



KIN Energy Forum

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The Kellogg Innovation Network (KIN), Kellogg School of Management

Forum Co-Chairs: Peter Bryant, Senior Fellow KIN & Mark Mills, Senior Fellow Manhattan Institute Rapporteur: Satish Rao

Introduction

The KIN Energy Forum, sponsored by BP, was an intimate gathering of 35 leaders from different parts of the energy ecosystem to explore Unconventional Hydrocarbon Energy... and its impact over the next ten years. Unconventional hydrocarbon energy, characterized by tight rock formations, horizontal drilling, and hydraulic fracking, could become one of the most profound industry innovations in decades. However all of the implications over the next ten years are still not well understood. This paper summarizes the insights from the Energy Forum, which explored these implications through three lenses — technology, the economy and environment, and geopolitical.

It was clear from the interactions at the KIN Energy Forum that the industry is falling short on meeting societal expectations, and that the level of trust between all stakeholders is at an all-time low. A number of factors appear to cause this: stakeholders speaking different languages, lack of respect for real concerns, regulatory ambiguity, and a general antipathy amongst all key stakeholders. As a result the industry's social license is under real threat across the globe.

This paper summarizes the proceedings of the KIN Energy Forum, and commentary from panelists and participants. Each panelist shared their perspectives for 10 minutes, and this was followed by a robust conversation amongst all the participants. A summary of the key points and insights from this session follows.

Technology

This panel comprised of the following speakers:

Rustom Mody VP R&D Baker Hughes Inc.

Donald Paul Executive Director USC Energy Institute Former CTO Chevron

Mark Mills

Advisory Board Northwestern University McCormick School of Engineering Senior Fellow Manhattan Institute Author Energy Intelligence Column, Forbes



Innovation Upsets the Peak Oil Theory

The panelists presented a discussion on the peak oil theory developed in the 1970s. The peak oil theory proposed a view that the world will run out of recoverable oil in the near future; time and innovation has shown this is not realistic. The world is not running out of hydrocarbon molecules; producers require new technology to get to them. Only a tiny fraction of the oil that exists in the technically challenging source rock has been tapped, and that is the direction the industry is going. The world will continue to use oil for the foreseeable future due to favorable energy density, storability, transportability, and cost.

The global demand for oil is also increasing, particularly in the transportation sector, as seen by the forecasts in the number of passenger miles. In the next decade, the world is estimated to add 2 trillion in air miles, and 5 to 10 trillion miles in auto transport. Alternative energy sources will only provide a fraction of this demand, and gasoline and diesel are expected to continue to dominate. This economic reality is driving the development of unconventional hydrocarbons

The Innovation Revolution in Shale Extraction

Panelists outlined that four factors have converged to unlock this revolution; horizontal drilling, fracking, private ownership of mineral rights, and advances in software such as seismic imaging.

Technology has played a pivotal role in the development of shale reserves. For example, smart drilling lets producers know where to look and drill, and how to operate in the sub-surface. Accessing reserves, however, does require engagement with government, regulators, environmental groups and local communities to resolve critical public policy and safety issues.

Innovation in technology has enabled organizations to realize the potential from source rocks that have converted geologic energy into oil and gas, and in some cases, to coal. Typically, a minor fraction of this energy escapes over geological time and is trapped into more permeable rock formations, and that is what we have historically tapped as "conventional" oil and gas. The fact is that unconventional hydrocarbons are available in the more technically challenging source rock that is abundant in much larger quantities.

The growth in unconventional hydrocarbon in the US is not a bubble; it is a permanent shifting in the epicenter and the quantities of energy production, at least until alternative energy sources become competitive.



Resources Pull Technology

Natural resources are a long lived asset, and this provides the timeframe and context for technology innovation across its life time. We are just seeing the start of a cycle of significant technology innovation, which if to be impactful must show the following:

- The ability to integrate technology advancements into work process and operationalize them.
- Access to capital for investing in the exploration and production.
- The scalability of shale technology will benefit due to private ownership of natural resources and short technology development cycle times.
- Captivating and utilizing advances in broader technologies such as sensors, measurement, and computing.
- Ability to economically address environmental concerns such as waste water, methane gas and others.

Sensors and communications are two of the largest opportunity areas, and they are attracting new entrants to the industry. The industry was slow to adapt the technologies from the subsea and energy markets for land-side as the opportunity weren't as significant. This equation has changed with the advent of fracking, and we are seeing the likes of Emerson, Honeywell, Siemens, and other instrumentation companies seeing this opportunity, and trying to develop new technologies.

The history of development in oil and gas technology shows that, in a given resource class, recovery rates go from single to double digits in a decade. Recovery rates for unconventional hydrocarbons are expected to, at minimum, double over the next 10 years. They will also benefit from advancements in other areas such as materials sciences. The outlook for the decade is likely to resemble the 1920s when the Gulf Coast oil business was born. The only difference is the cycle time will be significantly faster!





Economics and Environment

This panel comprised of the following speakers:

Matthew Foss

- Executive Director Economics and Markets, Department of Energy, Government of Alberta, Canada
- Derek Mathieson President Western Hemisphere Operations, Baker Hughes Inc.
- Tony Will Senior VP Manufacturing and Distribution, CF Industries

The panel highlighted that an opportunity exists for the US to become energy independent – and much less oil dependent -- in a relatively short period of time, and create an energy cost advantage relative to other mature markets, such as Europe. These large unconventional supplies and the ability to develop infrastructure provide opportunities for technologies and industries that use natural gas and other unconventional hydrocarbons. The key question to consider is what opportunities open up in the US if natural gas is well distributed, and its price is permanently set to "reasonable levels", where even that can still mean a doubling from today's prices?

Environmental Concerns Regarding Fracking

The rise of fracking has been rapid and surprising, and as a result a lot of tension amongst the various ecosystem players has arisen, along with many societal concerns.

This was discussed at length and the need for leadership to address these concerns and ease tensions. It was apparent in the Forum that various stakeholders do not speak the same language, and there is a degree of suspicion amongst them and this erodes the industry's social license. The main concerns discussed are summarized below.

The Energy –Water Nexus

The amount of water consumed by fracking: Fracking typically consumes 3 to 6 million gallons per well. Panelists mentioned that, on a relative basis of per BTU generated, the consumption of water in the fracking process is generally less than other energy sources, but could be significant when these wells are located in water distressed areas. However the counter point from a number of participants is this is a lot of water and at a local level it remains a concern, and it is dangerous to trivialize.

Contamination of water: Any contamination potential typically exists at the well source.



Thus well integrity is critical to its safety and the fracking process. The technology includes cementing around the steel well pipes to improve its integrity. It was mentioned that recent studies have not found conclusive evidence of contamination from the well source. However, other participants also mentioned that there are conflicting sets of data from other sources. It was clear from the debate that this is a real concern which needs to be addressed.

2012 was a huge year for the unconventional hydrocarbon industry, with over 18,000 horizontal wells drilled; now totaling 72,000 in a ten-year period from 2002 to 2012. These come at a significant scale of inputs, with typical 2 million pounds of propane and 3 million gallons of water used per well. This has meant that in 2012 alone, 36 billion pounds of propane were used, along with 56 billion gallons of fresh water. These volumes are not sustainable and need to be reduced – it was highlighted there is a lot of innovation efforts occurring to address these factors. How the industry uses water, re-uses, and treats it, is crucial going forward.

The industry is not close to efficiencies that it needs to reach in the future. A very high percentage of the wells drilled in 2012 were non-productive. This highlights the additional imperative for improving the efficiency curves.

Environmental Concerns Regarding Toxicity, Earthquakes, and Greenhouse Gases

Fracking uses toxic chemicals: Fracking involves the pumping of water mixed with sand and various chemicals. The liquids that are used in the fracking process comprises water (91%), sand (8.5%), and the remaining 0.5% include breakers or gels. Gels carry the sand over long distances, and breakers serve to break up formations. Whilst the industry may consider these chemicals comparable to household products in terms of hazard and the impact to the environment, others took an opposite but equally acceptable view. It was clear from the discussions that a lot has to be done to bridge these differences.

Hydraulic fracking causes earthquakes: Panelists mentioned that hydraulic fracking, according to various studies, does not induce earthquakes. However, it does induce 'micro' earthquakes (the fracturing process); these micro seismic events, we were told, are typically comparable to the vibrations caused by a large truck.

Natural Gas production releases significant quantities of methane: The production of natural gas often results in the leaking of methane, a potent greenhouse gas.



Industrialization of the Countryside and Inconsistent Regulations

Industrialization of the countryside: Panelists stated that the shale gas boom is expected to usher in a massive industrialization of the countryside, with natural gas fracking operations, and also facilities to storage, processing, and transport.

Fragmented and inconsistent regulations: Panelists expressed concern that in the disparity in how individual states regulate the fracking process, and that there is no standard over operational processes that could impact the environment.

It is clear that a new level of open dialog and collaboration needs to occur amongst all the stakeholders.

The Decoupling of Natural Gas and Oil Prices

It is reasonable to expect that natural gas prices, currently at about \$3 per MMBTU right now, will continue to stay reasonably low for a while. Even at a range of \$3 to \$5 per MMBTU, gas prices provides for a very competitive environment for the US, relative to \$9.50 to \$10 per MMBTU in Europe.

Oil prices are unlikely to come down substantially given the combination of the technical challenges in the resource base and the magnitude of global demand that is more easily served (shipped) than for natural gas. Improving efficiencies and pushing the technological envelopes impacts industry margins, and therefore, prices are not likely to go down. In fact, it is possible that price may creep up a bit higher, but unlikely to reach \$200 per barrel levels some talk about.

Prices for natural gas in the US will continue to be decoupled from oil, while continuing to be connected globally.

Impact to Other Energy Sources

- Impact to coal: The footprint for power generation using natural gas is smaller, and environmentally cleaner than coal, and significant switching from coal to gas has already happened in the USA. Quite the opposite in Europe, where for example Germany is replacing natural gas with coal, as coal is cheaper!
- Panelists mentioned that solar and wind will have to continue to rely on subsidies to compete, although recent advances contradict this claim, and also that investment flows to these may slow as a result of natural gas.
- Utilities accelerate natural gas adoption as it allows them to stabilize outputs and expand their renewable portfolio. This is particularly true of utilities in states with renewable mandates like California and Colorado.



Impact to Manufacturing

The boom in shale gas is expected to positively impact industries that are a significant user of energy or depend on hydrocarbons as a raw material. Fertilizer and chemical production, for example, use natural gas as an input, and are likely to see a significant revival of production in the US due to lower prices. Companies are investing enormously in the US, betting that natural gas will be cheap and will stay decoupled from oil prices. This is an economic advantage that, for all practical purposes, will be permanent. Many participants felt that other regions with significant unconventional energy, such as China, will not be able to duplicate this at the same scale. A number of manufacturers are also moving off the grid, and using self-generation plants; this has big implications for the utility industry.

Birth of an Entrepreneurial Movement

It was claimed that the US has a global competitive advantage due to its development of unconventional hydrocarbons. There are 200-300 operators in the Permian region of Texas alone, including active venture capitalists, and many small companies operating and supplying services. This constitutes an unprecedented entrepreneurial environment at national scale. In the next 10 years, activities relating to unconventional hydrocarbons could easily double – the industry needs to prepare for this. The major oil producers represent 10% or less of overall unconventional production, this is not a well understood. One of the difficulties is that this diversity makes it challenging to have a dialog with the 'industry'.

The Social License to Operate

It was clear from the interactions at the KIN Energy Forum that the industry is falling short on meeting societal expectations and the level of trust between all stakeholders is at an all-time low. This is due to a number of factors: stakeholders speaking different languages, a lack of respect for real concerns and opposing views, regulatory ambiguity, and a general antipathy amongst key stakeholders. As a result the industry's social license is under real threat across the globe.

This situation is further compounded by a regulatory mish mash in the US and other countries. While the economics are solid, the industry needs to lead an open and transparent discussion on the environment and societal implications with stakeholders to ensure that there is a shared purpose and a means to effectively address concerns.



The industry will be called on to engage communities, local, state and federal regulators, and other stakeholders to find solutions that improve transparency, and resolve conflicts. The absence of this dialog, using a common language, agreement on a shared purpose and transparency will make it easier for misunderstandings and conflict to occur. This situation in the unconventional hydrocarbon industry is similar to the mining industry over the last two decades.

Geopolitics

This panel comprised of the following speakers:

Sir Anthony Brenton Energy Diplomat, Former UK Ambassador to Russia **Bob Hanfling** Former Assistant Secretary of Energy of the US

One of the most prominent global issues that impacts energy geopolitics is the issue of climate change. As demand for energy continues to grow in emerging economies like China, oil prices are likely not going to fall in the near future. This makes for a very optimistic scenario for the US, but the downsides need to understood as well.

Impact on the US

There are two propositions for the US from realizing the potential for unconventional hydrocarbons:

- Source of cheap natural gas: The US may edge away from coal for electricity. An interesting question is how does that impact its stance to climate change and pollution? Arguably, it makes it easier for the US administration to play a more cooperative position in the geopolitics of climate change.
- The US is on its way to energy independence: In the past, justification for US interest in the Middle East and other areas has centered around energy and oil, and it will be interesting to see how this perspective changes going forward. One possible scenario is that there will be likely diminishing US interest in the Middle East, and some may argue this is evidenced by the current administration's reluctance to get involved in Syria. The US is also slowly pivoting towards the growth regions of Asia, with diminished interest in the Middle East sea lanes.

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The European Situation

The development of shale gas in the US has stirred interest and debate in Europe. Even the German beer industry has come out against fracking – this shows the intensity of feeling prevalent in some industries and regions of Europe. Russia is the great looming shadow in energy policy in Europe; it supplies 25% of Europe's natural gas, and has often used that position as a strategic negotiating lever. Countries like Poland and Ukraine have large supplies of shale gas; however the technology and estimation methods leave much to be desired. Russia is under pressure to lower the price for its natural gas, and the current Gazprom anti-monopoly case, a direct challenge to Russian hegemony, is one to watch. It is a direct consequence of downward pressure on natural gas prices due to shale.

The Asian Situation

Japan has been trying to get out of decades of economic torpor, and needs access to hydrocarbons. This is seen by the interest of companies like Mitsui and Mitsubishi, who are large and early investors in shale technology in the US. Japan is going to be an important part of unconventional energy consumption as well.

Energy consumption in China is rising by 6% per year, while greenhouse gases have been rising 10% per year. The Chinese government has shown an interest in controlling their economic inputs – from buying farms in Sudan to resource projects in Africa and elsewhere. The prospect of China and Russia coming together over hydrocarbons has huge implications to geopolitics. China has enormous quantities of unconventional resources, similar to the US. However, thus far only 40 wells have been drilled to date in China, a drilling rate that is exceeded nearly daily in the U.S. There is a concern in the environmental community as well, leading to an important question on the role of the US in helping China in this regard.

China is adding 50GW of electricity produced by coal every year; that is equivalent of 7 cities the size of New York City per year. For comparison, the UK capacity of the UK is 80GW. Unconventional hydrocarbons can significantly alleviate the energy burden for China. This hunger for energy resources can be evidenced by the visits of both, Benjamin Netanyahu and Mahmoud Abbas to China recently. Is this a sign that China is going to be more interested in the Middle East and "inherit" it from the US?

Other Geopolitical Issues and Impacts

There are other regions that will be challenged. For example, it is well known that the ice cover of the Arctic region is becoming lost. Only one supertanker got around the Arctic 5 years ago; this year, 40 will transit, as the Arctic region continues to open up to shipping route and potentially in the future, as well as another source of abundant hydrocarbon resources. The existing Arctic Council may be too politically weak to address these large issues, including those of national borders and security.

The US may cease to be an important export market for production, and big new markets will be the emerging regions such as China, India, Indonesia, and Latin America. With the US pivoting towards Asia, the growth of countries with Islamic influence, such as Indonesia, and border disputes between China and India, it is very likely that the next big geopolitical crisis may come from Asia. A conflict between China and India could cause a significant crisis on a global scale.

Takeaways and a Call to Action

It is clear that the boom in unconventional hydrocarbon production harkens dramatic change for energy, and that the US stands to benefit most significantly. However, the environmental and societal concerns regarding fracking must be addressed. The industry must provide transparency and enter an open and collaborative dialog with all stakeholders. The current polarized debate must be replaced by an effort that creates a common language and gets stakeholders together. This opportunity will not be determined by science and technology alone, the human factors involved are just as paramount.

The impact in the rest of the world is unclear. The players in the US operate within a dynamic and locally regulated environment underpinned by private ownership of resource rights. This does not exist in the rest of the world to the same degree. Sharing of best practices and knowledge with the rest of the world will be critical to the environmentally and operationally safe adoption of this technology.

The technology underpinnings to expand unconventional hydrocarbon exist. The industry has, and can continue to develop monitoring to measure the environmental impact on air and water. However, broader engagement with stakeholders is missing. Therefore, the unconventional hydrocarbon industry needs to seize the opportunity to be leaders to create a means to engage in such dialog in way that effectively addresses the economic, environmental and social issues for all stakeholders.

ABOUT THE KELLOGG INNOVATION NETWORK (KIN)

Founded in 2003, the KIN is a global platform for collaboration between Kellogg School of Management faculty, corporate innovation leaders, non-profit organizations, and the government. KIN's mission is to facilitate dialogues that promote innovation-led growth and build long-term prosperity for industries and society worldwide. Through events like KIN Global, KIN Dialogues, and KIN Catalyst, KIN is building a network of thought leaders who have the collective ability to advance the global prosperity agenda.

For more information please visit <u>www.kinglobal.org</u>

For more information about KIN and The KIN Energy Forum, please email Peter Bryant, Senior Fellow, at pbryant@kinglobal.org

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