

Adapting to Plenty: Effects of the Oil and Gas Boom



Bill White, Chair
Leonard Coburn, Rapporteur

Adapting to Plenty: Effects of the Oil and Gas Boom

2014 Global Forum on Energy, Economy and Security

Bill White, Chair

LEONARD COBURN, RAPPORTEUR

For additional copies of this report, please contact:

The Aspen Institute
Publications Office
2014 Carmichael Road
P.O. Box 222
Queenstown, MD 21658
Phone: (410) 820-5326
Fax: (410) 827-9174
E-mail: publications@aspeninstitute.org
Web: www.aspeninstitute.org/eee

For all other inquiries, please contact:

The Aspen Institute
Energy and Environment Program
One Dupont Circle, NW
Suite 700
Washington, DC 20036-1193
Phone: (202) 736-2907
Fax: (202) 467-0790

David Monsma
Executive Director

Nicole Alexiev
Deputy Director

John A. Riggs
Senior Fellow

Timothy Olson
Senior Project Manager

Avonique De Vignes
Project Assistant

Copyright © 2014 by The Aspen Institute

The Aspen Institute
One Dupont Circle, NW
Suite 700
Washington, DC 20036-1193

Published in the United States of America in 2014
By The Aspen Institute

All rights reserved

Printed in the United States of America

14/018
ISBN: 0-89843-612-5

Table of Contents

Foreword	v
The Challenge of Energy Abundance.....	1
Global Outlook.....	5
Technology and Investment	7
Oil and Gas Technology	7
Investment	9
Vehicle Technology and Oil Demand	10
Energy Security in an Era of Abundance.....	11
Infrastructure	15
Global Issues Coping with Scarcity or Abundance.....	17
European Dilemmas.....	17
Mexican Reforms	19
Middle East	21
Foreign Direct Investment in the United States	22
Natural Gas Development in the United States	25
Reliability.....	25
Public perceptions	26
Environment.....	26
LNG Exports.....	28
FERC Regulation	29
Conclusion	31

Appendices

Agenda.....35

Participants.....39

Foreword

In 2005, the Forum on Global Energy, Economy, and Security spun off from the Aspen Institute's long-running Energy Policy Forum to allow a more concentrated focus on international oil and gas and their relationship to economic and security issues. The Forum includes about 70 invited energy leaders, primarily from industry and government.

The goal of the Forum is to encourage new, collaborative, cross-disciplinary, and non-partisan thinking among people with diverse experiences, disciplines, and views. Each half-day session is introduced by brief presentations, with the majority of time reserved for informal and candid dialogue. To encourage candor and create a safe place to explore ideas, all discussions are off the record.

As in the previous two years, the 2014 Forum focused on the durability and the implications of the North American oil and gas boom. Individual sessions examined additional opportunities for production and the challenges of achieving them, international impacts of new North American production, the changing rationale for U.S. energy security measures, the prospects for and the problems of growing U.S. natural gas production and possible exports, and the midstream and downstream impacts of the production boom.

Once again Bill White chaired the Forum. As Chairman of Lazard Houston, former Houston Mayor and Deputy US. Energy Secretary,

energy industry executive, and attorney specializing in energy-related matters, he brought deep knowledge and a breadth of experience to the task. A highly qualified group of speakers provided a wealth of information and a variety of perspectives, and the diverse expertise of a particularly well-qualified group of participants added to the richness of the dialogue.

Leonard Coburn wrote this report, as he has done for each of the ten Global Energy Forums. Although no summary can do justice to a wide-ranging and detailed discussion, his extensive knowledge of energy enabled him to understand and capture the highlights and to present them in understandable language. I also thank Avonique DeVignes, whose efficient and good-natured handling of the administrative arrangements contributed to a pleasant and smoothly run Forum. Timothy Olson, who managed the logistic of the Forum for several years, ably assisted her this year while organizing other meetings.

The Aspen Institute acknowledges and thanks the following Forum sponsors for their financial support. Most have been participants and supporters for multiple years. Without their generosity and commitment to our work, the Forum could not have taken place.

Schlumberger	Statoil
Aramco Services	Sempra
Bracewell & Giuliani	Trafigura
Cheniere	TransCanada
ConocoPhillips	Van Ness Feldman
Lazard	

This report is issued under the auspices of the Aspen Institute, and the Forum speakers, participants, and sponsors are not responsible for its contents. Although it is an attempt to represent views expressed during the Forum, all views expressed were not unanimous and participants were not asked to agree to the wording.

John A. (Jack) Riggs
Senior Fellow
Energy and Environment Program

Adapting to Plenty
Effects of the Oil and Gas Boom

Leonard Coburn
Rapporteur

The Challenge of Energy Abundance

The evolution from energy scarcity to abundance in the United States creates dislocations. Technology, infrastructure, laws, regulations, trade flows, and environmental and security policies developed during American energy deficits must be adapted to cope with its new energy prosperity. Significant improvements in oil and gas technology are leading to production increases outpacing projections. A need for infrastructure development follows energy production, necessitating adaptations. Laws passed in the 1970s during times of energy disruptions require reconsideration in a period of relative plenty. The shift of the United States and Canada from an oil and gas importing region to an exporting region has enormous global implications. Policies need to be readjusted in light of new realities, and the effects of the oil and gas boom in North America will require new thinking by governments, industry and consumers.

Global Outlook

The North American boom is taking place in a changing global context. The outlook through 2035 projects a shift in energy consumption and production from west to east and from the industrialized world to emerging economies. Overall energy consumption is expected to climb by about forty-one percent through 2035; ninety-five percent of this growth will come from emerging economies, principally China and India. The Asia-Pacific region will come to dominate both energy production and consumption during the next two decades. By 2035, North America will become the second largest regional producer. North America will move from energy importer to exporter by 2018, due to American and Canadian oil and gas production increases. Significant changes in the global LNG market will occur as Australia replaces Qatar as the largest LNG exporting country by 2019, followed by the United States overtaking Qatar in 2030. The Middle East will continue to be a significant energy producer; however, Africa will overtake it by the end of 2035.

China's energy requirements in liquids, gas, coal, nuclear and renewables will dominate the world's energy future. By 2029, China will surpass America's liquids demand, becoming the largest global consumer and importer. China's natural gas demand will soar as imports rapidly increase. China will remain the world's largest coal consumer, despite the largest global decline in coal consumption. By 2035, China will surpass European renewables growth and will dominate nuclear power growth.

Europe will continue its trend as a net importer of energy and will be the only region through 2035 where energy production declines. In Europe as globally, liquid demand will continue its downward trend due to increasing transport efficiencies and more natural gas vehicles. Europe's natural gas demand will grow, with gas becoming its dominant fuel by about 2031. Through 2035, indigenous European gas supplies will decline requiring additional pipeline and LNG imports. The shale revolution impacting North America now is expected to have no European impact by 2035, and it will begin in China only after 2020.

Technology and Investment

Oil and Gas Technology

New technology is creating a paradigm shift in hydraulic fracturing (fracking) used for shale gas and tight oil development. The trend is for longer horizontal wells, more fracturing and more wells per pad. New technology has improved average production by twenty percent per well since the 4th quarter of 2010 in several counties in south Texas (the Eagle Ford Formation) while reducing the environmental footprint. Water use was reduced on average by 25 percent per job, and proppant (sand used to force open impermeable rock) by 42 percent, saving more than 16 million barrels of water and 2.7 billion pounds of proppant and avoiding 110,000 road journeys. More than 26 million pounds of production-related CO₂ emissions were prevented.

Overcoming the physical limitations of extraction will be necessary to meet new demand. Technological developments are rapidly dealing with these limitations. Forty percent of wells, stages or fractures, and completions do not produce. The challenge of advanced technology is to reduce the 40 percent nonproductive level. New integrated workflow technology can decrease well costs, increase productivity and efficiency, and reduce equipment usage by up to 50 percent. Well placement is approaching optimal levels. Significant improvements are occurring with well fractures and completions. The goal is to reduce the number of fractures that do not open additional production, resulting in less water and proppant use.

Enhanced technology and increased production can occur only if industry, communities and government create a more robust social contract. State and local governments and the public are demanding smaller environmental footprints and more disclosures on well drilling, hydraulic fracturing and completions. Better understanding of seismicity, the below ground disturbances caused by re-injecting water, is critical. Industry needs to do a better job in communicating and educating to enhance its social contract to operate.

Technological advances are not limited only to shale gas and tight oil production. Deepwater technology is also moving forward rapidly. Prospectively, global deepwater will be the largest new source of production. In the United States, although less than unconventional production, it will add almost 2 million barrels per day (bpd) by 2020.

Deepwater production will be increasingly complex. Water depth will increase by fifty percent from 10,000 feet to 15,000. Water pressure will increase by a third, from 15,000 to 20,000 pounds per square inch. Temperatures will drop from minus 400 to minus 500 degrees Fahrenheit. All these changes will occur in more remote geographies, in extreme climates lacking infrastructure and in politically challenging environments.

The solutions will be complex. The greatest complexity will involve putting all production functions on the seabed rather than splitting them between the surface and seabed. The costs will be high, and cost-effectiveness will be essential. Standardization can assist realization of these goals.

In unconventional onshore development better analytics will be essential. The engineering plan may envision 40 or more fracturing stages, but better analysis may show that only 20 stages are needed, eliminating equipment, water, proppant, and traffic. New tight formation technology will allow operators to understand the reservoir better, lowering risk and increasing production. In deepwater development, new robotics and analysis will be the keys to production gains. Today's projections are likely to underestimate future production levels.

Investment

Advanced technology will require more investment. In previous unconventional development, exploration and production companies averaged more than \$175 billion investment annually onshore and offshore in North America, with \$200 billion expected in 2014. Producers are currently spending more than their cash flow, averaging twenty percent over cash flow for large companies and fifty percent for small companies. By outspending cash flow, producers lower their return on capital. Producers are making money in the Bakken and Eagle Ford, but it is less than expected.

Outspending cash flow occurs due in part to public markets rewarding quarterly increases in production and in part to oversimplification of the complexities of unconventional development, and it results in lower than expected returns on capital employed. Straightforward applications of existing technology can be more complex than engineering predicts. There are delays in accessing services and transportation from the field. Demand exceeds supply in field services, slowing down spending but costing more when it occurs. Backlogs in outgoing transportation can force flaring or more storage, increasing costs and reducing payments from purchasers. Despite their greater efficiencies, multi-well pads lead to uneven, “peakier” production. A series of single wells increases production over time with relatively smooth cash flows. Flows from a four-well pad lead to production spikes as the four wells start producing at closer to the same time, requiring faster capital deployment. Technological improvements reduce drilling times, also requiring faster capital deployment. In Eagle Ford, time to drill and complete a well lessened from 68 days in 2010 to 25 days in 2014, with further reductions to 20 days expected in the near future. Similar reductions occurred in the Bakken.

Companies will continue using joint ventures to access investment funds to accelerate development and bridge the gap between cash flow and investment needs. As operators learn more, cash flow will improve, reducing overspending. Technology advances and

investment are closely tied together, as technological development enhancing efficiencies will improve margins and cash flow.

Vehicle Technology and Oil Demand

Federal Corporate Fuel Economy Standards (CAFE) of 54.5 miles per gallon (mpg) by 2022 are forcing all automobile manufacturers to develop advanced technologies. Improved fuel economy relies on innovations including electric, bi-fuel (compressed natural gas-CNG-and gasoline), hydrogen fuel cells, electric-gasoline hybrids, and advanced internal combustion engines.

Today's electric vehicles with high mpg and zero tailpipe emissions are limited by lack of battery recharging stations, expense, and inadequate battery technology. CNG-gasoline bi-fuel vehicles can be effective in enhancing mileage, but they have limitations due to lack of refueling infrastructure. The cost of fuel cell vehicles has declined to affordable levels, and one manufacturer will be introducing a hydrogen fuel cell vehicle in the near future on an experimental basis. Refueling remains a serious infrastructure issue.

Manufacturers are improving the internal combustion engine to obtain greater fuel economy. The turbocharger is one way to enhance performance and fuel economy. Another is to pair the internal combustion engine with an electric motor in hybrid vehicles and rely on the generation and storage of kinetic energy to recharge the battery.

The latest technological advance is "energy harvesting," a concept being demonstrated in racing cars to recover heat energy and store it. The introduction of this technology in passenger vehicles will be the next big development in the effort to improve fuel economy. Probably the best internal combustion engine on the road today, in one expert's opinion, is one that approaches the fuel savings of energy harvesting. An aluminum frame and chassis are being introduced to lighten the vehicle and further improve fuel economy.

Energy Security in an Era of Abundance

The global energy landscape is undergoing historic transformations. These transformations, occurring as a result of America's oil and gas boom, have significant energy security implications. In the United States, surging crude oil production means lower import dependency and reduced vulnerability to supply disruptions from foreign sources. Oil imports are expected to decline by 2035 to about 1 million bpd or less than ten percent of projected demand. Although North America may achieve oil independence, the United States will not and will continue to be affected by global oil market price increases and volatility.

America's oil supply surge offset outages occurring in Libya, Nigeria, Iraq, Syria, and both Sudans. Offsetting these disruptions provided stability to the global oil market, reducing price volatility. The United States was able to obtain international support for its sanctions policy against Iran by demonstrating that America's reduced need for imported oil would keep the global oil market stable. Since January 2011, U.S. crude production has increased by more than 2.8 million bpd, more than offsetting the 1.2 million bpd decline in Iranian exports.

American policymakers are debating the ban on most crude oil exports in effect since the 1970s. U.S. refiners are finding it difficult to adapt to the increased flows of light sweet oil from tight oil plays, and as a result U.S. light sweet crude has at times been as much

as \$10 per barrel cheaper than Brent. More condensates (oil that is very light, 50 degrees of gravity or higher), which are produced simultaneously with light, sweet oil, are challenging the U.S. refining infrastructure. Some refiners are investing to handle more light oil and condensates. Simultaneously, the United States government has recently loosened the ban on crude oil exports on a very limited basis by allowing some condensate exports technically not considered crude oil.

The U.S. refining sector has invested in two-thirds of world coking capacity and is configured to process domestic and foreign heavy oil. Cokers break down the heavy oil into usable and profitable lighter products such as gasoline and distillates. The configuration of a refinery to process heavy oil limits its ability to process light oil. Once this limitation is reached, the refinery must reduce operational capacity, lowering production and reducing profitability. Two options are available: substantial new refinery investment or export of the crude. The oil export debate centers on refiners' intentions and government policy. Will refiners make the necessary investments to process the surging supply of light oil, or will they restrain investments, creating bottlenecks and pressure to change government policy to permit exports?

Some refiners expect that future investment will accommodate most additional light tight oil. They point to the increasing export of refined products, which are not banned, as being highly profitable. Widening refining margins will reflect the difference between discounted domestic light tight oil prices and high product prices on world markets. They worry that opening the crude oil export spigot will undermine their efforts to invest in new refining facilities as domestic oil prices increase, narrowing refinery margins and profitability.

Others respond that discounted light oil prices resulting from domestic surpluses and export barriers are reducing wellhead prices, profitability, and investment. They argue that allowing greater crude oil exports will lead to more domestic production — as much as 2.5 million bpd more than with the export ban unchanged. Additional

exports will increase global oil supply and lower domestic gasoline prices, since domestic gasoline prices follow world prices. The price of crude comprises about 60 percent of the pre-tax gasoline price.

Opponents of eliminating the crude oil export ban want to maintain the status quo. In their view, exporting refined products is the better option. Global oil prices may not decline with more American crude oil due to OPEC's potential influence over prices. From their perspective, the product market is not subject to OPEC domination and therefore is a freer market.

The debate over the crude oil export ban is primarily based on who benefits and who is hurt. If consumers benefit through lower product prices, greater price stability, and lower disruption vulnerability, policymakers may eliminate the existing ban. If consumers will not benefit and domestic refiners are less profitable, leading to refinery closures and job losses, policymakers likely will opt to maintain the ban.

Infrastructure

One of the greatest impacts of the North American oil and gas boom is on infrastructure. Increased Canadian and American production requires reworking the pipeline and rail infrastructure to meet current and future needs. By one analysis, a total of \$641 billion will be required by 2020 in the United States alone to meet new production from natural gas, crude oil and natural gas liquids. Investment in Canadian crude oil pipeline projects alone could total almost US\$30 billion.

In the United States, crude pipeline construction is lagging despite new and proposed projects. Rail is filling the gap and is now approaching eleven percent of all crude shipments. These shipments are far more costly, as much as double the pipeline cost per barrel. More rail shipments, especially through congested areas, are focusing attention on heightened safety concerns due to a series of accidents, some fatal.

In Canada, crude pipelines are the lifeline for land-locked Alberta oil sands development. Canada projects that by 2030 additional oil sands and conventional production totaling 6.3 million bpd will have to be shipped through new and expanded pipelines. These include the Keystone XL, the Northern Gateway to the Canadian west coast, and Energy East to the Canadian east coast. An expansion of the Trans-Mountain pipeline to Vancouver also is contemplated. The cornerstone of these proposals is TransCanada's 830,000 bpd

Keystone XL pipeline, costing \$6 billion. The decision from the American government on the required permit to cross the border has been pending for more than five years. The company expects a positive decision in early 2015.

Similar issues arise with the development of natural gas transmission pipelines in both the United States and Canada. The American Marcellus play is rejuvenating natural gas production in areas long thought to be played out. As shale gas development surges in this region and the development of pipelines lags, producers are suffering because wells must be shut in or cannot be completed due to insufficient pipeline capacity to the most lucrative markets. In Canada, natural gas pipelines to the west coast and LNG facilities are being proposed, but they face enormous regulatory obstacles.

In the downstream oil sector, refinery closures and capacity reductions eliminated the majority of inefficient capacity, enhancing the profitability of those remaining. Refinery ownership also changed significantly from 2000 to 2013. Today, 58 percent of refineries are owned and operated by independent and private entities, up from 41 percent, while integrated company ownership decreased from 47 percent to 25 percent. This change provided an opportunity for mid-stream companies, operating from wellhead to refinery, to fill the gap left by the withdrawal of integrated companies. Refiners are profiting from low domestic natural gas prices that give them an average \$2.00 per barrel cost advantage compared to foreign competition. The refinery sector is healthy, profitable and growing stronger. Its biggest challenge is new emissions standards.

Global Issues Coping with Scarcity or Abundance

European Dilemmas

European energy markets reflect growing scarcity and insecurity. Recession, increased efficiency and gas-to-coal switching have reduced recent European gas demand since 2008; however, projections to 2035 indicate slow gas demand growth. By 2031, gas will be the dominant fuel, overtaking oil. Indigenous European gas supplies will continue to decline as its pipeline gas and LNG imports increase. Today, Europe is the largest gas importing region. In 2012, Europe imported about 355 billion cubic meters (bcm) (12.5 trillion cubic feet, or tcf) or about 66 percent of total demand of 18.8 tcf. Russian gas comprised the largest portion of imports, about 130 bcm (4.6 tcf) or about 37 percent. Europe's gas insecurity is a result of its relationship with Russia.

The European dependence on Russia is exacerbated by the strained Russian-Ukraine relationship. The European gas market was upended in 2006 and 2009 when Russia temporarily shut off Europe's gas supply transiting Ukraine. Reflecting historical trade flows, about 80 percent of Russian gas to Europe flowed through Ukraine. Russia built two Ukrainian bypasses, Nord Stream pipeline carrying gas directly from Russia under the Baltic Sea to Germany and Blue Stream pipeline transporting gas directly from Russia to Turkey under the Black Sea. Today, Russia ships between 50 to 60 percent of its European gas through Ukraine, comprising just 16

percent of total European gas demand. European energy supply instability is reduced but not eliminated.

Europe is the largest and most important market for Russia's oil and gas, which contribute almost seventy percent of Russia's total export revenues. Oil and gas taxes account for about 50 percent of Russia's budget revenues. Changes in the Euro-Russian relationship can significantly influence Russia's energy demand security and Europe's energy supply security.

Europe's future energy and gas security will depend upon its diversification strategy even without a comprehensive European Union energy policy. In the short term, low-priced coal is replacing gas in electricity generation, but better overall balance is gradually being achieved by replacing coal and gas with more renewables and enhanced efficiency. By 2035, though, gas will surpass coal as Europe's most-used fossil fuel. Europe's climate strategy depends heavily upon its future use of gas. Despite Europe looking beyond Russia for future supplies from the Caspian and more LNG imports, individual country dependency on Russian gas, now ranging from 16 to 100 percent, will remain for the foreseeable future.

Europe must deal with Russia's most recent disruption to its gas supplies. Ukraine is permitting reduced gas flows to European markets as part of its recent cooperation agreement with the EU. How long Europe can withstand any supply reduction is an open question given its storage capabilities and intra-Europe pipeline connections capable of rerouting gas flows. Some Eastern European countries, however, are fully reliant on Russian gas. At some point, particularly during high demand seasons, full Russian supplies will be needed. Russia is proposing another Ukrainian bypass called South Stream that would deliver gas directly to Bulgaria under the Black Sea and onward to Europe. Many in Europe do not want South Stream to proceed since it would cement future reliance on Russia. Caspian gas pipeline options through Turkey and onward to Europe have greater allure since they would reduce dependence on Russia. Policymakers must find ways to manage Europe's gas relationship with Russia; replacing Russian gas is not an option.

Europe is Russia's largest gas market. Unstable demand forces Russia to seek alternative markets. After years of negotiations, Russia and China recently concluded a long-term supply agreement requiring Russia to develop its East Siberia gas fields and build pipelines to China, while China takes responsibility for delivery within its country. This \$400 billion agreement marks a milestone in Russian and Chinese efforts to diversify.

By 2016 the United States will be exporting LNG. Policymakers have speculated that some of these exports could go to Europe, improving European energy security and reducing Russia's influence. In the next five years, however, no American LNG exports are likely to arrive in Europe. By 2020, small volumes will arrive, with larger volumes after 2025. Even if these American supplies reach 12 to 19 percent of overall future European gas demand, Russian gas still will be essential.

Mexican Reforms

The Mexican government passed constitutional reforms in December 2013, which opened up the possibility of private investment in oil and electricity and introduced competition to the electric power industry. These reforms are the beginning of the end of state monopolies that have been in place in oil for 76 years and in electricity for 53 to 55 years.

Today the government is focused on the enabling laws necessary to implement the generic reforms. These discussions are extremely complex, raising many questions not answered in existing legislation. The government also is looking back at the original legislation and is making significant changes due to initial misjudgments. Re-opening the legislative process has its drawbacks, since many are striving to insert pet projects that were not part of the initial legislation. Redrafting and implementation of enabling laws will take longer than expected.

The implementation process requires a decision on how much of the legacy assets will be allocated to PEMEX, the national oil com-

pany. The initial asset allocation is expected to conclude by the end of the third quarter of 2014. Once this asset allocation is made, work can proceed on policy design, regulation and regulatory frameworks, environmental rules, bidding and contract signing. Most of these important steps are not likely to take place before the first half of 2015 with contracts not likely to be signed until at least 2016.

The delays in execution stem from the government's initial focus on the upstream, with little thought given to mid-stream and downstream. These delays can lead to frustrated expectations both internally and externally. Promises of enhanced revenues from new oil production may not be forthcoming when expected, leading to opposition to the government's efforts. International energy companies may turn elsewhere for investment opportunities if the opening of the Mexican sector is delayed beyond expectations.

Important decisions in the upstream sector must be resolved before any bidding can take place. For example, what size block will be put up for bid — small as in the United States offshore or large as in the Angola offshore? Will only deepwater offshore assets be in the bid package or a mix of offshore and onshore shale assets? Will all the legacy assets go to PEMEX or will some be available to international companies? These fundamental questions must be resolved before any bidding can take place.

The legislation is silent on the disposition of crude and product pipelines now owned by PEMEX. Will a new entity take over? In the downstream market for gasoline and other refined products, legislation contemplates more competition. Questions on its achievement are likely to be deferred.

The reforms are a work in progress, with final results years away. They are unlikely to have an impact on oil production for the next five years. Opinions differ on the pace of implementation of the reforms and their success. Public opinion will be important. For example, the public worries over increased opportunities for corruption, undermining the goals of the oil reforms.

Middle East

Outages in the global oil market are the current focus in the Middle East and OPEC. Within OPEC, outages are occurring in Iran, due to sanctions; in Iraq, Nigeria and Libya; and in non-OPEC countries Sudan and Syria. All the outages result in 3.0 to 3.5 million bpd off the market.

Instability in the global oil market due to these outages was averted as the United States and Saudi Arabia increased production. Saudi Arabia increased to over 10 million bpd, approaching 10.5 million bpd during the summer of 2014. The risk associated with more Saudi production is the narrowing of global spare capacity and the inability to respond to additional outages quickly. The Kingdom indicates it can produce 12 million bpd within a short period of time. Many doubt this claim. The United States increase in production also helped stabilize global markets. The downside risk associated with U.S. production is that current tight oil surpluses without an export option could lead to future reductions in investment and production.

With so many outages occurring within OPEC, there is a simultaneous lessening on the global call on OPEC production. Part of this has to do with increased American production, but part also comes from other production outside of OPEC.

Analysts struggle with whether the current outages will last or decline. Iran sanctions will continue as long as no long-term agreement on its nuclear program is reached. Iran is exporting condensates since they are not included in sanctions. The question is whether the United States will allow these exports to take pressure off world markets, or whether it will attempt to tighten its sanctions policy. Uncertainty at Libya's ports and in its producing fields is currently making it impossible to predict future production. Other hot spots, such as Nigeria, Iraq, both Sudans, and Syria continue to create uncertainty in the oil markets.

A new threat in Iraq comes from the Independent State of Iraq and the Levant, also known as ISIS or the Islamic State. The poten-

tial threat of a takeover of Iraq's main producing areas in the south by these terrorists is creating significant uncertainty in world markets. In northern Iraq, Kurdish assertion of sovereignty over and production from oil fields in its area may partly offset declines in other parts of Iraq.

The ability of OPEC to maintain control among its members is being put to the test. Saudi Arabia can offset other member outages for some time, but what happens when each country resolves its problems and increases production? How will Saudi Arabia react and how will OPEC adjust when demand for its oil is falling?

Foreign Direct Investment in the United States

The United States oil and gas industry topped the Foreign Direct Investment (FDI) attractiveness index in 2013, bringing in more than \$250 billion since 2010. The reasons include an open investment policy, established contract law, and robust infrastructure providing access to large domestic markets supported by significant and increased domestic reserves.

Investment in oil and gas is coming from two principal sources: National Oil Companies (NOCs) and private investors. NOCs, mainly from China, seek secure resources as they gain access to technology and project execution management. Private investors want to acquire secure tangible assets, put their money to work as other high return options decline, and establish a long-term presence where there is a large resource potential.

With several years of drilling experience, risks are better understood. There is a steep learning curve for enhanced well recovery and achieving cost reductions in both gas shale and tight oil plays, and investors are aware of the diversity of choices offered by producers with various levels of experience.

To a foreign investor, the U.S. oil and gas boom is providing risk-reward choices that are superior to most other resource areas. FDI

will continue to flow into the United States because the market is more stable and better understood. Large NOCs paved the way, and private investors are following their lead. This trend is supported by vast resource potential, large capital needs and the extensive experience of many of the production companies.

Natural Gas Development in the United States

Natural gas development issues include public perceptions, environment, LNG exports, FERC (Federal Energy Regulatory Commission) regulation, and reliability — the ability to deliver gas where and when it is needed. The adequacy of the resource base and the fear of rapidly declining production curves no longer appear to be serious issues in the United States.

Reliability

Infrastructure and storage underlie the concerns over reliability. Are pipelines available where production occurs? Is there sufficient capacity in existing pipelines? Can they deliver the gas to demand areas? If so, can it be stored until needed? The industry is addressing these issues.

Natural gas transmission pipelines offer firm and non-firm services to shippers. Some gas shippers opt for firm service that guarantees their pipeline capacity. Other shippers opt for cheaper non-firm service that allows service to be interrupted in times of heightened demand. Producers would like to see their electric power customers opt for firm service in order to provide a reliable source of demand.

Public perceptions

Perceptions of fracking are inconsistent. The results of opinion polls in two producing states showed that more than eighty percent of respondents believed that fracking is in their state's economic interests. A majority in each state believed that economic benefits outweighed environmental risks. A similar majority in each state favored a temporary ban on fracking.

The economic argument has not been persuasive enough to overcome the public's perception of the risks of fracking operations. More must be done to secure the trust and acceptance of the public. Industry should change the conversation, spending less time downplaying fracking's risks and more time disclosing its real risks and what industry is doing to minimize them. The public may not be aware that the risks they associate with fracking are primarily risks of well bore integrity or water re-injection, entailing different solutions. Smart regulation, communication and education may be able to alleviate the public's concerns once these risks are better understood.

Environment

About 29 percent of all U.S. methane emissions come from shale gas and tight oil systems (production, storage, transportation, and distribution). The replacement of coal with gas in electric power generation is a potentially large contributor to the reduction of climate change, since gas combustion has half the CO₂ emissions of coal combustion. Methane leakage undercuts these benefits, however, as methane is a more potent greenhouse gas than CO₂. According to the Environmental Defense Fund's Methane Leakage Model, leakage rates above one percent indicate that switching to gas will not provide climate benefits, although it will still reduce other regulated air pollutants. Most leakage occurs at the well bore and during transmission and storage. Within natural gas systems, about two thirds of methane emissions from shale gas production can be reduced with modest costs, about \$580,000 per well.

The International Energy Agency (IEA) 2012 World Energy Outlook projected greenhouse gas emissions to 2035 showing high probabilities that global temperatures would increase to significant levels above pre-industrial levels, with substantial climate change impacts. The IEA proposed an ambitious “450 Scenario” (a target of a maximum of 450 parts per million atmospheric concentration of carbon dioxide equivalent) that set out a global energy pathway that could have a 50 percent chance of limiting the long-term increase in average global temperature to two degrees Celsius above pre-industrial levels. The carbon budget is a short-hand way of identifying the elements of the IEA pathway.

The carbon budget established a limit for all fossil fuel production and then allocated production for each fuel. At the current rate of investment, global oil and gas production is likely to be 10 percent above the IEA’s 450 Scenario by 2023 and 25 percent over budget by 2035. Considering the top 380 oil and gas projects, representing \$5.6 trillion of on-going investment through 2060, producers would have to reduce their production an overall 16.2 percent to comply with the 450 Scenario. Production weighted, total liquid fuels output would have to decrease by 17 percent and gas output would have to drop by 14.5 percent. To reach the target, industry would have to make substantial changes in capital expenditures. The greater the delay, the larger the changes will have to be.

Discussion focused on the implications of this carbon budget and whether it was realistic. Not only would future oil and gas consumption have to be reduced, but coal consumption would have to be reduced even more. Achieving this result without significantly limiting economic growth would require huge gains in conservation, energy efficiency, and non-fossil fuels but would substantially reduce impacts on the world’s future climate. The underlying issue is whether there are adequate incentives for the global economy to make these adjustments.

LNG Exports

The outlook for LNG exports from the United States is robust. All projections indicate exports starting in late 2015 or 2016. Most projections show the United States moving from net gas importer to net exporter by the end of this decade. The adequacy of American gas resources is no longer in dispute. Economic benefits derived from LNG exports can be significant, reducing the trade deficit, increasing government revenues, growing the economy and supporting about 45,000 jobs by 2018 spread among many states. Opponents of exports argue that the competitive advantage of U.S. petrochemical and other industries, and the resulting job creation, would be reduced if exports increase domestic gas prices. The remaining questions focus on timing of the process for permitting LNG export facilities, financing, and public perceptions.

The Department of Energy (DOE) and FERC are responsible for approvals for all LNG export facilities. A DOE export permit is required after a public interest finding for all exports to countries without a Free Trade Agreement (FTA), which includes potential customers of virtually all LNG export projects. DOE now considers proposals whether or not they have completed the FERC environmental review. Approved facilities then apply to FERC for a permit. The remaining facilities are in a “queue” awaiting DOE approval before entering the FERC approval process. DOE is proposing to change its approval process to eliminate the queue, with Department consideration coming only after FERC completes its review.

FERC environmental review is the more extensive review and therefore the critical pathway for permitting LNG facilities. It now is taking as much as 20 to 30 months as many facilities apply for approval. Resource constraints within FERC and other participating agencies, increased public participation and more careful scrutiny are leading to these stretched out reviews. To date, only one export facility has both FERC and DOE permits and is under construction, with first delivery in 2015 or 2016. Two other facilities are expected to obtain permits and start construction this year. Twelve more facilities, representing about 19.5 billion cubic feet per day (bcf) of

gas, have entered the FERC process, seven of them with conditional DOE approval. Another 20 facilities have been proposed, representing about 17.9 bcf. Not all of these facilities will be built, since global demand for LNG is not unlimited and financing based upon customer commitments will not be forthcoming.

Merely complying with the requirements of the licensing process is insufficient. LNG export facilities increasingly have to focus on working with the local community. For facilities that will operate for 30 years, local concerns must be understood and addressed. Traffic problems at intersections or traffic congestion during shift changes must be rectified if the facilities want to be good neighbors. Respecting community concerns and outreach through many local institutions, including schools, is critical for success.

FERC Regulation

FERC permits are essential for LNG exports but may not be for other LNG projects. A number of small projects using LNG or CNG in innovative ways for transportation or upstream production are pending at FERC. Each petition has no opposition. FERC has not acted on these petitions. At this point it is not clear whether any FERC action is required.

Conclusion

Uncertainty pervades the global energy outlook. Bottlenecks are developing throughout the American oil and gas industry because government and industry have not fully adapted to the oil and gas boom. As the vulnerabilities of the 1970s fade into history, energy security policies based on a scarcity mindset must be updated, including government responses to proposed crude oil and LNG exports. Industry leaders need to implement the rapid advances in technology in a cost-effective manner while working with local communities and governments to communicate and ameliorate the environmental and other risks associated with the surge in oil and gas production. Expanding infrastructure, including pipelines, refineries, and railroads, is critical to encourage producers to continue investing and producing to meet future requirements.

Europe, without a regional energy policy, is struggling to find solutions to the instability of its gas markets. Mexico is slowly implementing its legislative initiatives to open its oil and gas industries to foreign investment. OPEC is attempting to adjust to substantial oil production outages among its members and non-OPEC producers.

As the United States reorients its energy thinking, the rest of the world also needs to readjust to the future reality that China, India and the Asia-Pacific region will account for the overwhelming new demand for energy. No longer will the industrialized world domi-

nate energy markets. Emerging economies in Asia will dominate in the future, providing fundamental issues for energy policymakers everywhere.

The United States is making efforts to adapt to plenty. Other regions are struggling to adapt to scarcity or changing trade flows. The American oil and gas boom raises many issues on energy security, technology, environment, infrastructure, and government policies. The continuing success of the boom, and achieving the full economic benefits it makes possible, rests on the ability of so many actors to understand and adapt to change.

Appendices

Agenda

Monday, July 7

6:30 – 9:30 PM

Opening Reception and Dinner

Tuesday, July 8

8:30 – Noon

SESSION I: PRODUCTION CHALLENGES AND OPPORTUNITIES

Increases in North American oil and gas production have made most analysts and observers bullish on prospects for future supply. What do forecasters project for the next 20-25 years? What changes in demand, new sources of supply, potential production bottlenecks, or policy changes could alter these forecasts?

Energy Outlook to 2035

**Mark Finley, General Manager
Global Energy and U.S. Economics, BP**

**Innovation and Potential
Bottlenecks**

**Jean-François Poupeau
Executive Vice President
Corporate Communication
and Development
Schlumberger**

**Deepwater Technologies
and Potential**

**John Grempe, Chairman,
President and Chief Executive
Officer, FMC Technologies Inc.**

**Cash Flow and Investment:
Mind the Gap**

**Claire Farley, Member
Kohlberg Kravis Roberts & Co.**

Innovations in Transportation

**Bill Reinert, National Manager of
Advanced Technology (ret.)
Toyota Motor Sales**

1:30 – 5:00 PM

SESSION II: GLOBAL DEVELOPMENTS

A variety of global issues will affect and be affected by increased North American production. How do Europeans see these issues? How likely is reform of the Mexican petroleum sector and what will be the impact on production and trade flows? What might happen with currently offline production in the Middle East? What are the prospects for and problems of direct foreign investment in North American production?

A View from Europe	John Knight, Executive Vice President Statoil
Reform of Mexican Petroleum Sector	Adrián Lajous, Senior Fellow Center on Global Energy Policy Columbia University, and Former Chief Executive Officer, Pemex
Middle East Production	Jamie Webster, Senior Director IHS Energy Insight
Foreign Direct Investment in U.S.	Denis Prokofiev, Principal Business Development QRI International

Wednesday, July 9

8:30 – Noon

SESSION III: THE NEW ENERGY SECURITY

The oil and gas renaissance is reducing North American oil imports, increasing the exports of refined products and natural gas, and raising questions about the narrative of energy security that has prevailed since the 1970s. What are the arguments for and against eliminating or modifying the ban on U.S. crude oil exports? Should the size, composition or even the existence of the Strategic Petroleum Reserve be revisited? How should energy security be considered in an increasingly globalized energy market?

New Approaches to Energy Security	Jason Bordoff, Director Center on Global Energy Policy Columbia University
--	---

Energy Security: A Downstream Perspective	Gary Heminger President and Chief Executive Officer Marathon Petroleum Corporation
The U.S. Crude Oil Export Ban	Marianne Kah, Chief Economist ConocoPhillips
The U.S. Crude Oil Export Ban	Graeme Burnett Senior Vice President, Fuel Delta Air Lines
Complexities of Oil Trading	Bryan Keogh Chief Financial Officer, North America Trafigura

1:30 – 5:00 PM

SESSION IV: NATURAL GAS

Multiple questions accompany the positive news about the growth in shale gas production. What is its current status, and what problems could slow it down? What is the policy on U.S. gas exports, and what are the trends in global LNG trade? Where, when, and at what price will shale gas be developed outside North America? What is the status of knowledge about and action on fugitive methane emissions?

North American Shale Gas	Mark Boling, Executive Vice President Southwestern Energy
Methane Emissions and CCS for Gas	David Hawkins Director, Climate Programs Natural Resources Defense Council
LNG Exports and Global Trade	Pat Outtrim, Vice President Government and Regulatory Affairs Cheniere Energy
LNG Exports and Global Trade	Martha Wyrsh, Executive Vice President and General Counsel Sempra Energy
Challenges to New Infrastructure	Kirstin Gibbs, Partner Bracewell & Giuliani LLP

Thursday, July 10

8:00 – 11:30 AM

SESSION V: PIPELINES AND REFINERIES

The location and grades of new North American oil and gas production pose challenges to the transportation network and to some refiners. What are the possibilities and limitations of new pipelines or rail transportation? What is the future of U.S. refining, and of product exports? What is the status of the Keystone XL decision and the prospects for the export of oil and gas through British Columbia with or without KXL?

North American Transportation	Robert Phillips Chairman, President and Chief Executive Officer Crestwood Midstream Partners LP
North American Transportation	Dennis McConaghy, Executive Vice President, Corporate Development TransCanada Pipelines
Refining	Greg Goff, President and Chief Executive Officer Tesoro Corporation

Participants

Rick Agnew

Chairman and President
Van Ness Feldman, LLP
1050 Thomas Jefferson
Street NW
Washington, DC 20007

Hiroshi Akiyama

Director
Lazard Frères K.K.
Sanno Park Tower, 25th Floor
2-11-1 Nagata-cho, Chiyoda-ku
Tokyo 100-6125, Japan

William Arnold

Professor in the Practice
of Energy Management
Rice University
Room 247 McNair Hall -
MS 531
6100 Main Street, Jesse H. Jo
Houston, TX 77005

Roger Ballentine

President
Green Strategies, Inc.

816 Connecticut Avenue NW,
Suite 200
Washington, DC 20006

Peter Blair

Executive Director
Division on Engineering and
Physical Sciences
National Academy of Sciences
500 Fifth Street NW
Washington, DC 20001

Mark Boling

Executive Vice President
Southwestern Energy Company
2350 North Sam Houston
Parkway East, Suite 125
Houston, TX 77032

Jason Bordoff

Founding Director
Center on Global Energy Policy
Columbia University
420 W 118th Street, Room 901F
New York, NY 10027

Graeme Burnett

Senior Vice President, Fuel
Optimization
Delta Air Lines
1030 Delta Boulevard
Atlanta, GA 30354

Janet Clark

Member, Board of Directors
EOG Resources, Inc.
1111 Bagby Street, Sky Lobby 2
Houston, TX 77002

Leonard Coburn (Rapporteur)

President
Coburn International Energy
Consultants LLC
2828 Albemarle Street NW
Washington, DC 20008

Douglas Crowther

Partner
Dentons Canada LLP
850 Second Street Southwest,
Suite 1500
Calgary, AB T2P0R8, Canada

Kyle Danish

Partner
Van Ness Feldman LLP
1050 Thomas Jefferson
Street NW
Washington, DC 20007

Daniel Domeracki

Vice President, Government
and Industry Affairs
Schlumberger
5599 San Felipe, 17th Floor
Houston, TX 77056

Ted Eck

Energy Economist
GTI
PO Box 8
Orford, NH 03777

Claire Farley

Member
Kohlberg Kravis Roberts &
Company
600 Travis Street, Suite 7200
Houston, TX 77002

Anatol Feygin

Senior Vice President, Strategy
and Corporate Development
Cheniere Energy, Inc.
700 Milam Street, Suite 800
Houston, TX 77002

Mark Finley

General Manager
Global Energy and
U.S. Economics
BP America
1101 New York Avenue NW,
Suite 700
Washington, DC 20005

Jim Ford

Vice President, Federal
and State Government Affairs
ConocoPhillips
325 7th Street NW, 12th Floor
Washington, DC 20004

Doug Fordyce

Managing Director
Lazard
600 Travis Street, 23rd Floor
Houston, TX 77002

George Frampton

Principal
 New Energy Advisors LLC
 1054 31st Street NW
 TowPath Partners, Suite 340
 Washington, DC 20007

Paula Gant

Deputy Assistant Secretary
 Oil and Natural Gas
 Department of Energy
 1000 Independence Avenue SW
 Washington, DC 20585

Kirstin Gibbs

Partner
 Bracewell & Giuliani LLP
 2000 K Street NW, Suite 500
 Washington, DC 20006

Tim Glassco

Principal
 Podesta Group
 1001 G Street NW,
 Suite 1000 W
 Washington, DC 20001

Greg Goff

President and Chief
 Executive Officer
 Tesoro Corporation
 19100 Ridgewood Parkway
 San Antonio, TX 78259

David Goldwyn

President
 Goldwyn Global Strategies, LLC
 700 6th Street NW, Suite 700
 Washington, DC 20001

John Grempe

Chairman, President
 and Chief Executive Officer
 FMC Technologies Inc.
 5875 North Sam Houston
 Parkway West
 Houston, TX 77008

Evan Harrje

Government Affairs Advisor
 Aramco Services Company
 1667 K Street NW, Suite 1200
 Washington, DC 22046

Marilu Hastings

Sustainability Program Director
 Cynthia and George Mitchell
 Foundation
 2630 Exposition Boulevard,
 Suite 214
 Austin, TX 78703

David Hawkins

Director, Climate Programs
 Natural Resources Defense
 Council
 40 West 20th Street, 11th Floor
 New York, NY 10011

Gary Heminger

President and Chief Executive
 Officer
 Marathon Petroleum
 Corporation
 539 South Main Street
 Findlay, OH 45840

Jason Hutt

Partner
 Bracewell & Giuliani LLP
 2000 K Street, NW, Suite 500
 Washington, DC 20006

Robert James

Managing Director
Enterprise Asset Management
Inc.
521 Fifth Avenue, Suite 1804
New York, NY 10175

John Jimison

Managing Director
Energy Future Coalition
1750 Pennsylvania Avenue NW,
Suite 300
Washington, DC 20006

Barbara Judge

Member, Strategic Advisory
Council
Statoil
One Wood Street
London, EC2V 7WZ, United
Kingdom

Fred Julander

President
Julander Energy Company
475 17th Street, Suite 460
Denver, CO 80202

Yonghun Jung

Counselor to the Minister
Ministry of Trade Industry and
Energy
402 Hannuri-daero
Sejong-si, 339-012
Republic of Korea

Marianne Kah

Chief Economist
ConocoPhillips Company
600 North Dairy Ashford
Houston, TX 77079

Andy Karsner

Chairman and Chief Executive
Officer
Manifest Energy
1400 I Street NW, Suite 540
Washington, DC 20005

Bryan Keogh

Chief Financial Officer, North
America
Trafigura AG
1401 McKinney Street, Suite
1500
Houston, TX 77010

John Knight

Executive Vice President
Statoil
1 Kingdom Street, 9th Floor
London, W2 6BD
United Kingdom

Adrián Lajous

Senior Fellow, Center on
Global Energy Policy
Columbia University
Colegio 620, Jardines del
Pedregal
México, DF 01900, Mexico

James Lambright

Senior Vice President,
Corporate
Development
Sempra Energy
101 Ash Street, HQ18
San Diego, CA 92101

Hoesung Lee

Professor
 IPCC Vice-Chair/Korea
 University;
 Korea Meteorological
 Administration
 16-61 Yeouidaebangro,
 Dongjak-gu
 Seoul, 156-720
 Republic of Korea

Michael Levi

Senior Fellow, Energy and the
 Environment
 Council on Foreign Relations
 58 East 68th Street
 New York, NY 10012

Brantley Liddle

Vice President and Chief of
 Research
 Asia Pacific Energy Research
 Centre
 Inui Building, Kachidoki 11F,
 1-13-1 Kachidoki
 Tokyo, 104-0054, Japan

Vivek Mahajan

Senior Analyst Strategy
 Statoil
 1 Kingdom Street, 9th Floor
 London, W2 6BD
 United Kingdom

James Mandel

Manager
 Rocky Mountain Institute
 2317 Snowmass Creek Road
 Snowmass, CO 81654

Jan Mares

Senior Policy Advisor
 Resources for the Future
 1616 P Street NW
 Washington, DC 20036

Bill Marko

Managing Director
 Jefferies LLC
 333 Clay Street, Suite 1000
 Houston, TX 77002

Dennis McConaghy

Executive Vice President,
 Corporate Development
 TransCanada PipeLines
 450 - 1st Street SW
 Calgary, AB T3K 4L8, Canada

Ryan Moss

Partner
 Perella Weinberg Partners
 767 Fifth Avenue, 5th Floor
 New York, NY 10153

Rod Nelson

Senior Advisor
 Schlumberger
 5599 San Felipe, 17th Floor
 Houston, TX 77056

Richard Newell

Director, Energy Initiative
 Duke University
 PO Box 90467
 Durham, NC 27708

Boyko Nitzov

TSO Cooperation Officer and
 Team Leader
 Agency for the Cooperation of
 Energy Regulators

Trg Republike 3
Ljubljana, 01000, Slovenia

Kazuyuki Onose
Senior Vice President
Energy Sumitomo Corporation
of Americas
820 Gessner Road, Suite 600
Houston, TX 77024

Pat Outtrim
Vice President, Government
and Regulatory Affairs
Cheniere Energy, Inc.
700 Milam Street, Suite 800
Houston, TX 77002

Robert Phillips
Chairman, President and
Chief Executive Officer
Crestwood Midstream Partners
LP
700 Louisiana Street, Suite 2060
Houston, TX 77002

Jean-François Poupeau
Executive Vice President
Corporate Communication
and Development
Schlumberger
5599 San Felipe, 17th Floor
Houston, TX 77056

Richard Powers
Partner
Venable LLP
575 7th Street NW
Washington, DC 20004

Tom Price
President
The Price Group
14320 Santa Fe Street
Westminster, CO 80023

Denis Prokofiev
Principal, Business
Development
QRI International
909 Fannin Street, Suite 2200
Houston, TX 77010

Lucian Pugliaresi
President
Energy Policy Research
Foundation
1031 31st Street NW
Washington, DC 20007

Jim Ragland
Economist
50 Green Meadow Drive
Carbondale, CO 81623

William Reinert
1645 Antonio Court
Loveland, CO 80538

Mark Renton
Managing Director
Lazard Freres
30 Rockefeller Plaza
New York, NY 10112

Scott Rotruck
Director of Energy and
Transportation Services
Spilman Thomas & Battle,
PLLC
48 Donley Street, Suite 800
Morgantown, WV 26508

Tisha Schuller

President and Chief Executive
Officer
Colorado Oil and Gas
Association
1800 Glenarm Place, Suite 1100
Denver, CO 80202

Wayne Simmons

President and Chief Executive
Officer
Sundrop Fuels
2410 Trade Centre Avenue
Longmont, CO 80503

Kyle Simpson

Senior Advisor
Hogan Lovells US LLC
555 13th Street NW
Washington, DC 20004

Roger Wallace

Vice President, Federal Policy
Pioneer Natural Resources
5205 North O'Connor
Boulevard, Suite 200
Irving, TX 75039

Michael Webber

Deputy Director
Energy Institute
University of Texas at Austin
204 East Dean Keeton Street,
Stop C2200
Austin, TX 78712

Jamie Webster

Senior Director
IHS Energy Insight
1300 Connecticut Avenue,
Suite 800
Washington, DC 20036

Bill White (Forum Chair)

Chairman, Lazard Houston
Lazard Freres
600 Travis Street, Suite 2300
Houston, TX 77002

Martha Wyrsh

Executive Vice President and
General Counsel
Sempra Energy
101 Ash Street, 19th Floor
San Diego, CA 92101

Staff:**Nicole Alexiev**

Deputy Director
Energy and Environment
Program

Avonique (Nikki) De Vignes

Project Assistant
Energy and Environment
Program

David Monsma

Executive Director
Energy and Environment
Program

Timothy Olson

Senior Project Manager
Energy and Environment
Program

John A. (Jack) Riggs

Senior Fellow
Energy and Environment
Program

