travels; and (3) diplomatic and military logistics relationships and port calls in the Persian Gulf and Africa. Ports in Oman, Yemen, and Djibouti have been the most frequent sites where PLAN vessels and sailors have stopped for logistical support and replenishment.

Like other militaries, the PLAN uses these commercial ports as pit stops, but it is reportedly looking for more permanent military logistical arrangements, perhaps in the Seychelles. If China wants to become the kind of power able to protect global sea lanes, it will need permanent bases and perhaps even formal allies close to the Gulf.

In addition to building naval flotillas akin to carrier-strike groups, the PRC is developing capabilities to protect its energy interests in three ways. First, it is growing its submarine force by beginning to foray into the Indian Ocean and Gulf. Recently, a Chinese diesel submarine transited the Malacca Strait to make a port call in Colombo, Sri Lanka, before continuing on to the Gulf. This was the first known voyage by a Chinese submarine into the Indian Ocean. Although China's submarine force currently does not have global power-projection capability, its growing fleet of nuclear-attack submarines may be able to frequent the Indian Ocean and provide some retaliatory capability should the US or other perceived hostile powers interdict Chinese energy supplies.

Second, China is engaging in sea lines of communication (SLOC) protection missions. As of late December 2013, the PLAN's 16th escort formation relieved the 15th formation for the Gulf of Aden mission. The 16th escort mission conducted port visits in Africa and repositioned a guided-missile frigate, the Jiangkai II, in the Mediterranean to support removing chemical weapons from Syria.

The Gulf of Aden task force is a SLOC protection, anti piracy, and antiterror mission that has provided the PLA with an opportunity to learn how to project power far away from China's shores, develop diplomatic and military relationships, and explore more permanent support for overseas missions. Next, the PLAN is developing aircraft carriers that can provide SLOC protection along China's long maritime trade routes. China's first carrier, the Liaoning, was commissioned by the PLAN in 2012.

Third, as Andrew Erickson and Gabe Collins insightfully point out, China is flagging more oil tankers as a security hedge. State-flagged tankers enjoy the protection of the flag state under international law; if a state-flagged vessel is interfered with, the state would have a legitimate claim that its sovereignty had been breached. Thirty-three percent of China's large tankers are flagged, and this percentage is growing. Ninety-one percent of India's are flagged, whereas import-dependent South Korea and Japan flag 5 percent and 14 percent, respectively.

These Chinese maritime security developments comprise a hedging strategy against US interdiction. There are also signs of the gradual development of global maritime power. The latter would require a global basing infrastructure, a significant carrier-strike-group fleet, and alliances of the kind the PRC has never had. Beijing has not yet had to make a firm decision about whether it wants this kind of maritime power-projection capability.

Oil and Gas Pipelines. Another element of China's energy-security hedging strategy has been the construction of continental pipelines. China has operational transnational oil or gas pipelines with Kazakhstan, Uzbekistan, Turkmenistan, and Russia. China also revived its plans to construct an oil-import pipeline from Myanmar through an agreement signed in March 2009. China began importing gas from Myanmar in September 2013.

China gets 4 percent of its imported oil from Kazakhstan and 9 percent from Russia—some by rail, some by sea, and some by pipeline. In 2013, it got about half of its imported gas—24.4 billion cubic meters—from Turkmenistan. While China's pipeline plans have had some impact on Central Asia's geopolitics, such as increased Sino-Russian competition for political influence in the region, they will not do much for China's energy needs. Pipelines are expensive to build, and imports from them are more expensive than maritime-based imports. As Collins and Erickson have written, China imports 40 percent of its oil by sea and pipelines and simply cannot replace that amount of oil.

Pipelines are also vulnerable to terror attacks and political instability in the countries of origin. As long
as they are not economically viable, pipelines are likely to continue to be viewed by Chinese strategists both as a hedge against maritime transit risk and as a way to politically connect to Central Asia to defend against other national security threats, such as terrorists flowing to Xinjiang.\textsuperscript{10} If Beijing decided that despite the higher energy costs it has no choice besides investing more heavily in continental pipeline infrastructure, it would need to concurrently invest in more continental security capabilities.

**China’s Potential Challenge to the Global Order.** While energy import dependence is not the only driver of China’s increased maritime power-projection capabilities, energy demand tracks closely with Beijing’s new national security policies. For example, China’s relationships in the Gulf and Africa are mostly energy driven, and its desire for a blue-water navy with overseas basing and logistical arrangements is highly influenced by its energy profile.

While there is ample evidence that China has been carefully and deliberately developing maritime power projection since the 1980s, the Chinese security establishment has had to speed things up to respond to China’s demand shock.\textsuperscript{11} China has certainly made itself a more important diplomatic and security player in and around major supply countries. But its energy security strategy still favors hedging against risk over pursuing a revisionist change in the energy security system status quo.

China still relies on the US for global maritime security, oil price stability, and the security and stability of major Gulf producers. It is a responder to rather than a shaper of global energy events, including the sanctioning of Iran and Russia. It is a market player, if a more mercantilist, less-price-sensitive one than the US. It has made changes to the energy security system only at the margins. But with its new maritime capabilities and diplomatic relationships, it has the capacity to change the energy security system if it decides to pursue such a course.

China’s future challenge to the energy security system is at the systemic level—challenging the global order (as are Russia and Iran) of which the energy system is a part. If the American world order is changed, the energy system will most surely be transformed with it.

**The New Geopolitics and Energy Status Quo**

A new energy order is developing. The Chinese demand shock appears to be ending as China’s growth slows. The US energy revolution is unfolding, hastening a possible end to the Organization of the Petroleum Exporting Countries’ (OPEC’s) market manipulations. And Russia, China, and Iran are challenging the international
The end of the Chinese demand shock will mean that China will be less frenetic about its going-out energy strategy, giving it time to rethink how it implements its new maritime diplomatic and military strategies. The US energy revolution is pushing the energy system back in a free-market direction by breaking the artificial production quotas favored by OPEC and undermining Russia’s ability to use energy as a weapon.

More oil and gas on the market assists US policy in implementing multilateral sanctions on Iran and Russia and helps consumers weather the supply disruptions of the Arab revolutions.\(^{13}\) While the energy revolution may undermine the geopolitical manipulations of major suppliers, it has not fundamentally changed America’s Middle East policy. The Carter Doctrine still governs: the US is currently fighting yet another war in Iraq to defeat terrorists who might gain abundant energy resources. And it is still providing security for sea lanes and choke points in the Gulf.

The most substantial US geopolitical gain resulting from the shale revolution has been in the economic and ideational realm. It reflects positively on the American free-enterprise system. The shale revolution is a consequence of an entrepreneurial vision and the US commercial and innovation system that facilitated it. The revolution has added to US wealth and therefore latent national power: The investment bank UBS predicts that the revolution will add 0.5 percent of GDP per year to the US economy for 10 years (about $85 billion a year). US political leaders could decide to translate more wealth into national power and use US energy resources as a tool of national power, although they have not yet done so.

The major rivals for US global leadership are likely taking into account the possibility that the US translates its energy revolution into a strategic revival. Russia is a rival in long-term decline, and Iran is at best a regional power (although if it becomes nuclear, it will affect global nuclear proliferation; if it dominates Iraq, it will become a global energy power). China is the only one of the three major revisionist powers that may have the economic means and strategic ambition to pose a peer threat to US global leadership.

The current order will falter either if the US loses the will or desire to play the prime role in the international system, or if China successfully stymies the US role and offers an alternative to the current US-led system. China would have to accrue more power to pose this type of systemic challenge. It could do so by translating more of its resources into military power or by achieving diplomatic breakthroughs—for example, by allying with a major country such as Russia or Iran.

If China manages to create such a new alignment, it is doubtful that the energy system status quo will endure. For example, a Chinese-Iranian alliance could challenge the US Fifth Fleet’s control of the Gulf, creating a security vacuum in the global provision of maritime security and in maintenance of political stability in the Gulf. The international energy market would likely balkanize and energy blocks would likely form, negatively affecting the price and availability of energy.

Consequently, the two most pertinent geopolitical questions as they relate to energy security are: is China both willing and able to pose a systemic challenge to the US, and will the US have the power and will to continue to guarantee the international security system? The following section summarizes the net energy demand scenarios outlined earlier in this report that provide a useful analytic framework to consider these important geopolitical questions.

### Scenarios for the Future of US and Chinese Energy Security

The scenarios summarized here are driven by net energy demand and analyze the geopolitical effects of relative net energy demand on China and the US. Given the relatively pessimistic assessments of the future of Russian, Iranian, and Iraqi energy production made in this report, those three countries are considered secondary energy players, although they could become more important geopolitical players if China (or the US) decides to more closely align with them.

There are other potential major changes to the energy security system that are not evaluated in this report but that are plausible and merit further examination. These include major internal unrest in China that threatens the integrity of the Chinese political system, and radical market reform in India, which would...
make India a major player in energy geopolitics over the next 15 years.

**Scenario One: Present Trends Continue.** This is the most likely scenario. US production levels continue apace and US net energy demand moves to zero, making the US a net energy exporter. This scenario results in lower global prices and a global dollar-denominated gas market.

The Chinese economy grows at a slower rate than it has over the past two decades, and there is no real economic or energy reform. Energy production and consumption grow far more slowly than the US Energy Information Administration, International Energy Agency, BP, or others anticipate. Imports rise, but at a slower rate than they have over the last 15 years. Thus, the US becomes a supplier nation while China remains a net importer.

China would still need to increase its energy imports, although at lower rates of growth. It would look to one or more of the potential major producers—Iran, Iraq, and Russia—to meet its demand. China may be in a better price- and supply-negotiating position than it has been over the past decade. It no longer experiences a demand shock and could more gradually and deliberately choose its suppliers and contracts. Furthermore, it is not in the desperate position of energy hunting that it was before (for example, it can forego contracts in places such as Sudan).

The big energy and geopolitical story in this scenario is the demise of the global energy demand shock (this trend has already begun) and a more market-driven global energy system. The demand shock created an explosive growth of Chinese presence and influence in the Gulf and parts of Africa. It was a world of perceived resource competition with the energy-importing United States.

However, as noted earlier, the desire to defend overseas energy resources was only one driver of China’s more assertive maritime and diplomatic behavior. The ongoing perception of a threat from the United States and a nationalistic desire to have a great global navy are two other drivers of increased Chinese maritime capability.

In this present-trends-continue scenario, the US appears stronger and more threatening. Contrary to China’s more recent assessments of American power, the US would be undergoing a strategic revival, and China would consider itself worse off both in relative soft and hard power.

Thus far, the ideational soft power dimension of the US energy revolution is a clear competitive advantage and win for the free-market economic system, while China’s more negative outlook is the consequence of its state-dominated energy sector and economy. As the full extent of this entrepreneurial revolution is better understood, countries will realize that there is yet no model of innovation and wealth creation that can match the US system. The idea that China has found a better way in “authoritarian development” will lose steam. This process will quicken as China’s state-dominated energy sector is unable to recover Chinese shale reserves.

But US political leaders could move beyond an ideational victory and decide to translate the US gains from the shale revolution into instruments of statecraft, placing the US further ahead in its geopolitical competition with China. If leaders summon the political will to translate the energy revolution into national power, the US would have many new strategic options to consolidate its geopolitical position relative to China. The main geographic area of strategic competition with China is the Asia-Pacific, and the US could bolster its position there by becoming an energy supplier to its Asian allies, particularly energy-import-dependent South Korea, Japan, and Taiwan.

Washington would have the potential to address some of its major challenges with its Northeast Asian friends and allies. It could assist South Korea and Japan in overcoming some of their diplomatic difficulties by helping arrange an allied energy purchaser, infrastructure, or logistical group to reshape how these allies buy and transport energy. Seoul and Tokyo are in very similar energy positions, as is Taiwan. Washington could strengthen Taiwan’s strategic position by encouraging its entry into such a grouping.

The US would also have new means to court new friends and partners in Asia. The possibility of safe and reliable energy supply is another diplomatic tool Washington could use as it develops relationships with potential economic powerhouses such as India, Vietnam, and Indonesia. All three could see their energy demands skyrocket if they were to undertake major
market reforms. With the US as a reliable exporter, they could diversify their supply from Russia and the Middle East.

Finally, US political leaders would have the ability to address US fiscal problems and bolster US military and diplomatic power, a much-needed redress to the current budgetary pressures now negatively affecting US military posture in Asia. A correct accounting of US economic resources, as opposed to misleading annual GDP numbers, would help political leaders see that a mere fraction of US net wealth is needed to sustain a robust military and diplomatic posture in Asia.15

The US would also likely continue to abide by its Carter Doctrine in the Middle East, working to ensure that no one country could dominate the Gulf’s energy resources. It would do so to keep oil prices stable and guard against the threat of jihadists setting up a state in an oil-rich country or of Iran dominating the Gulf. As Washington continues to place more oil on the market, the US could also take a more aggressive posture against Iran driving toward nuclear weapons.

Although the PRC would be less frenetic in its search for energy in and around the Gulf and less beholden to Middle Eastern suppliers, it would still need a large volume of imports and would look to Iran and Iraq—the countries that Vakhshouri argues have the most potential new supply—to put more oil and gas on the market. In that sense, China would share the US interest in Iraqi stability. But it would care far less about a nuclear Iran or the possibility of an Iraq swallowed by Tehran, as long as it is able to secure supply contracts. China could work harder to help Iran lift its sanctions and revitalize its energy sector.

Still, China would generally find this scenario very threatening. Unless the US decides to voluntarily forgo its prime geopolitical position, it would seem stronger and more powerful to China. The PRC would thus still have concerns about overrelying on US maritime security for its main sources of energy supply.

To reverse its strategic fortunes, China would consider forming a truly meaningful alliance. Candidate countries would include Iran, Iraq, or Russia (or both Iran and Iraq if Iran continues to slowly take over Iraq). Although the PRC’s economy would be growing at a slower rate than it has in decades, China could still devote more resources to an increased global maritime posture, as it has already gained experience in extended maritime operations that it can build on.

A Gulf ally could help China extend its reach into an energy-rich arena and provide more protection against and complicate the strategic calculations of a potentially hostile US. The PRC would not be in any rush to exercise these strategic options, as its energy demand growth is slowing.

Another, perhaps more attractive, option for China is to really come to terms with Moscow on energy. That could lead to the setting aside of both historic and current mistrust in favor of a strategic alignment between the two nations. In theory, this makes great sense. Goldthau makes a strong case for Russia having to look east to export its energy (given the likelihood of decreased exports to Europe), and China will still have great cash reserves to invest in Russia’s decrepit energy infrastructure. A Chinese continental strategy would allow Beijing to avoid the treacherous politics of the Middle East and somewhat mitigate its dependence on extended maritime supply lines.

The Russia (continental) option would be more attractive to China than an alliance with Iran or Iraq, as Beijing has greater experience dealing with Moscow than with Middle Eastern states. It might be able to establish more cooperative relations with Moscow in energy-producing Central Asian states. China would still want a maritime and possibly logistical presence near the Gulf, but it would not attempt to become a major Gulf player.

A relatively weaker China could still pose a systemic challenge to US leadership. China would not have the same growing economic resource base, but if it developed an alliance with one of the other revisionists—Russia or Iran—it would still present a formidable challenge.

In this most likely scenario, geopolitics could undergo transformative change. The years of a fast-growing China scouring the earth for energy would be over. And the US would be a producer and exporter of energy and would be in a strong position to strengthen its global strategic position and defend the liberal order it helped create. A China growing at a slower rate could still pose a systemic challenge to this order, but it would need to develop an alliance with Russia or allies in the Gulf.
Scenario Two: Chinese Reform. A second likely (though far less so) scenario is that China reforms both its economy and energy system. Its economic growth would not slow and its net energy demand would fall as its domestic energy production increases. The US network energy demand would still be low, as its production picture is still rosy. The difference from scenario one is that both China and the US would become wealthier, more powerful, and less dependent on energy imports.

China may be in a very favorable position, as former US energy suppliers need the Chinese market more than Beijing needs them. China would be courted by Iraq, Iran, and Russia, placing China in a favorable position to negotiate supply contracts (albeit smaller ones) and new political and military arrangements in the Gulf and Africa.

China could also be a more formidable geostrategic competitor, with leverage in the Middle East and Russia, and would have more resources to become a global military power. Rather than scrambling to catch up to the overseas activities of China’s energy companies, the PLA could get back on plan and develop the kind of global maritime power that the Chinese Communist Party wants on its own timeline.

This scenario places US allies, such as Japan, in a relatively less advantageous strategic position. They would still be in an energy-import-dependent position, with less clout than China among traditional suppliers. To retain its prime political position in Asia, the US would prioritize alleviating the risks for its allies by becoming a robust energy exporter and by shoring up its strategic position in the Middle East to keep energy prices stable. It would remain involved in issues central to the Middle East’s power balance, such as Iranian deterrence.

China would over time have the wealth and the power to pose a systemic-level threat to US global leadership. It could focus more coercive power on the Asia-Pacific, shaping that region in accordance with Chinese interests. It could avoid dependencies on unstable regions while building a global maritime presence. It would have the leverage to exchange capital for energy and to align producers such as Iran, Iraq, and Russia with its global interests.

However, the US would remain wealthy and powerful. Thus, the two countries could engage in a truly global security competition. The potential upside for the US is that the global economy grows faster than in scenario one, and Beijing and Washington might mitigate their rivalry by finding ways to keep oil prices stable and low and to keep the global economy growing. Since an economically reformed China is very likely to be relatively more open and pluralistic, the two countries may converge on basic issues of international economic and financial management.

Scenario Three: The Best Outcome for China. A less likely but still plausible scenario is a world of lower US production, if political forces end the production boom, and Chinese reform leading to lower net demand. This is the worst outcome for the US, which would need to be very active in and dependent on the world market, while China would be less active.

Like scenario two, this scenario would probably result in more Chinese geopolitical focus on gaining advantages in the Asia-Pacific. The death of the US shale boom would tie Washington up with the fortunes of unreliable energy suppliers. The US would have less relative wealth and power to compete vigorously in Asia. China might be able to become the regional hegemon.

In this scenario, the US will continue to be more like it was before the shale revolution—more solicitous of Gulf producing states and with less leverage over Iran and Russia. In the short term, allies dependent on US energy imports may cheer that they are in the same boat as the US and that, for a time, the US is acting in the energy market in ways that they are used to. They may be soothed that China may be relatively less interested in the major producing states. But a deeper concern would emerge that the US is unable to protect the liberal order and therefore would be less able as an alliance partner.

Similar to the second scenario, a mitigating factor for the US and its allies in scenario three is that deep Chinese reform will require political changes. China’s move from Maoist to Dengist economics was as close to a regime change as the PRC has ever seen. China is far more pluralistic and open under the legacy of the Deng revolution. As in the second scenario, if China goes through its next phase of economic reform, the economy will require more rule of law, financial openness, and consumer choice, and the political system would be more open. Just as the US and its allies found
more to cooperate with under Dengist policies, it is likely that a similar pattern would develop under a new, reforming regime. The change in China would mitigate but not reverse the downward trend in the US geopolitical position.

**Conclusion**

The status quo energy system reflects the US-dominated liberal order. The US helped create an international oil market tradable in US dollars. It has intervened politically and militarily when the market failed and has provided security to the major Gulf producers and global consumers. China has been a prime beneficiary of this system: the open economic architecture was able to absorb China's energy demand shock. China has been unhappy with US dominance but decided to hedge against the potential for future US hostility rather than directly challenge the US.

The energy status quo is changing. First, the Chinese demand shock over the last 15 years, which propelled Beijing onto the international stage, is probably coming to an end. Second, the US production revolution is continuing, lessening US import dependence, adding to US wealth and latent power, and providing the US with more strategic options in dealing with energy producers.

The most likely change that all energy players will need to adjust to is China's stagnating economy. Unless China undertakes major economic reforms, its growth will slow appreciably. This will put China in a relatively disadvantageous geopolitical position, mainly because of the consequences of a slower growing economy for Chinese power. But this is also because China is not likely to reform its energy sector, meaning it will still be dependent on energy imports (though at a slower rate of growth). It will have less relative national power but will be more energy import dependent.

Meanwhile, the most likely scenario for the US is a continued production boom that lowers its net energy demand. This will provide the US with many strategic options: It will have more wealth to potentially turn into military power and could arrange new energy supply relationships with key countries in Asia. And while it will continue to have interests in the Middle East, it will approach the region with more leverage and less dependence on particular supply relationships.

As it perceives the US to be more powerful and menacing, China will still feel the need to grow its power-projection capabilities, even with relatively fewer economic resources. To do so, it will probably need an ally in the Gulf, Indian Ocean, or Russia. A Chinese ally would be the biggest change the world has seen in a very long time.

China will also have a strong interest in Iraqi and Iranian oil production. These two countries and Russia will play an increasingly important role in the long-term Sino-American strategic competition. There may be some more cooperation on Iraqi stability but divergent views on Iranian sanctions.\(^1\)

In the highly likely 15-year net energy demand scenario, China could also decide to reverse a downward trend in its geostrategic position. A weaker China would need allies to regain ground. Beijing could align with another revisionist power such as Iran or Russia and pose a systemic threat to US leadership of a liberal order. China would have to make major changes to its national security doctrine to form alliances. If it does so, the US ability to uphold the energy order as a subset of the world order would face its most serious challenge to date.

US allies in Asia—particularly Japan and South Korea—have a strong interest in a continued US production boom and consequent revival of US strategic power. They could make a continued US energy boom and a push for the US to create new supply arrangements in Asia a high diplomatic priority in discussions with American counterparts. The US will need to determine how it uses its positive energy profile as a tool of national power. In the meantime, the US shale boom is another victory for the US economic system. It came about because of entrepreneurship, risk capital, and disruptive technology. While many Western elites and political leaders were searching for their Manhattan Project on energy (big government and corporate spending), entrepreneurs were busy at work.

The effects on the US psyche will be very positive over time and should put to rest the notion that China's state-dominated system has any advantage over the US free-enterprise system. Now that the private sector
has started an energy revolution, it is up to US policymakers to beat back political efforts to stop it. Most importantly, US national security leaders would be wise to turn added wealth into enduring US power advantages as competition with China increases.

Notes

9. Collins and Erickson, Energy Nationalism Goes to Sea in Asia.
11. Toshi Yoshihara and James Holmes, Red Star over China (Annapolis: Naval Institute Press, 2010).
12. The international political and economic system also faces a continued threat by ever-morphing groups of radical Islamists who find the liberal system profoundly threatening.
14. This development should encourage analysts to be wary of intellectual fads such as the existence of a Beijing model that threatens the US economic model.
16. This report does not address the possibility of major Indian market-based reform or a Communist Party in crisis. These are two events that could substantially change international politics and the energy system. The latter would probably mean a period of very low energy demand for China. The former could bolster the liberal order while creating a new demand shock.
About the Authors

Dan Blumenthal is the director of Asian Studies at AEI, where he focuses on East Asian security issues and Sino-American relations. He has both served in and advised the US government on China issues for more than a decade. From 2001 to 2004, Blumenthal was senior director for China, Taiwan, and Mongolia at the US Department of Defense. Additionally, he served as a commissioner on the congressionally mandated US-China Economic and Security Review Commission from 2006 to 2012, holding the position of vice chairman in 2007. He has also served on the academic advisory board of the congressional US-China Working Group. Blumenthal coauthored the book *An Awkward Embrace: The United States and China in the 21st Century* (AEI Press, 2012) and has authored numerous articles in the *Washington Post*, the *Wall Street Journal*, *National Review*, and the *Weekly Standard*.

Andreas Goldthau is a professor at Central European University and associate with the Geopolitics of Energy Project at Harvard University’s Belfer Center for Science and International Affairs, where he focuses on energy security and global governance issues related to oil and gas. Before joining Harvard, Goldthau worked at the RAND Corporation and Johns Hopkins University’s School of Advanced International Studies. His latest research project, supported by the European Union’s Marie Curie International Outgoing Fellowships Program, deals with energy technology innovation and transfer, with a focus on shale gas prospects beyond the United States. His articles have been published in the *Journal of European Public Policy*, *Energy Policy*, *International Affairs*, and *Global Policy*.

Michael Mazza is a research fellow in foreign and defense policy studies at AEI, where he analyzes US defense policy in the Asia-Pacific region, Chinese military modernization, cross-Taiwan Strait relations, and Korean peninsula security. Apart from writing regularly for the AEIdeas blog, he is also program manager of AEI’s annual Executive Program on National Security Policy and Strategy. At AEI, Mazza has contributed to studies on American grand strategy in Asia, US defense strategy in the Asia-Pacific, and Taiwanese defense strategy. He has written op-eds for the *Wall Street Journal*, *Los Angeles Times*, and the *Weekly Standard*, among others.

Derek M. Scissors is a resident scholar at AEI, where he studies Asian economic issues and trends. In particular, he focuses on the Chinese and Indian economies and US economic relations with China and India. Scissors is also an adjunct professor at George Washington University, where he teaches a course on the Chinese economy. Before joining AEI, he was a senior research fellow in the Asian Studies Center at the Heritage Foundation. He has also worked in London for Intelligence Research Ltd., taught economics at Lingnan University in Hong Kong, and served as an action officer in international economics and energy for the US Department of Defense.

James A. Slutz is the president and managing director of Global Energy Strategies LLC, focusing on energy project development (oil, gas, and geothermal) and technology commercialization, primarily with oil and gas environmental applications. Slutz serves on the Committee on Earth Resources of the National Research Council (National Academy of Sciences), serves on the advisory board of the Canada Institute at the Woodrow Wilson International Center for Scholars, and is a distinguished associate of FACTS Global Energy. Before founding Global Energy Strategies, Slutz served as US assistant secretary of energy. In that position, he was the executive responsible for leading the Office of Fossil Energy, which includes the coal, oil, and natural gas research and technology components of the US Department of Energy (DOE). He previously served
as the deputy assistant secretary for oil and natural gas. Before joining DOE, Slutz served as the Indiana oil and gas director, regulating the state’s upstream oil and gas industry.

**Sara Vakhshouri** is the president and founder of SVB Energy International LLC, a Washington, DC–based strategic energy consulting firm that provides critical advice and counsel to various organizations. Previously, Vakshouri served as an independent consultant advising energy companies, think tanks, and investment banks about Middle Eastern energy markets, geopolitics, and economics. She has also served at the National Iranian Oil Company, Petroenergy Information Network, and the Iranian Ministry of Petroleum. In addition to her experience working for the Iranian government, she has worked in the private Iranian energy sector for Pasargad Energy Development Company and Oil Pension Fund Investment Company, among others. Vakshouri is the author of *The Marketing and Sale of Iranian Export Crude Oil since the Islamic Revolution* (2011) and has published articles in the *Economist*, *Middle East Economic Survey*, and the Huffington Post.