Business Executives for National Security

Security in the New Energy Landscape:

Assessing the Geostrategic Impact of the Unconventional Oil & Gas Revolution

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WHO WE ARE

Business Executives for National Security is a unique nonpartisan, nonprofit organization of senior executives who volunteer time, expertise, and resources to assist defense and homeland security leaders on a variety of national security challenges.

OUR MISSION

Apply best business practices to develop, for government officials, solutions to our nation's most challenging problems in national security, particularly in defense and homeland security.

ACKNOWLEDGMENTS

BENS gratefully acknowledges the BENS Oil & Gas Steering Committee for their leadership and the BENS Energy Council for their endorsement and support. We would also like to extend our gratitude to our contributors for their expert insight as well as recognize the BENS Board of Directors and general membership for their continued backing of all BENS efforts to improve U.S. energy security.

PREFACE

Recent revelations of the scope and accessibility of US oil and gas resources have sent tremors through the world's energy markets, fundamentally shifting international energy politics. Markets are realigning as the United States imports less foreign energy every year. In fact, the United States holds the potential to export energy worldwide. This new energy reality will ripple across the American public policy spectrum, boosting the economy and strengthening national security. With the global economy continuing to depend on fossil fuels, the United States will assume a new level of geopolitical importance. In assuming this status, the United States must reassess certain core tenets of its domestic and foreign policy.

BENS has assembled industry and security experts to explore and contextualize this new landscape, providing a unique and instructive perspective for policymakers responsible for reassessing American energy security policy. In collaboration with our subject-matter experts, the BENS Oil and Gas Steering Committee conducted in-depth research on the domestic and global ramifications of the United States energy boom. The following issue paper represents the culmination of this research. It intends to provide a high-level overview of the boom's effects with a focus on US national security.

The BENS Energy Council hopes this issue paper will initiate a large and complex conversation that will evolve as new forecasts and better technology develop. We commend the BENS members instrumental to the development of this publication for highlighting this topic and welcome continued dialogue with policymakers and thought leaders around the world as they explore all aspects of this issue.

Edward Blessing, Blessing Petroleum Group
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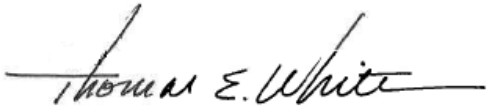

The Honorable Thomas White, DKRW Energy
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Executive Summary

The United States is experiencing a surge in the discovery and production of oil and gas resources. Whereas just several years ago experts warned of the decline in global oil and gas supply, the US energy industry is now booming – driven by the increased use and affordability of horizontal drilling and hydraulic fracturing (fracking) technology. US oil production saw a 13.9 percent increase from 2011 to 2012 due to development in the country's shale and other tight rock formations and natural gas production increased 4.7 percent. This abrupt shift is forcing US policymakers to reevaluate a myriad of policies from infrastructure and trade to security and foreign policy.

Today, shale and tight rock development is unique to the United States. Countries like China, the United Kingdom, Poland, and Argentina struggle to exploit their shale reserves for a variety of reasons. As an example, China faces geographical hurdles while Europe faces internal political opposition to drilling. The US, on the other hand, has effectively utilized its unique combination of resources, private property rights, pre-existing network of pipelines, abundant financial tools, and entrepreneurialism to a spike production and enable world energy supply to meet rising world demand.

US shale oil production is playing a large role in driving approximately 1.4 million barrels per day in annual production growth, but the production of natural gas from shale formations (shale gas) promises to have a much greater impact on global energy. US shale gas will have a larger share of global gas production by 2030 than US shale oil will have on global oil production. Abundant American natural gas resources could supplant more traditional fuels across sectors, from industry to residential power generation. Also, the United States is considering exporting natural gas. However, today, the lack of necessary export infrastructure and the absence of trade agreements with major importers remain major hurdles.

The sudden increase in US oil and gas production has reverberated throughout the world. With the United States now viewed internationally as a potential energy supplier rather than buyer, new interactions and negotiations appear through the lens of energy politics. As examples, Japan seems more amenable to Iranian sanctions, reflecting an expectation that the US will be able to make up for shortfalls in Iranian energy supply. Meanwhile the decreasing US reliance on the Middle Eastern energy resources appears to be easing tensions between China and United States.

US production has important implications for global trade as well. For instance, increases in Middle Eastern liquefied natural gas (LNG) exports to Europe diversify European supply and break the tremendous market share held by Russia, and significantly reducing its pricing power. Reduced Russian pricing power lessens its influence over the region's politics, and the fear of Russia shutting down its pipelines for political leverage will be a thing of the past.

Additionally, the United States oil and gas boom has important implications for diplomatic and trade relationships in the Western Hemisphere. Despite increases to domestic supply, the US will continue to partially rely on imports to meet its energy demand. Increased imports from Canada will strengthen the bond between the two countries and reduce reliance on hostile countries such as Venezuela. These developments will also encourage and invigorate the Mexican energy economy and US-Mexican relations.

Of all the international bodies affected by the unconventional oil and gas boom, OPEC – a cartel of oil-producing countries – is the most directly threatened. There is speculation OPEC could ramp up production of oil in order to lower crude prices and drive marginal US producers out of business. However, this seems unlikely considering producers, with the right incentives, could continue energy production by simply switching their operations to natural gas development and sale if oil prices make tight oil extraction uneconomical. Alternatively, larger American oil companies capable of maintaining profits in the face of cheaper oil would likely snap up marginal producers in expectation of the future value of American tight oil.

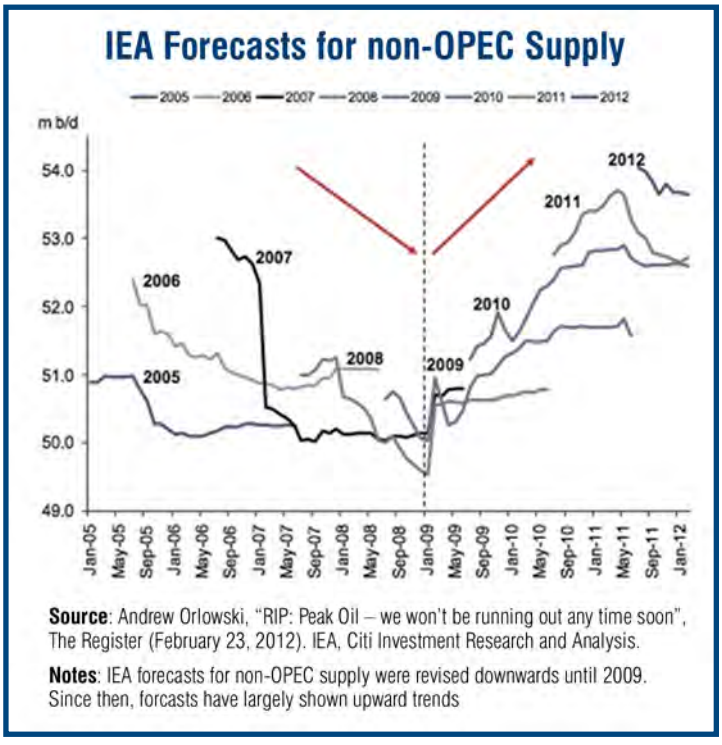
The shale boom remains unique to the United States for now, but the oil and gas industry is rapidly changing and is prone to surprises. Markets are in flux and the United States sits at the cusp of a wave of technology that will have profound effects on production. As global energy demand rises, so too will incentives for oil and gas development. And as the world adjusts to these new circumstances, no one can predict what is next.

Background

The past several years in the United States have been marked by an unexpected boom in the discovery and production of natural gas and oil. Not long ago, experts and politicians alike warned the public of "peak oil" – the concept of indefinitely declining oil supplies – and growing shortages of natural gas. Google searches for "peak oil" spiked in late 2008 and headlines from major publications predicted a dire future. Time Magazine ran stories like "Why US is Running Out of Gas" in 2003, while Reuters warned in November 2009 that "Peak Oil Closer than IEA Forecasts Show".

Today, search frequency for "peak oil" is declining as headlines decree "RIP: Peak Oil – we won't be running out anytime soon" (The Register) and "US Natural Gas Reserves at Record Levels…" (Denver Business Journal). Supply trends are exploding amidst optimism of a new American revolution in energy not seen since the turn of the last century. All the while, Google reports that the quickest rising related search term is "peak oil debunked" by a broad margin.

FIGURE 1



Source: Andrew Orlowski, "RIP: Peak Oil – we won't be running out any time soon", The Register (February 23, 2012). IEA, Citi Investment Research and Analysis.

Notes: IEA forecasts for non-OPEC supply were revised downwards until 2009. Since then, forcasts have largely shown upward trends

TECHNOLOGY DRIVING THE BOOM

This remarkable transformation is a direct result of the greater use and affordability in technology, namely horizontal drilling and hydraulic fracturing (or fracking) that have been around for decades. The first horizontal well was drilled in Texas in 1929, while 1947 saw the first instance of fracking in Kansas. Horizontal drilling remained largely infeasible until the late 1970s and early 1980s when external supply shocks raised oil prices to a point where the technique could be used profitably. Fracking, on the other hand, has been widely used since its inception. The National Petroleum Institute reported that by 2002, more than a million wells had been tapped using the technique.[1]

Horizontal drilling and hydraulic fracturing work hand-in-hand to access both natural gas and tight oil trapped in shale deposits or other tight rock deep below the earth's surface. The shallowest hydrocarbon-bearing shale formation (or shale play) in the United States is the Marcellus Shale in the Appalachian Basin, ranging from 4,000 feet to 8,000 feet deep. Shale plays in other parts of the country reach depths of nearly 15,000 feet.[2] In contrast, freshwater aquifers (well water) are largely only 300 to 1,000 feet below the surface, separated from the shale by thousands of feet of solid rock.

Wells are drilled vertically into the rock until the "kickoff point", then horizontally to maximize surface area contact with the boreholes. Depending on the well, the horizontal section can extend for several miles. A multilayered casing of steel and concrete is inserted into the well to prevent groundwater contamination and to enable fracturing. At this point, a mixture of freshwater, sand, and chemicals is pumped at high pressures into the pipes. Holes along the sides of the horizontal portion of the well created by a perforation gun allow the fracking fluid to escape into the surrounding rock, creating fractures. The sand in the fracking fluid enters the cracks and holds them open after the water pressure is relieved. Hydrocarbons flow through these fractures into the boreholes and move toward the surface. From there, systems of pipelines and trucks transport the product to market. Horizontal drilling enables multiple wells to be drilled from a single location, reducing environmental impact on the surface. The entire process takes between four and five months, and creates wells that can extract gas or oil for decades.

FIGURE 2

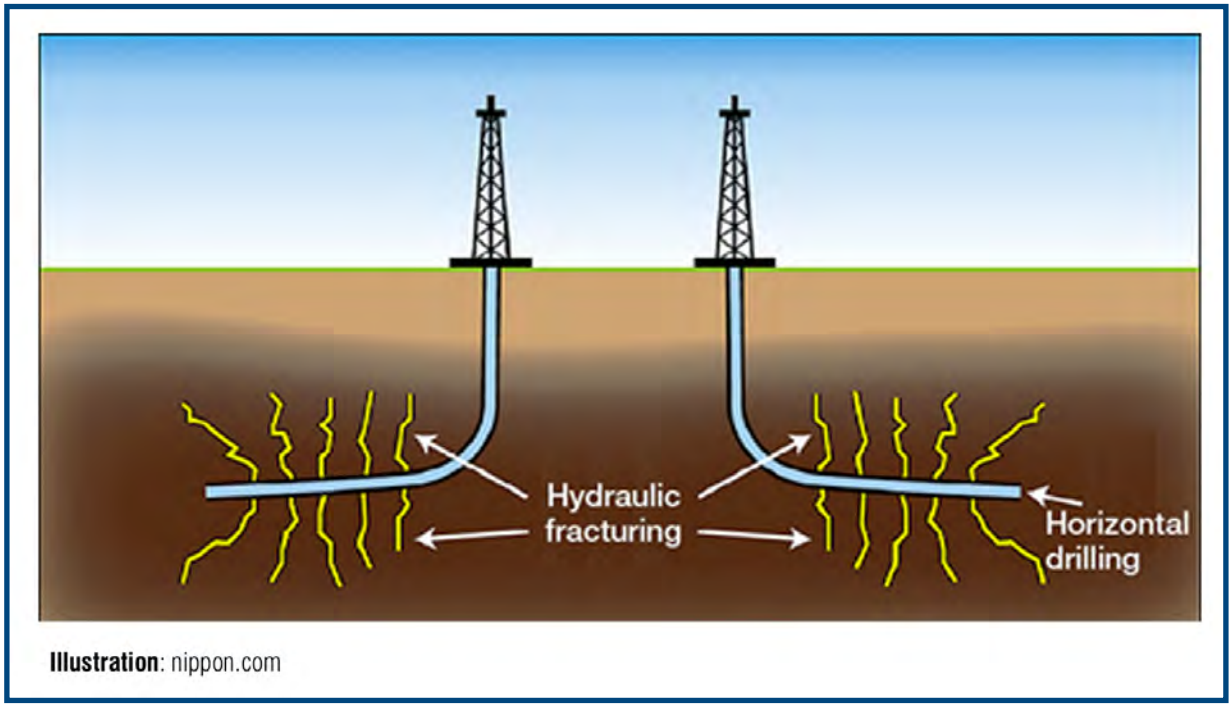


Illustration: nippon.com

SHALE DEPOSITS IN THE UNITED STATES

There are 22 known shale plays across the contiguous United States.[3] Of those 22, six produce considerably more natural gas than the rest:

- Barnett Shale in Texas
- Woodford Shale in Oklahoma
- Haynesville Shale in East Texas and Northwest Louisiana
- Antrim Shale in Michigan
- Fayetteville Shale in Arkansas
- Marcellus Shale in the Appalachian Basin

While the Marcellus Shale is geographically and volumetrically the largest play in the Continental United States, covering 50,000 square miles, the Barnett Shale is the most productive. Covering 5,000 square miles, the Barnett Shale produces 7 percent of the natural gas used in the United States.[4] The Energy Information Agency (EIA) reported as of 2010 that the Barnett Shale produced 1.9 trillion cubic feet (tcf) of gas of its total reserves of 31 trillion cubic feet. Haynesville produced 1.5 tcf of its 24.5 tcf reserves. Fayetteville produced .8 tcf of its 12.5 tcf reserves. Woodford produced .4 tcf of its 9.7 tcf reserves. Marcellus produced .5 tcf of its 13 tcf reserves. Finally, Antrim produced .12 tcf of its 2.3 tcf proven natural gas reserves. Production from these and other shale plays sums to 97.5 trillion cubic feet.[5] BP's 2013 Statistical Review of World Energy estimates 300 trillion cubic feet of proven reserves exist in the United States.[6]

According to BP's Statistical Review of World Energy, the United States' 300 tcf represents 4.5 percent of the world's total proven reserves. The largest contributors include Iran, with 1,187.3 tcf (18 percent of the global total), Russia, with 1,162.5 tcf (17.6 percent), and Qatar, with 885.1 tcf (13.4 percent). However, the United States leads the world in natural gas production, extracting 20.4 percent of the world's total natural gas. The United States' absolute figure, 681.4 billion cubic meters, represents a 4.7percent increase over last year's numbers.[7]

American oil reserves follow a similar pattern with the most productive oil plays being:

- Bakken Shale in North Dakota
- Eagle Ford in Texas

The United States' 35 billion barrels represent only 2.1 percent of the world's total proven reserves, compared to Canada's 173.9 billion barrels (10.4 percent), Venezuela's 297.6 billion barrels (17.8 percent), and Saudi Arabia's 265.9 billion barrels (15.9 percent). The more impressive numbers, however, come from increased US oil production attributable to unconventional shale development. In 2011, the US produced 7.868 million barrels per day. In 2012, production jumped to 8.905 million barrels per day, a 13.9 percent increase. This marked, percentage-wise, the second largest increase in the world, trailing only Libya (+215.1 percent). In absolute terms, US production led world increases, rising by around 1.037 million barrels per day between 2011 and 2012.[8]

As shale exploration in the United States increases, policymakers have developed concerns about the possible associated ecological and health risks. Some Americans fear irresponsible drilling practices have the potential to contaminate groundwater, either during extraction of gas or in disposal of fracking fluids. They also express concern with the expansion and renewal of oil pipeline infrastructure, fearing increased carbon emissions and the potential for a spill. Other methods of oil transport, including rail, carry risk as well. Another potential drawback is the availability of fresh water. Although fracking comprises a tiny percentage of global water usage, in drought-stricken areas, shortages drive prices up considerably – threatening profit margins and operation. Nonetheless, unconventional hydrocarbon development appears to be proceeding smoothly and production continues to increase steadily.

FIGURE 3

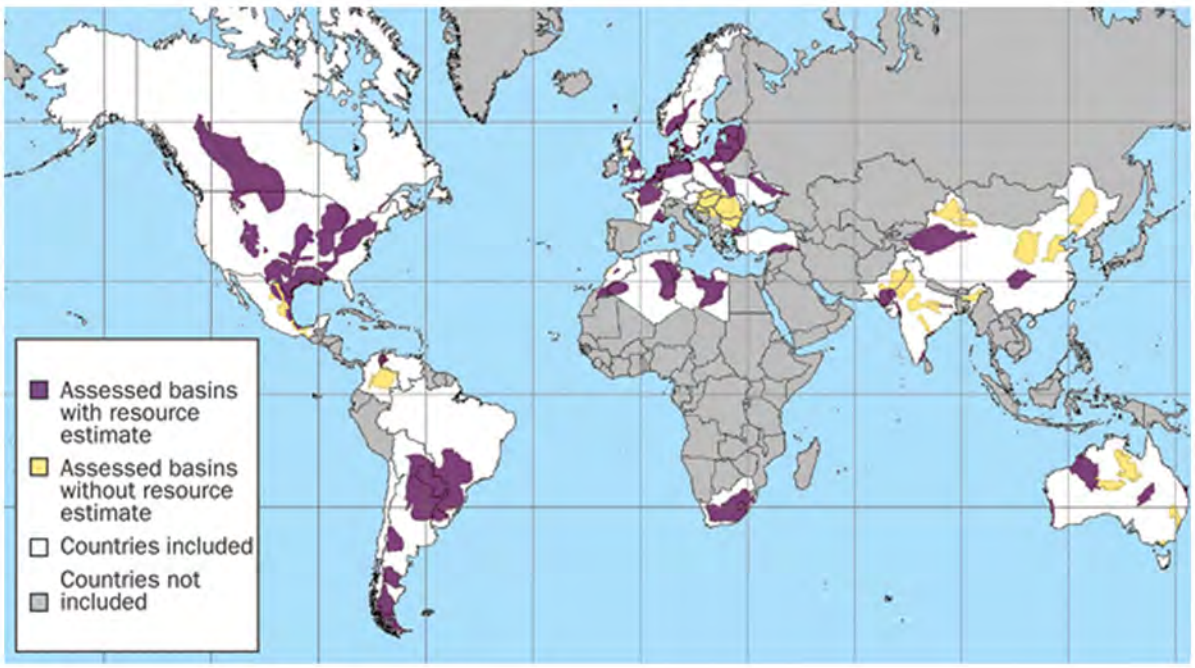


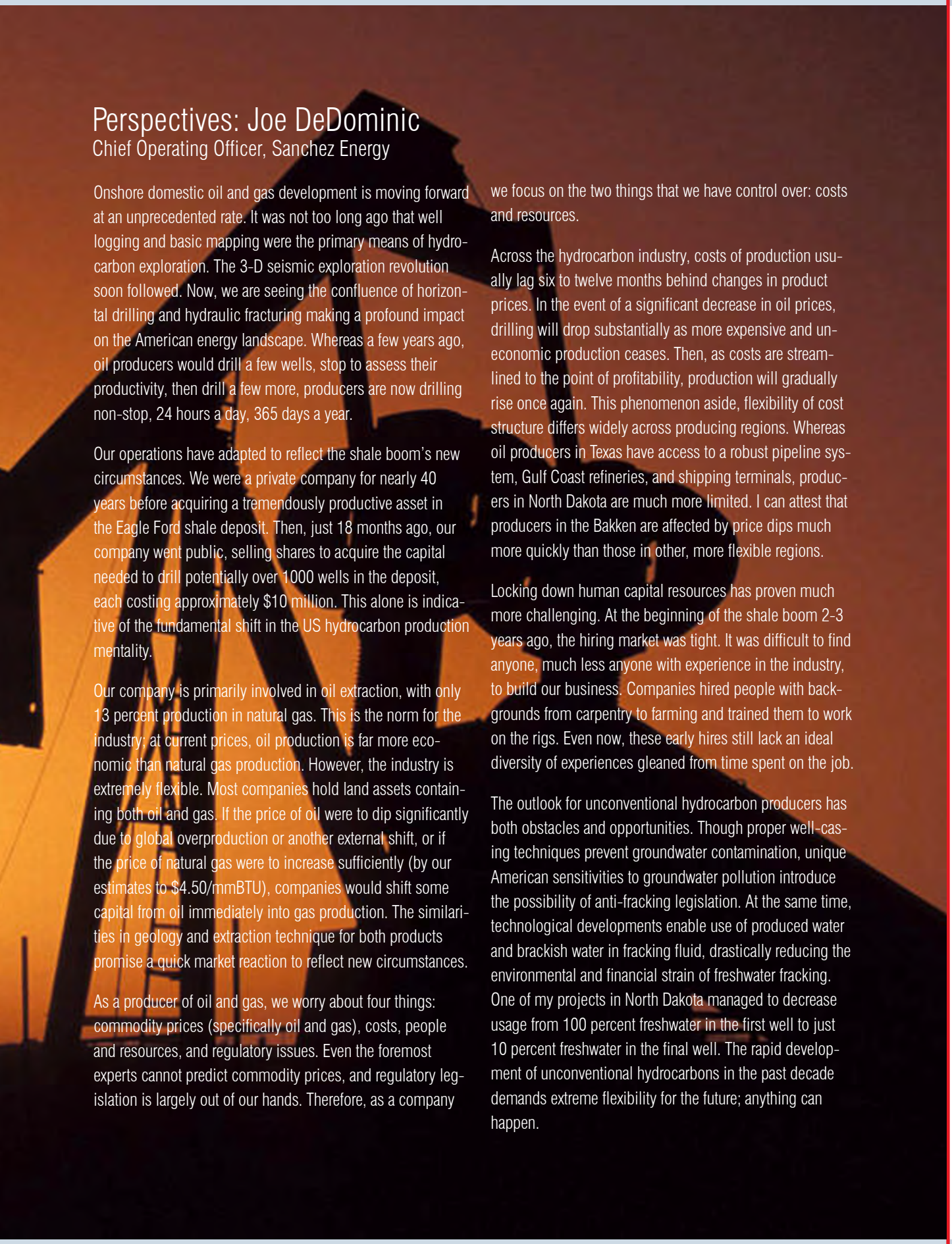
Illustration: sciencenews.org, US Energy Information Administration

INTERNATIONAL SHALE DEVELOPMENT

The same cannot be said, however, for other countries with recently discovered shale deposits. Countries like China, the United Kingdom, Poland, and Russia are struggling to exploit their shale reserves for a variety of reasons. While Chinese shale deposits are geographically difficult to access, European countries face significant political opposition to fracking and horizontal drilling. Experts from both business and policy communities assert that the conditions enabling the US shale oil and gas boom are unique in the world today. They point to the distinctively American combination of private property rights, individual mineral rights, a pre-existing network of pipelines, a robust venture capital market (not to mention other widely available financial tools), and an abundance of risk-taking entrepreneurial spirit. The results of this exceptional endowment are plain – although the United States possesses only approximately one quarter of the world's technically recoverable shale resources, it accounts for nearly one hundred percent of global shale hydrocarbon production.[9]

STUDY AND APPROACH

In considering this issue, it is important to note that the situation is highly dynamic. Prospects for future development change quickly, and official reports are functionally obsolete practically as soon as they are issued. This can be seen in the radical changes in predictions and attitudes in just the last three years. The United States and the world sit at the beginning of a wave of technology. Further developments and tweaks of the supply chain will have profound effects on the market's future. Keeping this caution in mind, the bulk of this issue paper is devoted to exploring the implications of the recent monumental shift in global hydrocarbon production and speculation. It will first examine major trends and domestic market consequences in the American hydrocarbon industry. Specifically it will look at private sector developments and potential governmental regulation and behavior in the industry. Finally, this paper will detail the broad array of geopolitical and geostrategic consequences of the US oil and gas boom with specific attention given to implications for United States national security. This paper is the product of independent research, interviews with key contributors Mona Sutphen, Mark Finley, Michael Levi, and Bob McNally, and guidance and input from BENS members.



Perspectives: Joe DeDominic

Chief Operating Officer, Sanchez Energy

Onshore domestic oil and gas development is moving forward at an unprecedented rate. It was not too long ago that well logging and basic mapping were the primary means of hydrocarbon exploration. The 3-D seismic exploration revolution soon followed. Now, we are seeing the confluence of horizontal drilling and hydraulic fracturing making a profound impact on the American energy landscape. Whereas a few years ago, oil producers would drill a few wells, stop to assess their productivity, then drill a few more, producers are now drilling non-stop, 24 hours a day, 365 days a year.

Our operations have adapted to reflect the shale boom's new circumstances. We were a private company for nearly 40 years before acquiring a tremendously productive asset in the Eagle Ford shale deposit. Then, just 18 months ago, our company went public, selling shares to acquire the capital needed to drill potentially over 1000 wells in the deposit, each costing approximately $10 million. This alone is indicative of the fundamental shift in the US hydrocarbon production mentality.

Our company is primarily involved in oil extraction, with only 13 percent production in natural gas. This is the norm for the industry; at current prices, oil production is far more economic than natural gas production. However, the industry is extremely flexible. Most companies hold land assets containing both oil and gas. If the price of oil were to dip significantly due to global overproduction or another external shift, or if the price of natural gas were to increase sufficiently (by our estimates to $4.50/mmBTU), companies would shift some capital from oil immediately into gas production. The similarities in geology and extraction technique for both products promise a quick market reaction to reflect new circumstances.

As a producer of oil and gas, we worry about four things: commodity prices (specifically oil and gas), costs, people and resources, and regulatory issues. Even the foremost experts cannot predict commodity prices, and regulatory legislation is largely out of our hands. Therefore, as a company we focus on the two things that we have control over: costs and resources.

Across the hydrocarbon industry, costs of production usually lag six to twelve months behind changes in product prices. In the event of a significant decrease in oil prices, drilling will drop substantially as more expensive and uneconomic production ceases. Then, as costs are streamlined to the point of profitability, production will gradually rise once again. This phenomenon aside, flexibility of cost structure differs widely across producing regions. Whereas oil producers in Texas have access to a robust pipeline system, Gulf Coast refineries, and shipping terminals, producers in North Dakota are much more limited. I can attest that producers in the Bakken are affected by price dips much more quickly than those in other, more flexible regions.

Locking down human capital resources has proven much more challenging. At the beginning of the shale boom 2-3 years ago, the hiring market was tight. It was difficult to find anyone, much less anyone with experience in the industry, to build our business. Companies hired people with backgrounds from carpentry to farming and trained them to work on the rigs. Even now, these early hires still lack an ideal diversity of experiences gleaned from time spent on the job.

The outlook for unconventional hydrocarbon producers has both obstacles and opportunities. Though proper well-casing techniques prevent groundwater contamination, unique American sensitivities to groundwater pollution introduce the possibility of anti-fracking legislation. At the same time, technological developments enable use of produced water and brackish water in fracking fluid, drastically reducing the environmental and financial strain of freshwater fracking. One of my projects in North Dakota managed to decrease usage from 100 percent freshwater in the first well to just 10 percent freshwater in the final well. The rapid development of unconventional hydrocarbons in the past decade demands extreme flexibility for the future; anything can happen.

Key Market Trends and Effects

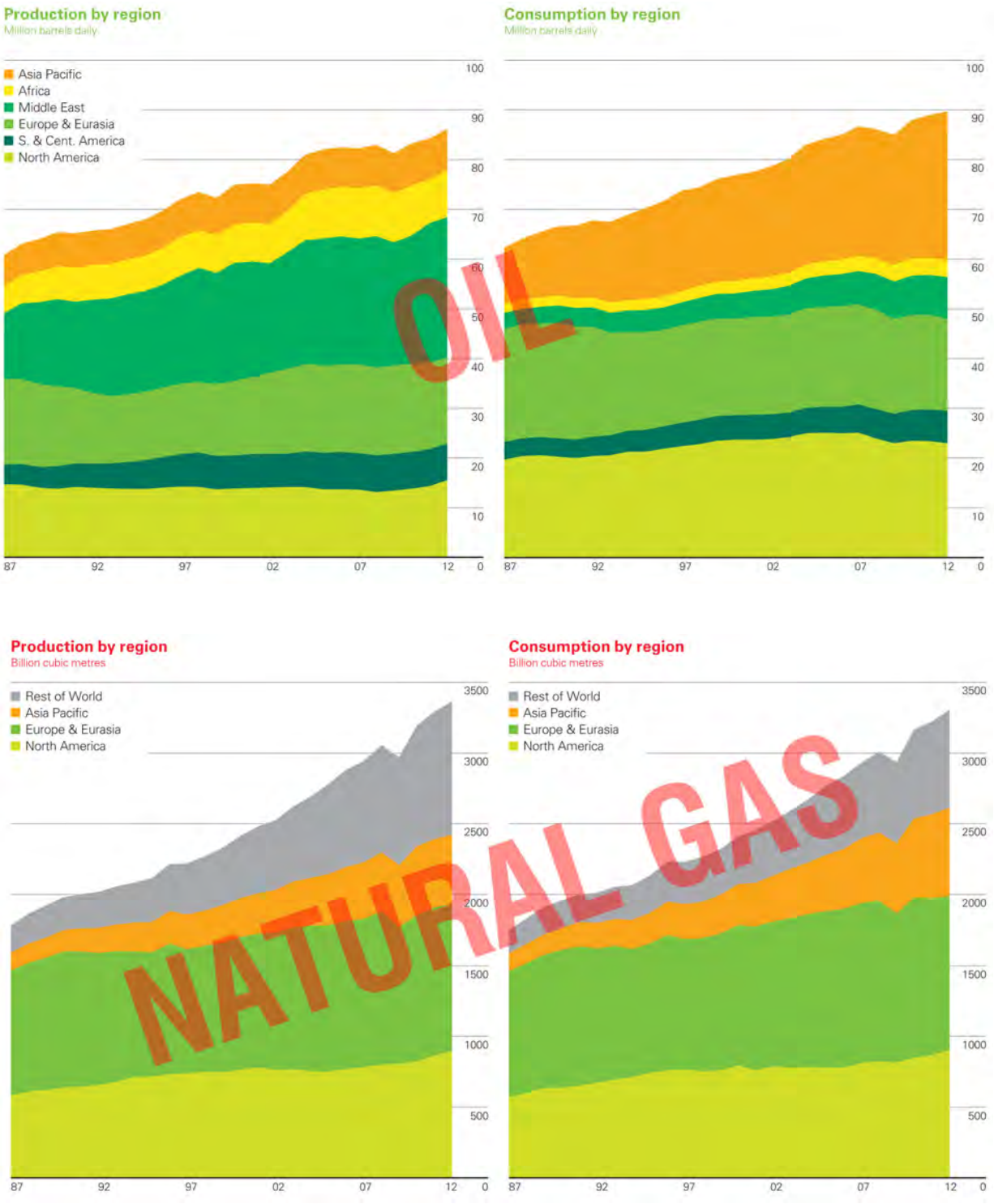
GLOBAL DEMAND AND THE ROLE OF US OIL & GAS

While the entry of US shale oil production will not upend the market, it will address rising demand. With the United States and other OECD countries reducing energy consumption and increasing efficiency, OECD demand for oil is decreasing. However, non-OECD emerging markets are quickly developing a thirst for oil. The top five countries in terms of energy intensity are all non-OECD, with China and Russia leading the pack. As a result, global oil demand continues to rise, threatening higher prices. The question, therefore, is whether unconventional oil development along with higher conventional production can enable supply to keep up with demand.

Increased US onshore production is projected to contribute more than four million barrels per day to global productive capacity between 2012 and 2019.[10] Trailing the United States in new production are Canada's unconventional oil sand development (more than two million barrels per day) and Brazil's offshore development (just under two million barrels per day). Although global productive capacity will decline by approximately 4.5 million barrels per day due to aging oil fields, increases in global productive capacity largely from unconventional sources will still drive approximately 1.4 million barrels per day in annual production growth. In this way, US shale oil production plays an important role in preventing oil prices from rising considerably and threatening economic stability.

FIGURE 4

Production and Consumption of World Oil & Gas



Source: BP Statistical Review of World Energy (June 2013). bp.com.statistcal review

Although shale oil plays a role in promoting economic growth and security, shale gas production promises a much greater impact on global energy. Shale gas will have a larger share of global gas production by 2030 than shale oil of global oil production. While shale oil does not have the dramatic potential to alter the American reserves-to-production ratio (its inclusion only approximately doubles US oil reserve life from 10 years to 20), the inclusion of shale gas resources increases US gas reserve life from around 10 years to nearly 70.

This bodes well for the future prospects of the United States hydrocarbon industry. Oil is expensive relative to other forms of energy. As a result, other forms of energy out-compete oil in every sector they can feasibly enter. This includes industrial power generation, residential power supply, and other lucrative industries. The final bastion of oil supremacy is in the transportation sector, where natural gas is set to make inroads. Currently, 120,000 vehicles in the United States operate on natural gas. In countries like Pakistan, 2.9 million vehicles run on natural gas, representing a staggering 64 percent of their fleet. Infrastructural concerns, particularly those related to the lack of natural gas refueling stations, will prevent natural gas vehicles from ever supplanting traditional gasoline vehicles. However, gradual adoption of natural gas vehicles in certain sectors such as heavy-duty trucking and local service provision (i.e. trash collection) has the potential to add 3.7 billion cubic feet per day of demand for natural gas. This, conservatively, represents a 5.5 percent increase in natural gas demand by 2020. It would also offset 32 million gallons per day of gasoline and diesel, contributing to a shift of 1.4 quadrillion BTUs from oil products to natural gas by 2020.[13]

INFRASTRUCTURE SHORTCOMINGS

Considering that natural gas has yet to develop into a global fungible spot market with a single price, the substantial natural gas reserves in US shale deposits could provide the American natural gas-powered transportation industry a competitive advantage relative to oil and relative to the rest of the world. US natural gas will be cheaper than many of its counterparts for several years, if not longer. Moreover, liquefied natural gas (LNG) – natural gas that has been liquefied to ease storing and transportation – is difficult and expensive to export. Not only do LNG terminals require substantial initial capital investment, but the liquefying process is very costly as well. Only one functional LNG export terminal currently exists in the United States. Cheniere Energy has begun work on two more, with the first expected to begin exporting in 2015 and the second in 2017. Even then, it may take years or even decades before US export infrastructure and market incentives are substantial enough to warrant meaningful and influential contributions of

US gas to the global market.

The United States also lacks infrastructure to cope with new oil production. The US Gulf Coast port and pipeline system was intended to import heavy sour crude from states such as Venezuela and Saudi Arabia to Gulf Coast refineries and then move it throughout the country. Similarly, East Coast ports were intended to import light sweet crude oil from states such as Nigeria and Angola. The oil produced by US shale formations is light and sweet, but the United States lacks the necessary infrastructure to transport and refine it economically. The oil flows most easily to Gulf Coast refineries optimized to process heavy sour crude. Attempting to process light sweet crude instead would be economically inefficient. The Jones Act of 1920 prevents economic shipment of light sweet crude from the Gulf Coast to refineries on the East Coast optimized for its quality. Furthermore, antiquated export regulations prevent meaningful export of excess crude oil except to Canadian refineries. Possible approaches include allowing Gulf Coast refineries to lightly process shale crude in order to allow export as a processed product. Alternatively, mixes of the different qualities of crude can be processed more efficiently than pure light sweet, but less efficiently than pure heavy sour. However, these approaches are sub-optimal, and will result in significantly poorer yields due to the physical limitations of existing refineries. Infrastructural and regulatory barriers in large part obstruct the efficiencies and profits of the US shale oil boom.

The glut of light sweet crude in the center of the United States resultant from these infrastructural and regulatory barriers has an interesting effect on prices. Since the beginning of the US oil boom, the West Texas Intermediate (WTI) index has been at a substantial discount to its equivalent Brent index. Whereas in 2010, WTI and Brent were roughly equivalent at $79.45/bbl. and $79.50/bbl., respectively, they sharply diverged in 2011. WTI was reported at $95.04/bbl., much lower than Brent's $111.26/bbl. The numbers were roughly the same in 2012: WTI dropped to $94.13/bbl. whereas Brent rose slightly to $111.67/bbl.[14] This discount appeared because producers of American shale oil were forced to sell at lower prices because they could not efficiently access the global market. In a fluid commodity market like that of oil, this result is rare and short-lived. A recent article in the Financial Times reported that, as of July 1, 2013, the price differential between WTI and Brent dropped below $5/bbl.[15] This attributable to higher use of freight trains, new pipeline capacity, and refinery startups to ship and produce oil that could not otherwise be transported. Infrastructural development will likely continue until peak efficiency is reached within regulatory constraints.

CONSIDERATIONS FOR THE EXPORT OF OIL & GAS

The tremendous increases in American hydrocarbon production and supply merit examination of US export potential. Currently, United States natural gas producers cannot easily export LNG to countries with which it does not have a free trade agreement. In order to export to non-FTA countries, producers must individually apply for permits through the Department of Energy. This process, although relatively streamlined, dampens LNG export prospects nonetheless. Some of the world's largest LNG consumers, including Japan, do not yet have free trade agreements with the United States.[16] While legislative debate has not yet turned toward lifting these restrictions, the United States is currently pursuing free trade agreements with Japan and other East Asian countries in the form of Trans-Pacific Partnership Agreements (TPPs). As regulatory barriers clear, high LNG production costs will decrease with scale and the United States will become a moderate net exporter of natural gas.

While LNG exporters face relatively moderate export restrictions, the discussion surrounding crude oil exports is much more contentious. The United States passed a law in 1979, known as the Export Administration Act, prohibiting crude oil exports except to Canada and Mexico in response to the 1973 OPEC oil embargo and the supply shock from the 1979 Iranian revolution. Fearing future shocks, the government determined that any excess crude oil produced domestically should either be consumed or stored in the United States. The Export Administration Act remains in force today – in February the Energy Information Administration reported exports of only 124,000 barrels per day, all to Canada.[17] Even if the US government chooses to lift the crude oil export ban, the United States will remain a net oil importer. However, exports will go a long way to relieving the glut of excess light sweet crude supply that is currently driving the discount gap between WTI and Brent.

This debate effectively splits the oil industry in half. Refiners fiercely oppose the prospect of exports – having a supply of artificially cheap crude oil reduces production costs of refined oil and increases profit margins. On the other hand, produc-

FIGURE 5

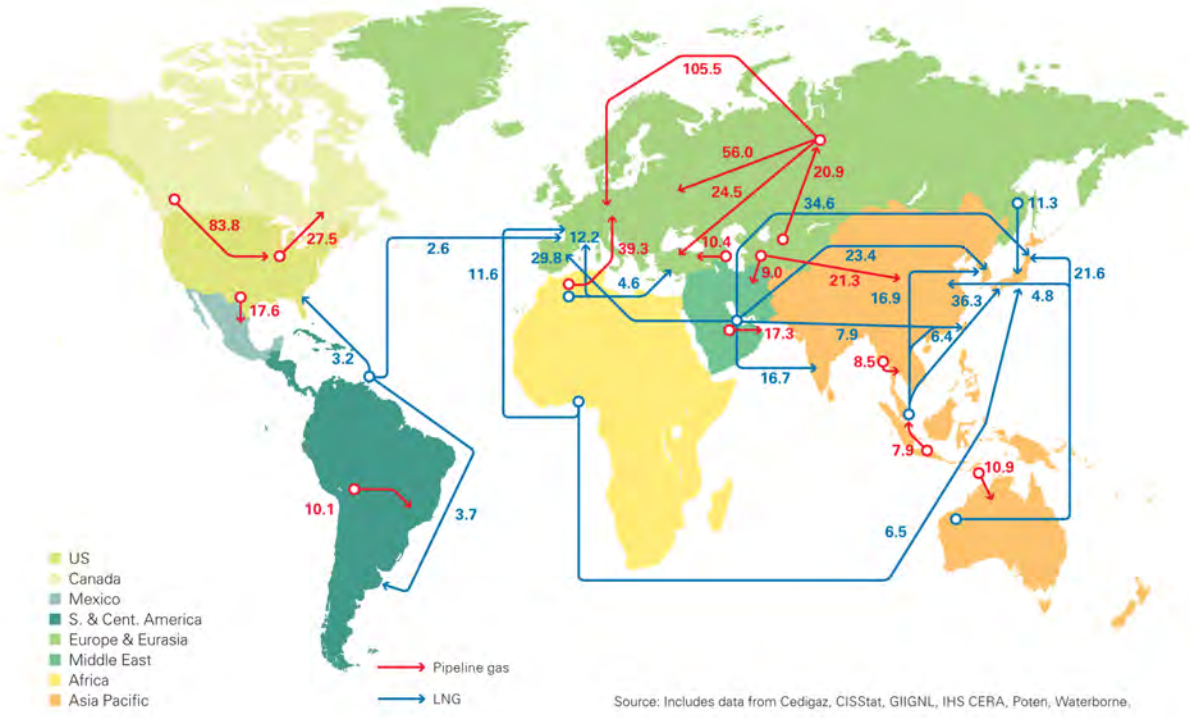


Illustration: BP Statistical Review of World Energy (June 2013). bp.com/statistcalreview

ers of the crude itself are frustrated by export bans because the supply glut forces them to accept prices below the world market. However, this disagreement will likely only persist in the short-run. In the long run, producers will find ways to move crude to market cheaply, minimizing the discount between WTI and Brent and eliminating contention within the oil industry. At that point, oil exports will help drive demand for US oil and spur further technological innovation, enabling growth of the American oil industry.

American exports, particularly of natural gas, have important implications for international energy trade. The combination of increased Middle Eastern LNG sales to Europe, diversified Russian trading partners, and US export potential greatly increases the elasticity of global natural gas supply. With so many producers capable of redirecting product at the behest of market forces, the possibility of a "Gas OPEC" arising between hostile states such as Russia, Iran, and Venezuela will be eliminated. As a result, regardless of the increasing utilization of natural gas, no organization of countries will be able to manipulate supply for political ends. This is of tremendous importance for the United States and its allies.

MACRO EFFECTS ON THE US ECONOMY

If the US oil and gas boom proceeds according to trend, it will have tremendous implications for the health of the American economy. Conservative estimates suggest the boom has the potential to create as many as 1.7 million new jobs. Other estimates predict as many as 3 million new jobs arising as a result of increased hydrocarbon production. These jobs are not exclusively directly involved in hydrocarbon extraction. Moody's reports that only a quarter of new shale jobs are attributable to energy companies themselves, while the remaining 75 percent come from related support industries.[18] This includes jobs in steel production for pipes and jobs in heavy-duty trucking for transportation. Jobs directly related to oil and gas extraction also pay extremely well relative to the national average – average yearly income in the sector is just under $150,000. The results of these added jobs and new production are striking. Experts project a boost in GDP of

between 2 and 3.3 percent attributable to unconventional hydrocarbon development, equivalent to between $370 and $624 billion. Of this, approximately $274 billion comes directly from greater hydrocarbon output by the energy industry, while the remainder arises from multiplier effects as demand for a variety of products increases, individuals increase spending, and companies increase investment.[20]

REGULATORY CONSIDERATIONS & CONCERNS

Although as of now, the oil and gas boom looks to proceed unhindered, potential regulations could still stall growth. Common to both oil and gas is the need for the government to continue opening up federally owned lands for exploration and production. While individually owned mineral rights fueled the initial boom, more exploration is needed to continue growth. Large oil and gas companies also fear any kind of environmental disaster that would bring government focus onto exploration, drilling, or production.

Some Americans have aired a variety of concerns about the impact of oil and gas production on ecosystems, communities, and the global climate. For natural gas, these concerns focus on the actual processes of horizontal drilling and hydraulic fracturing. At this early stage in the boom, there are many smaller marginal producers of hydrocarbons trying to enter the market. Vulnerable to price drops, these companies face strong temptations to cut corners in their drilling practices. If wells are drilled irresponsibly with insufficient safeguards, there is a possibility of either gas or fracking fluid leaking into underground aquifers and contaminating the water supply. This is particularly pertinent in more populated areas such as Pennsylvania where drilling in the Marcellus Shale passes through aquifers used by larger populations. To date, there are no confirmed cases of groundwater contamination from hydraulic fracturing, despite widespread use of the practice since the 1940s. If, however, there were to be a clear link between natural gas extraction and groundwater contamination, the government would be hard-pressed to avoid imposing restrictive regulations. In this case, the entire industry would suffer.

Shale oil development faces even greater opposition. In addition to resistance to the extraction process, oil producers also have to assure oil regulators that oil transportation is safe. Fears surrounding the development of the Keystone XL pipeline mirror greater opposition to the expansion of the US pipeline network. Opponents warn that a spill could severely damage local ecosystems and cost millions to clean up. While recent reports indicate that the oil flowing from Canadian oil sands is no more likely to cause corrosion in a pipeline than crude from any other source, reservations against the pipeline remains steadfast. If the Keystone XL pipeline fails to gain governmental approval, other pipeline projects in the United States aimed at improving aging infrastructure and enabling more efficient transport of American crude may also be derailed. Pipelines are not necessary to the growth of the American oil industry. However, the alternative transport method, by freight train, is far less efficient and much more expensive, not to mention accompanied by its own safety risks. The unconventional oil industry faces even stronger opposition to non-shale extraction. For instance, the BP Deepwater Horizon crisis soured many on offshore drilling. Further governmental regulations have the potential to handicap continued development of unconventional oil resources.

Geostrategic Implications

The North American energy revolution has already begun to influence national security considerations for the United States in a variety of areas. In many ways, the global response to the US oil and gas boom has moved more quickly than expected—geopolitical impacts of these new considerations can be seen even now, before the US has begun exporting. Certain countries such as Japan have proven more amenable to the Iranian sanctions regime than predicted, reflecting an expectation that the United States will be able to make up for shortfalls in hydrocarbon supply. Japan, along with several other Asian nations, has shown tremendous interest in negotiating terms for the Obama Administration's Trans-Pacific Partnership as an avenue to gain free-trade access to future American hydrocarbon exports. With the United States now viewed internationally as a potential energy supplier rather than buyer, new trade interactions and negotiations can be increasingly viewed through the lens of energy politics.

MIDDLE EAST CONSIDERATIONS

A popular assumption associated with the prospect of North American energy independence stipulates that, no longer relying on OPEC -supplied oil, the United States will withdraw its military and/or diplomatic presence in those states. Authorities in the Middle East subscribe to this notion, convinced that US involvement in the region is strategic rather than incidental, and viewing any US behavior as fitting into that narrative. They predict the US will adopt an isolationist posture in foreign policy. However, a variety of factors counsel against this move. Leonardo Maugeri (2012) points out that even in the aftermath of World War II, when the United States was relatively self-sufficient in terms of fossil fuels, Middle East policy remained an area of importance in forming diplomatic strategy. While then the United States' primary diplomatic motivations surrounded obstructing the spread of Soviet influence in the region, equally important considerations remain in play today.[21] Despite the potential of North America's resources, US hydrocarbon suppliers and consumers will not be insulated from the global market.[22] Private companies will inevitably export and import hydrocarbon products, tying the United States energy market to that of the world. As a result, prices, supply, and demand for both oil and gas will continue to draw cues from the internal and external politics of potentially unstable supplying states. Maintaining an American presence in the Middle East tasked with a stability mission will reduce the volatility inherent to hydrocarbon markets.

A closely related issue concerns US policy toward Iran. Iran's historical position in its region and single-minded quest to acquire nuclear capability is greatly concerning for US interests in the Middle East. Iran has the potential to act as a regional hegemon – disruptive to Middle Eastern stability should it continue to grow in power. The oil embargo against Iran is already adversely affecting its largest industrial sector. United States development of natural gas will amplify these effects. Reduced American demand for LNG will stifle the development of the Iranian LNG export sector by shrinking global demand. Without the power conferred by hydrocarbon exportation, Iran cannot leverage its natural resources as effectively for regional power or as a bargaining chip protecting its nuclear program. Furthermore, the promise of US hydrocarbon exports enables other countries dependent on Iranian resources to support strict international sanctions on Iran without condemning themselves to fossil fuel shortages. This strengthens the international community's hand, and further hinders the development of an Iranian nuclear weapon.

US-CHINA RELATIONS

The implications of the American energy boom for the US-Chinese relationship are particularly fascinating given China's growing role as America's primary geopolitical competitor. Before reports of the United States' tremendous wealth of retrievable hydrocarbons reached their current levels, discussion portrayed China and the United States competing in a zero-sum game that would inevitably end in a clash. Today, the United States' decreasing reliance on the Middle East for hydrocarbons appears to be easing tensions between the two. Medlock, Jaffe, and Hartley (2011) predict that reduced competition between the two powers in the Middle East will result in reduced geopolitical competition between the two overall.[23]

However, questions remain concerning responsibility for security in the Middle East and of the two powers' global roles. The United States will maintain a stake in safeguarding Middle Eastern security, among other reasons, in order to stabilize the region's effect on global hydrocarbon prices. Simultaneously, China will continue to demand increasing supplies of Middle Eastern hydrocarbons.

While China has discovered significant shale oil and shale gas resources in its own territory, a variety of roadblocks prevent it from producing meaningful quantities. Many of the areas sitting on the greatest shale oil and gas reserves face severe water shortages. While early-stage waterless fracking has been used successfully in West Texas, the technology is not yet widespread enough to enable use of alternative methods in China. As a result, much of China's shale resources are unrecoverable. China also faces tremendous infrastructural obstacles. Even if China manages to recover its significant natural gas reserves with new fracking techniques, its meager pipeline system has insufficient capacity to bring that gas to market. While China is famous for speedy and efficient infrastructural development, this represents an expensive hurdle for developing its hydrocarbon industry. To make up for these shortcomings, China is poised to become one of the largest markets for

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America's energy security paradigm has collapsed. For decades, politicians have promised that if we only drill for more oil or learn how to use less of it, we will pay less at the pump. We've done both: We drill more than ever and our vehicles are more fuel efficient than ever. As a result since 2005, U.S. oil import dependency dropped from 60 percent of demand to 36 percent today. Yet over the same period of time the price of crude has doubled and the amount Americans spend on oil imports has skyrocketed. How come?

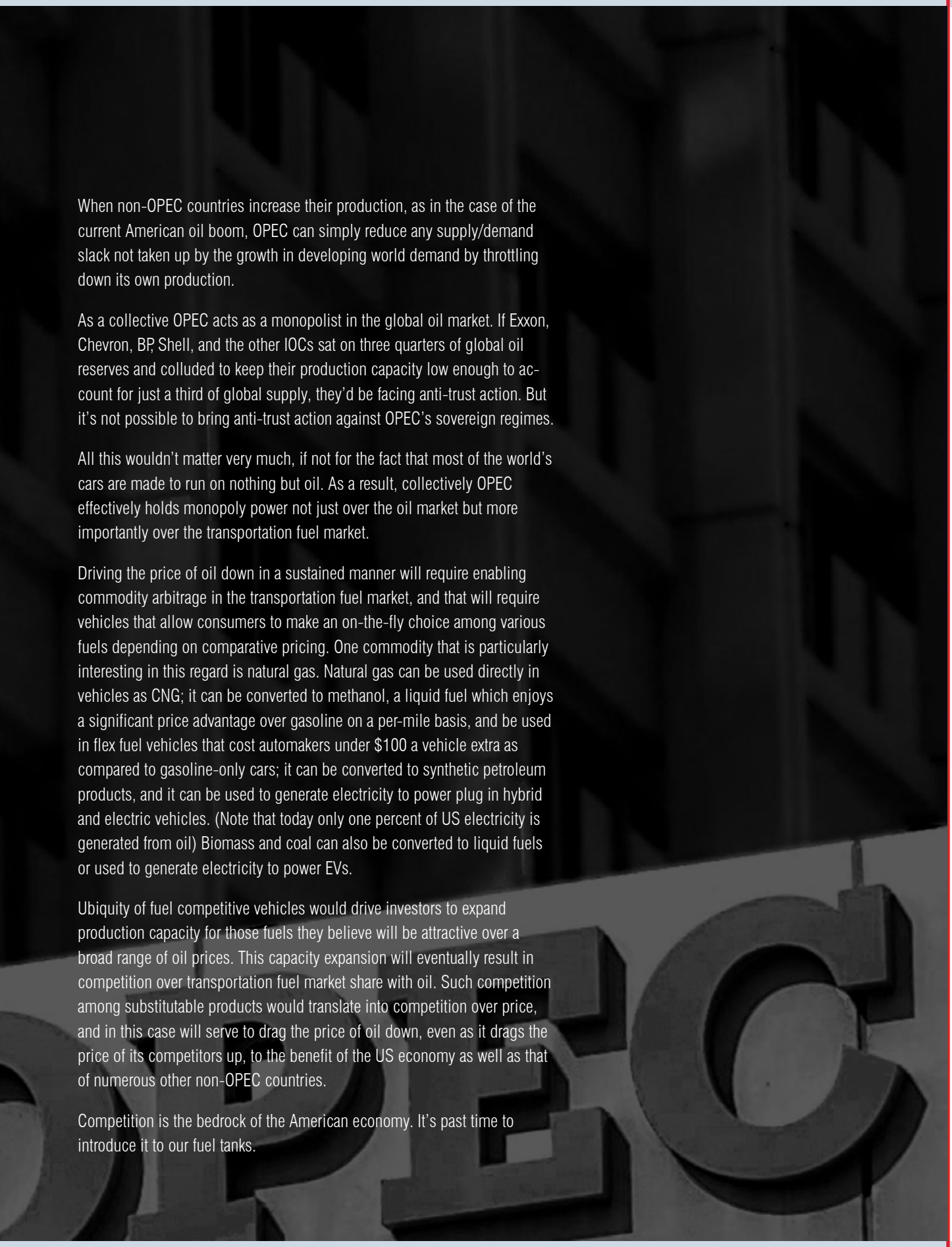
Oil is a fungible commodity with a global market. Price is determined by what happens in the global market, not just domestically. While oil production has increased and oil consumption has decreased in the U.S., this has not been the case in the global market.

One often ignored determinant of oil price trajectory is the fiscal breakeven price for the pricing doves within the Organization of Petroleum Exporting Countries, most specifically Saudi Arabia.

While the U.S. has never imported more than 15 percent of its oil needs from the Persian Gulf, that region more than any other determines global oil price. In the wake of the Arab Spring, the budgetary expenditures of key OPEC members, wishing to avoid the fate of Mubarak as protests flared through the region, have soared as royals lavished subsidies, grants, and salary increases on their subjects. Since the primary income for these regimes stems from energy exports, the revenue from their oil sales needs to go up in order for them to balance their budgets. The OPEC oil cartel's preferred method of achieving higher income is to keep supply tight: sell less oil and make more money per barrel.

Consider this: Over the past four decades global vehicle numbers have quadrupled and world oil demand has nearly doubled, yet OPEC supplies today 30 million barrels of oil a day (mbd), almost the exact amount it produced in 1973. The cartel has constrained production capacity to the point that despite holding some three quarters of global conventional oil reserves and enjoying the lowest marginal cost of production it accounts for only about a third of global oil supply.

OPEC's exports are further constrained by its members' growth in oil demand due to domestic fuel subsidies. For example, despite having a smaller population than Canada or France, Saudi Arabia ranks as the sixth largest oil consuming country. With more barrels demanded by the local market, fewer are allocated for export.



When non-OPEC countries increase their production, as in the case of the current American oil boom, OPEC can simply reduce any supply/demand slack not taken up by the growth in developing world demand by throttling down its own production.

As a collective OPEC acts as a monopolist in the global oil market. If Exxon, Chevron, BP, Shell, and the other IOCs sat on three quarters of global oil reserves and colluded to keep their production capacity low enough to account for just a third of global supply, they'd be facing anti-trust action. But it's not possible to bring anti-trust action against OPEC's sovereign regimes.

All this wouldn't matter very much, if not for the fact that most of the world's cars are made to run on nothing but oil. As a result, collectively OPEC effectively holds monopoly power not just over the oil market but more importantly over the transportation fuel market.

Driving the price of oil down in a sustained manner will require enabling commodity arbitrage in the transportation fuel market, and that will require vehicles that allow consumers to make an on-the-fly choice among various fuels depending on comparative pricing. One commodity that is particularly interesting in this regard is natural gas. Natural gas can be used directly in vehicles as CNG; it can be converted to methanol, a liquid fuel which enjoys a significant price advantage over gasoline on a per-mile basis, and be used in flex fuel vehicles that cost automakers under $100 a vehicle extra as compared to gasoline-only cars; it can be converted to synthetic petroleum products, and it can be used to generate electricity to power plug in hybrid and electric vehicles. (Note that today only one percent of US electricity is generated from oil) Biomass and coal can also be converted to liquid fuels or used to generate electricity to power EVs.

Ubiquity of fuel competitive vehicles would drive investors to expand production capacity for those fuels they believe will be attractive over a broad range of oil prices. This capacity expansion will eventually result in competition over transportation fuel market share with oil. Such competition among substitutable products would translate into competition over price, and in this case will serve to drag the price of oil down, even as it drags the price of its competitors up, to the benefit of the US economy as well as that of numerous other non-OPEC countries.

Competition is the bedrock of the American economy. It's past time to introduce it to our fuel tanks.

Middle Eastern LNG and Russian pipeline gas.[24] This creates a potential flashpoint between American and Chinese interests in the greater Middle East. However, the degree of this conflict will be determined by a variety of geopolitical and economic factors beyond energy politics.

EURO-RUSSIAN RELATIONS

Reduced American dependence on Middle Eastern hydrocarbons will have far-reaching implications worldwide. Middle Eastern LNG suppliers such as Qatar are looking for buyers elsewhere in Europe and Asia. This diversification is a particularly tough blow to the Russian national oil and gas company Gazprom. An influx of LNG into European states breaks the tremendous market share held by the Russians on gas supply and significantly reduces its pricing power. Medlock, Jaffe, and Hartley (2011) predict Russia's market share in non-former Soviet Union Europe will decline from 27 percent in 2009 to just 13 percent by 2040. Of all the planned pipelines between Russia and the rest of Europe, it is likely only the Nordstream will come to fruition in the face of decreased demand for pipeline gas.[25] This is a positive development for American interests in the region. Reduced Russian energy control over Europe greatly lessens Russia's power over the region's politics, and the fear of Gazprom shutting down its pipelines for political leverage will be a thing of the past.

Russian oil exports will continue to expand to China and other East Asian markets. It is likely that Gazprom will construct

FIGURE 6

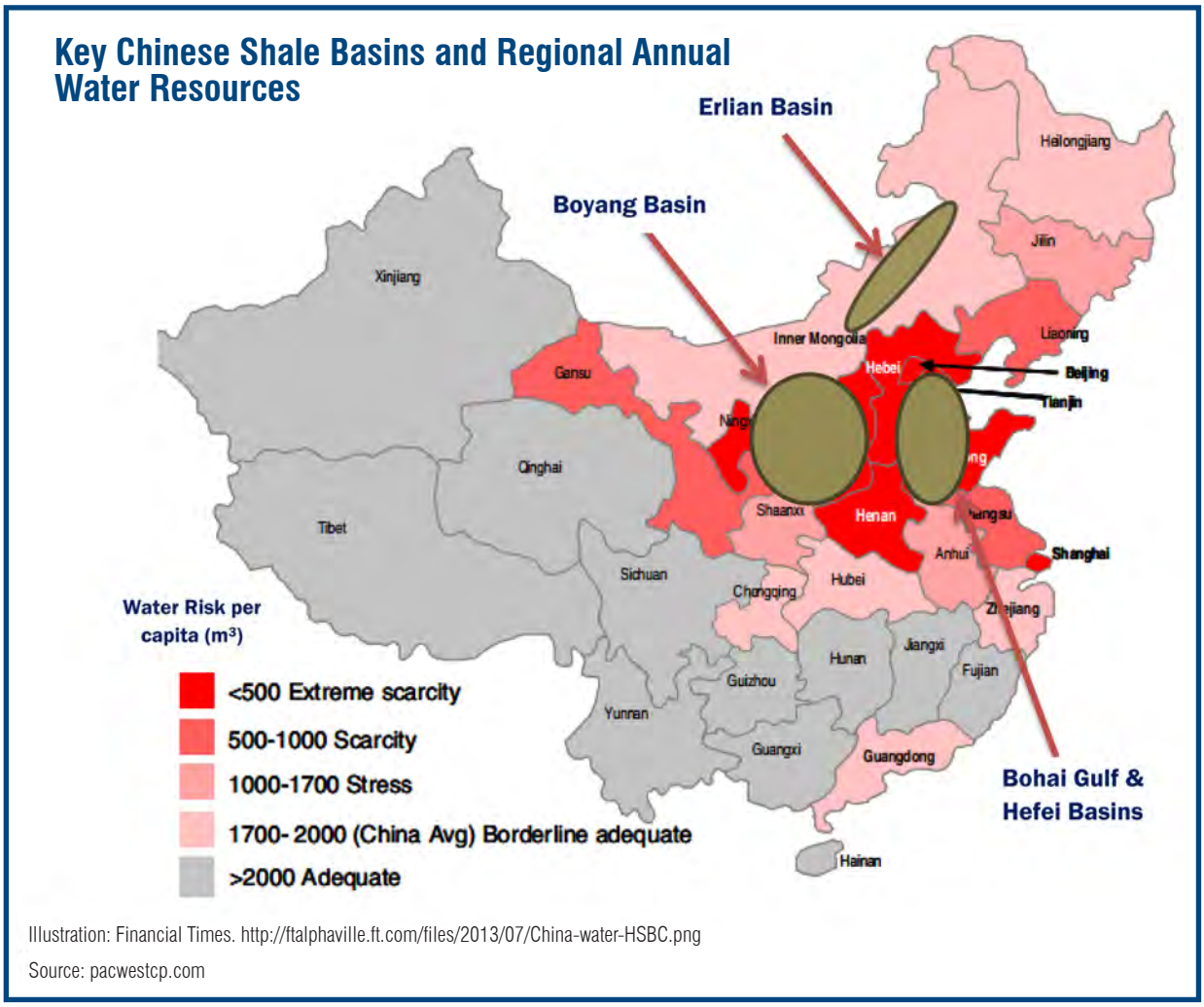


Illustration: Financial Times. http://ftalphaville.ft.com/files/2013/07/China-water-HSBC.png

Source: pacwestcp.com

a trans-Siberian pipeline in order to fulfill growing demand in the region. However, the loss of European market share threatens the energy-based Russian economy nonetheless. A report by the Russian Academy of Sciences' Energy Research Institute warned that Russian oil exports could drop as much as 50 million tons per year relative to current forecasts by 2040.[26] This would contribute to a precipitous drop in Russia's energy-based GDP, from nearly 25 percent today to 15 percent in 2040. Though not insurmountable, this development is certainly concerning for Russian policymakers, even as they continue to deny the legitimacy of these concerns.

CENTRAL ASIAN DEVELOPMENT

The only potential geostrategic downside of American shale hydrocarbon development is its effect on Central Asian and Caspian gas producers. The planned Nabucco pipeline will likely be rejected as commercially and economically infeasible in the face of reduced American consumption of foreign hydrocarbons and diversified European demand. Its chances are further reduced by the recent approval of the Trans-Adriatic Pipeline (TAP). As a result, countries with gas reserves that would have fed Nabucco will not develop their gas fields as extensively, hindering opportunities for economic development. Furthermore, Central Asian and Caucasus gas producers looking to export to China will face strong competition from Russian gas. This will strain relations between the regions and further threaten American goals for development.

However, recent discoveries of colossal natural gas fields in the Levantine basin off the coasts of Israel, Egypt, Jordan, Cyprus, and Turkey promise development of natural gas infrastructure in the Eastern Mediterranean. Regardless of whether that comes in the form of LNG export terminals in Cyprus and Israel or a pipeline through Turkey, this has the potential to bring Iraqi, Central Asian, and Caspian gas to market in the future.

WESTERN HEMISPHERE IMPACT

The United States oil and gas boom has equally important implications for diplomatic and trade relationships in the Western Hemisphere. US oil reserves are overwhelmingly comprised of light sweet crude oil, ideal for use as transportation fuel. However, heavy crude comprises an equally vital part of the US energy mix, fueling American industry. Therefore, the United States must continue to import heavy crude. The most geopolitically ideal trade partner for this purpose would be Canada—heavy crude from Canadian oil sands will fulfill the United States' needs and further the prospect for North American energy independence. Simultaneously, this will shore up relations between the US and Canada as American consumers power a major part of the Canadian economy. This is particularly important because the United States currently imports heavy crude from states such as Venezuela and Saudi Arabia. While the latter is a relatively reliable trade partner, the former goes to great lengths to maintain poor relations with the United States. Independence from trade with Venezuela will protect US national security while putting significant pressure on the recalcitrant Venezuelan government.

Improved and expanded US-Canadian oil relations may also affect Mexican energy policy. Mexico's government-monopolized oil company struggles to gain sufficient revenue to invest in deep-water drilling in the Gulf of Mexico. Fearing exclusion from the rapidly growing North American energy economy, Mexico's new government may look into privatizing its oil industry. This would allow joint exploration, development, and production ventures between American and Mexican oil companies in the Gulf of Mexico. Mexico's economy will receive a significant boost, potentially strengthening the government's hand in combatting the poverty-driven violence that plagues both Mexico and the southern border of the United States. In this way, North American energy cooperation will both strengthen American security and secure a positive relationship with Mexico.

US-Mexican energy relations do not only rely on deep-water oil development; they are now increasingly tied to natural gas as well. A recent article[27] in the Financial Times suggested that American natural gas gave Mexican manufacturers a competitive edge over countries like China with both higher labor and energy costs. United States gas exports rose 19 percent over the past year to 620 billion cubic feet. This exceeds the capacity of natural gas pipelines between the two countries, forcing Mexico to purchase more expensive LNG. This provides tremendous economic incentive to build new pipelines, connecting the two countries further and fueling Mexican development.

Finally, the American oil and gas boom will have important effects on US military preparedness and operations. Ideally,

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The wave of optimism around the hydrocarbon boom is not limited to the United States and Canada. New opportunities in the exploration, investment, and trade in oil and gas have Latin America buzzing as well. Significant shale deposits in Brazil, Colombia, Mexico, Argentina, and Venezuela promise to bring the shale boom south of the United States' borders, ushering in a new era of revitalized Latin American energy productivity.

Already, numerous countries have recognized Latin America's great energy potential. In just the past few years alone, countries such as Russia, China, Iran, and Vietnam have developed a significant presence in the region, filling a vacuum in an area that has historical animosity toward the United States. Foreign investment is focusing on both unconventional resource development and untapped conventional resources. China, in particular, has invested strongly in the future oil production of Ecuador and Venezuela – and of Argentina and Bolivia to a lesser extent. Meanwhile, Russian presence in Bolivia is growing rapidly along with Russian investment.

As the United States ramps up its production of hydrocarbons, its demand for Latin American hydrocarbons will decrease. This has particular implications for Venezuela and Ecuador, whose economies have become reliant on oil exports to the United States. However, the US shale boom arrived nearly simultaneously with astronomic economic growth in China and East Asia. As the hydrocarbon-driven economies of the Far East ramp-up manufacturing and consumption, demand for Latin American oil and gas will also increase. Increased Chinese demand will likely counter-balance decreased demand from North America, and the Latin American hydrocarbon industry and overall economies will continue to grow.

Decreased reliance on American imports of Latin American hydrocarbons, however, does not foreshadow the end of relationships between the two. On the contrary, connections between the US and Latin America could increase for two reasons. First, the United States will be seen as an increasing competitor to current energy-rich countries in Latin America. As an example, potential American natural gas exports to Brazil would directly compete with resources from Bolivia and Trinidad and Tobago. Good or bad, the competition will drive interconnection in the Western Hemisphere. Second, United States companies possess the technology and expertise needed by countries like Brazil, Colombia, Mexico, Argentina, and Venezuela to exploit their shale reserves. Without US advances in the oil and gas industry, these countries will struggle to develop their unconventional resources. Tension between the US and many Latin American countries will not change as each of their resources comes on-line, but economies will prosper if technology and expertise is shared.

The discovery of colossal pre-salt oil reserves off the coast of Brazil in 2006 immediately decreased Brazil's reliance on foreign sources - upsetting their highly-touted and well-funded ethanol sector that was their initial response to painfully high oil prices. This marked resurgence in Latin American's optimism for the production of traditional fuel. Indeed Latin America has yet to fully enter into its own unconventional oil and gas boom, but the potential is tremendous.

the US military will transition bases to run on microgrids that could be powered at least in part by natural gas. Additionally, the increased security of supply of both shale oil and shale gas promises a more robust support base for military operations in the event of major external supply shocks. Prolonged US military effectiveness will no longer hinge on the politics of potentially unstable hydrocarbon supply states. In this light, the military will likely reorganize and reprioritize force deployment to reflect the United States' new status as a world-class hydrocarbon producer.

EFFECTS ON AFRICA AND OPEC

The US oil and gas boom will not necessarily proceed unhindered and accepted by the international community. It affects all current producers of oil and gas negatively to an extent, particularly African states relying heavily on exports to the United States. In Nigeria, 95 percent of foreign exchange earnings and 80 percent of budgetary revenue come from the oil sector. Because the quality of American shale oil is so similar to West African crude, American imports of African oil fell 41 percent between 2011 and 2012.[28] This deals a blow to the continued economic vitality of these states, although the nature of the global oil market will likely redirect these exports to areas with rising demand.

Of all the international bodies affected by the unconventional oil and gas boom, OPEC is the most directly threatened. There is much speculation on their response. A recent article in Forbes[29] suggested OPEC could ramp up production of oil in order to lower crude prices and drive marginal US producers out of business. This makes sense – in a world of surging supply, more slowly increasing demand, and decreasing prices, OPEC will not willingly cede its market share to fledgling American producers. Even if OPEC maintains current levels of production, leaving its spare capacity untouched, some argue the resultant effect on prices will be equivalent to a knockout punch for marginal producers.

However, others point out that if OPEC had wanted to engage in predatory pricing, it should have done so earlier. Today, if oil prices make tight oil extraction uneconomical, producers, given the right incentives, can simply switch to natural gas instead. This would both preserve drilling infrastructure for the future and reduce overall demand for oil as industry seeks to find new ways to replace oil with cheaper and more abundant natural gas. Furthermore, larger American oil companies capable of maintaining profits in the face of cheaper oil would snap up marginal producers in expectation of the future value of American tight oil. This eliminates the marginal producer risk and insulates the American energy industry to a degree from external shocks, ensuring the return of hydrocarbon exploration and production once OPEC finds itself unable to continue artificially high production. Finally, it is important to consider the structure of the oil market. While in a competitive marketplace, shocks to cost precede changes in price, in the oil market, changes in price alter cost structures. It is therefore too simplistic to assert that there exists a particular price floor below which US producers can no longer exist – US producers have significant scope to reduce costs in order to remain in production.

CONCLUSION

The United States shale boom is unique, from its origins to its tremendous global implications. The combination of accessible geology, cost-effective technology, and a robust support and investment system fostered a new industry not replicable anywhere else in the world. The boom helps meet rising demand for hydrocarbons in the developing world by increasing global supply elasticity. New jobs are invigorating the American economy and the United States might even become an energy exporter for the first time in decades. Moreover, the US security portfolio is adapting. The world now treats the United States as an energy producer, assigning it even greater geopolitical significance. Meanwhile, decreasing American foreign energy imports is forcing global market realignment and with it tremendous changes in international politics. US policymakers must keep abreast of these issues. As regulatory and environmental concerns are addressed, the American energy industry is surging ahead. Though little is certain in this constantly changing environment, the one certainty is that the United States is experiencing an unexpected, and encouraging, shift in energy security.

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