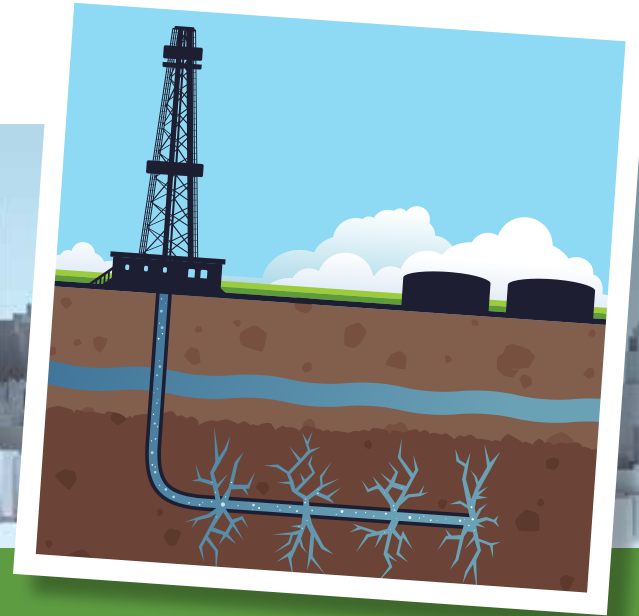
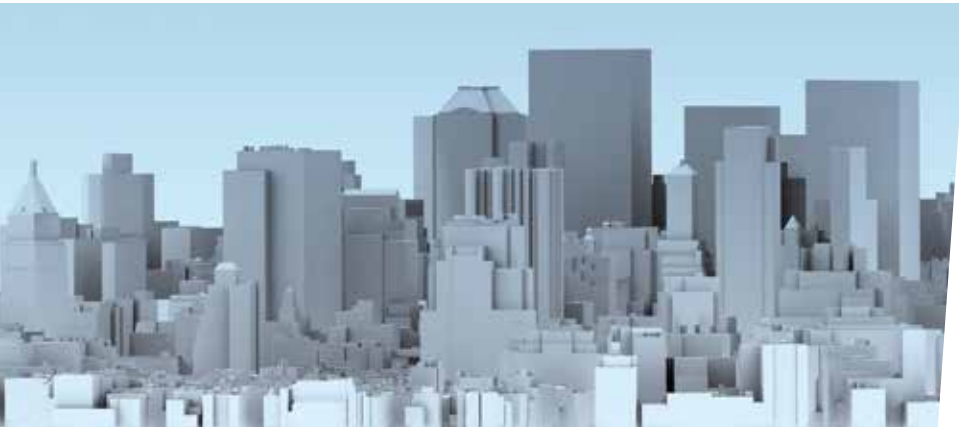


The 5th Eco-Engineering Forum

How Shale Gas is Shaping Energy Security and Environmental Issues across the World



Wednesday, October 16, 2013

October 16th, 2013 marked the fifth anniversary of a joint annual forum presented by Hitachi, Ltd., the American Association for the Advancement of Science (AAAS), and the Brookings Institution. This year's forum was centered on the ongoing shale gas boom and how it is shaping energy security and environmental issues across the world. The forum was held at AAAS headquarters in Washington, DC and featured a keynote presentation from the Director of the Energy Security Initiative at Brookings, Dr. Charles Ebinger. Two panel discussions on subtopics related to global shale gas development followed: one exploring the geopolitics of global energy supply, and the other looking at meeting environmental challenges through technology and governance. >>

Agenda

Welcome

MASTER OF CEREMONIES

Edward Derrick

Chief Program Director, Center of Science, Policy, and Society Programs
American Association for the Advancement of Science (AAAS)

Opening Remarks

Alan I. Leshner

Chief Executive Officer, AAAS
Executive Publisher, *Science*

Charles Ebinger

Senior Fellow and Director
Energy Security Initiative
The Brookings Institution

Takashi Hatchoji

Chairman of the Board
Hitachi America, Ltd.

Overview Address

Charles Ebinger

Senior Fellow and Director
Energy Security Initiative
The Brookings Institution

Panel 1: The Geopolitics of Energy Supply

MODERATOR

Charles Ebinger

Senior Fellow and Director
Energy Security Initiative
The Brookings Institution

PANELISTS

Michael A. Levi

David M. Rubenstein Senior Fellow for Energy and the Environment
Director of the Program on Energy Security and Climate Change
Council on Foreign Relations (CFR)

Nobuo Tanaka

Global Associate for Energy Security and Sustainability
Institute of Energy Economics, Japan (IEEJ)

Panel 2: Meeting Environmental Challenges through Technology and Governance

MODERATOR

Vaughan Turekian

Chief International Officer
AAAS

PANELISTS

Jonathan Fink

Vice President
Research and Strategic Partnerships
Portland State University

Sean J. O'Brien

Ohio State Representative - District 63

Gretchen Goldman

Analyst
Scientific Integrity Initiative
Union of Concerned Scientists

Closing Remarks

Yasuo Tanabe

Vice President and Executive Officer
Hitachi, Ltd.

Opening Remarks

Alan I. Leshner

Chief Executive Officer, AAAS
Executive Publisher, *Science*



The long-standing partnership between AAAS, Hitachi, and Brookings has made this annual event possible. This year's forum addresses the implications of shale gas on global energy and environmental security, understanding that the worldwide emergence of shale gas will have profound implications for decades to come. Effective policies will prove crucial to the global economic, environmental, and strategic landscapes moving forward. The diverse range of topics that pertain to shale gas is indicative of the multidisciplinary approach that is required to meet the energy needs of the 21st century. It is, therefore, important to foster collaboration among the scientific community, industrial stakeholders, and policymakers.

Takashi Hatchoji

Chairman of the Board
Hitachi America, Ltd.



Shale gas represents a crucial area of focus for energy supplies worldwide. Hitachi's commitment to contributing its expertise in the realm of the evolving shale gas industry exhibits its corporate philosophy: to contribute to the global society through advanced technologies. Hitachi hopes to play an important role in promoting social innovation business models and will offer valuable expertise amid the unprecedented shifts in the global gas market. The marketplace today has experienced a fundamental shift in focus toward sustainability. Efforts to promote sustainability would fall short without platforms for knowledge-sharing on critical issues, including energy and environmental security.

Charles Ebinger

Senior Fellow and Director, Energy Security Initiative
Brookings Institution



The world is experiencing an energy revolution at an unprecedented rate. The issues that arise from the increase in shale gas supply serve as a microcosm for future energy security challenges worldwide. As climate change continues to impact the way the world consumes fossil fuels, shale gas will play an instrumental role in bridging the gap between fossil fuels and renewable energy. The applications of new technologies have enabled extraction of resources previously-labeled as reserves at increasingly efficient rates. The collaborative ethos with which this conference engages is a reflection of the importance of a multifaceted approach to ensure the future of accessible and cleaner energy.



Keynote Address

Charles Ebinger

Senior Fellow and Director, Energy Security Initiative
Brookings Institution

Energy consumption is in the midst of a fundamental paradigm shift, which will have crucial implications on the global energy markets. Though supply of oil is expected to increase, the world will experience an unprecedented level of demand, with China and India commanding over half of the world's oil demand and the Asian Pacific region expected to demand 25 million barrels per day by 2035. Meanwhile, coal will replace oil as the world's primary fuel by 2020. In the absence of carbon pricing, coal will remain highly competitive in the global electricity market, particularly in Asia. But despite the crucial role that fossil fuels will play in the energy mix, the world will use more renewable energy than ever before. The increasingly cost-competitive technologies in solar and wind energy will contribute to this shift, although the renewable markets are still primarily run through subsidies. Nuclear power also ought to remain a potent force in the global reduction of fossil fuels. Despite the profoundness of these concerns, these issues are only one part of the current energy security discourse.

Shale gas production in the United States has become highly cost-effective through the application of scaled hydraulic fracturing technology, making conventional gas plants easier to build. The shale revolution will continue to contribute significantly to energy consumption worldwide. The International Energy Agency (IEA) projects gas consumption to rise by 50% from 2010-

2035. This increase comes as prices have fallen by 66% from 2005 to 2012. Japan is one exception to this trend, with prices there having risen 35% as the country continues to import more liquefied natural gas (LNG) to offset its losses following the shutdown of its nuclear power operations.

In addition to increased production of shale gas, huge conventional oil and gas resources in East Africa and the Eastern Mediterranean provide new opportunities, as do potential intercontinental pipelines in Southeast Asia, the Middle East, and Europe. Moreover, the potential reemergence of Iraq and Iran could significantly change the geopolitical gas market.

Currently we are seeing moves toward delinking the traditional price indexation between gas and oil, which would have profound implications for the gas market and create downward pressure on international oil prices. Such a change in prices could instigate major geopolitical challenges. In addition to any new international conflicts triggered by this delinking, a dip in revenues for Russia could affect domestic stability. Russia has long used its gas revenues to subsidize domestic energy prices, and LNG from Norway, Angola, Nigeria, and Qatar moving into English and Belgian gas hubs has put further pressure on Russian gas prices. As Russia is at risk of losing its current market share, some believe the future of Russian gas lies on

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developments in the high Arctic. Regardless of where the gas markets gravitate, import costs will continue to remain high worldwide.

Many nations also remain interested in the debate about the prospects for American LNG exports. These countries hope to decrease their import bills from less stable Russian and Middle Eastern markets. Many industrialists have voiced their opposition to LNG exports from the US, arguing that the US would benefit more from keeping the gas at home for feedstock. In May 2012, Brookings issued a report on LNG exports from the US, concluding that only 7 billion cubic feet (bcf) of LNG is expected to be exported by the mid-2020s. In fact, after 2020, Brookings predicts more LNG exports coming into the market from Australia, a country that could emerge as the largest LNG supplier in the world. When combining this projection with the potential of new suppliers from the Middle East, East Africa, and the Eastern Mediterranean, it seems the world will be awash in gas.

...it is important that not to overlook the too often-forgotten people who are at stake in the global debate on energy security today.

In the midst of this energy revolution two problems continue to be increasingly difficult to address. First, 1.2 billion people worldwide have no access to electricity whatsoever. Billions of others hold only limited access to energy and light, often in inefficient forms such as candles and matches. This reality has prompted a clarion call from UN Secretary General Ban Ki-moon for increased access to modern energy sources for all the world's citizens by 2030. Second, the earth's atmosphere and oceans have warmed, snow and ice have decreased, sea levels have risen, and greenhouse gas emissions have increased as a result of anthropogenic climate change. The Kyoto Protocol's goal of keeping the average yearly rise in temperature below 2°C will not be met.

Throughout this forum, while implications of the shale gas revolution in shaping economic, energy, and environmental policies are investigated, it is important not to overlook the too-often-forgotten people who are at stake in the global debate on energy security today.

Panel One: The Geopolitics of Energy Supply

Moderator:

Charles Ebinger

Senior Fellow and Director, Energy Security Initiative
Brookings Institution

Panelists:

Michael A. Levi

David M. Rubenstein Senior Fellow for Energy and the Environment
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Charles Ebinger



Michael A. Levi



Nobuo Tanaka

In the 20th century, access to petroleum served as the key indicator of energy security for a country. In the 21st century, energy solutions will take a more comprehensive approach, with a variety of energy resources considered for consumption. Today's resources include oil, gas, coal, and nuclear energy in addition to renewable resources such as solar and wind. Questions remain over how such an initiative will be worked into a broader security framework, especially amidst the tremendous rise in energy demand in Asia in the short-, medium-, and long-term.

Access to shale gas will provide great potential for energy diversification in the world's total consumption mix. According to the International Energy Agency (IEA), oil dependency will decline to less than 30% of consumption in the OECD by 2035. Owing to its domestic shale revolution, the United States is strongly considering exporting its gas – a move that could have profound implications for countries that are over-dependent on nuclear power such as Japan and



South Korea. Furthermore, as US dependency on Middle East oil is projected to decline dramatically by 2035, tensions may diminish along the Strait of Hormuz, through which 40% of the world's oil currently passes.

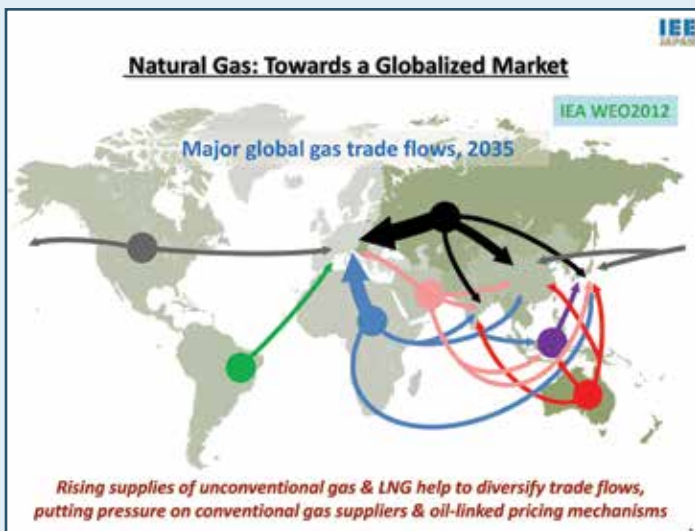
On the other side of the world, China is preparing for a series of pipelines that would carry fuel throughout South Asia and the Middle East as a way of reducing its dependence on the Strait of Malacca, a major chokepoint in Asia. In addition, China is building up its naval assets. These activities raise new security challenges which the world must untangle. Some Chinese government officials view the US presence in the Strait of Malacca as a threat to cut off the free flow of oil in the event of a conflict. US officials, on the other hand, have discussed the importance of maintaining a presence in the interest of the free flow of oil through the chokepoint. While some of these challenges may have a cooperative element, others will be more competitive. Continuing American global hegemony is uncertain, and with this uncertainty come questions as to whether the US will continue to help protect sea lanes for allies like Japan and what role China will play.

In Japan the cost of electricity is exorbitantly high, having increased by 20% since 2005. Despite the temporary shutdown of the country's nuclear power operations, nuclear power will still expand around the world. In Japan and elsewhere the crucial

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adjustment in nuclear policy calculations will be centered on the importance of safety. According to the 2013 IEA World Energy Outlook, nuclear capacity will reach 580 GW by 2035. The potential for clean energy from nuclear power will not disappear. The US and Japanese private sectors have a key opportunity to collaborate on nuclear power efforts, as GE-Hitachi's nuclear steam supply system and advancements in pyroprocessing have demonstrated. Japan is also pushing for an LNG futures market. The country's Ministry of Economy, Trade, and Industry (METI) has openly expressed its eagerness to build out a market for gas, as Japan expects natural gas imports from the US will lower the cost of importing energy. Yet expansion of the Asian gas market is restricted, as traditional long-term contracts face substantial destination cost limitations which particularly affect island countries like Japan and Indonesia. Furthermore, competition among LNG players spans the world. Within this context, it is important that discussions on LNG markets are international and address the role of various players, including future regional hubs like Singapore and the United States. Such collaboration could be a first step towards a more collective model of energy security.

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South Korea's need for reprocessing capabilities drives its interest in growing its nuclear power industry. Whether Korea reprocesses its plutonium, however, is a decision with large geopolitical implications for the United States. One approach to nuclear fuel reprocessing would be for Japan, Korea, and the US to join efforts in developing a reprocessing plant. Allowing Korea to develop safe reprocessing of plutonium would be a smart geopolitical move for the United States. Such a move could also set a precedent for the United States to engage in similar interactions with Japan.

Moving west, Russia will also play a significant role in future energy security discussions. As Russia worries about China's influence in the region, Japan becomes a necessary partner amid the shifting geopolitical landscape. Russia will eventually sell its gas to China, but it will also need to sell to Japan and Korea, who would offer a higher price. Russia also sees political and strategic risks associated with connecting to China by pipelines. In comparison, a pipeline connection with Japan remains a possible option. The Russian economy also depends heavily on Europe to import its gas. Europe has expressed tremendous concern on its dependence on Russian gas, particularly when the oil indexation prices are much higher than prices such as Henry Hub in the United States. In some parts of Europe, including Germany, a larger push toward policies to promote renewables draws attention away from prospects of developing local shale gas. In the case of the United Kingdom, however, a more market-oriented national energy policy makes developing shale gas more likely. In Poland, shale gas is an attractive alternative compared to its high

dependence on Russian gas. Furthermore, Poland is also facing new pressures from its opposite neighbor. Germany's nuclear phase-out and policies promoting renewables have led to extreme grid fluctuations and excess generation being dumped onto Poland's grid, leading Poland to consider disconnecting from the German grid. In other parts of Europe, for example Spain, a lack of capacity prevents connecting with neighboring countries like France. As a result these countries are subject to higher costs to incorporate renewable generation as they must maintain their vast gas power plants for backup. This situation shifts the cost of government subsidies for renewables onto consumer electricity bills. Meanwhile, in efforts to relieve some of its dependence on Russian gas, Europe is also attempting to build pipelines from the Caspian and Eastern Mediterranean. This apparent division in energy policies among European countries makes it harder to effectively address and devise alternatives to European dependence on Russian gas.

As worldwide fossil fuel consumption increases, the relationship between climate change and energy security become increasingly interlaced.

Climate change will become front and center in future discussions of energy and geopolitics. As worldwide fossil fuel consumption increases, the relationship between climate change and energy security become increasingly interlaced. The climate change discourse, however, appears to be heavily bifurcated with energy policy and environmental issues addressed within a vacuum. These issues cannot operate independently, and it is crucial that energy markets begin internalizing the costs that come with negative externalities. The IEA has attempted to address this issue by developing a series of models that establish a carbon price, which would also incentivize development of lower carbon technologies. Countries would need to commit to research and development supporting substantial amounts of nuclear power, more intermittent technologies like solar and wind, and carbon capture and sequestration (CCS) technology, among others. The prospects for climate change negotiations are certainly within the realm of possibility, but only on the condition that greenhouse gas emitters worldwide demonstrate their commitment to reducing greenhouse gas emissions.

Panel Two:

Meeting Environmental Challenges through Technology and Governance

Moderator:

Vaughan Turekian
Chief International Officer
AAAS

Panelists:

Jonathan Fink
Vice President, Research and Strategic Partnerships
Portland State University

Sean J. O'Brien
Ohio State Representative – District 63

Gretchen Goldman
Analyst, Scientific Integrity Initiative
Union of Concerned Scientists

The role that technology has played in shale gas development can be broken down into a wide array of issues. Before these issues are approached, however, there must first be clarity in the terminology and concepts that have become widely used. For instance, confusion abounds over the definition of hydraulic fracturing, or “fracking.” Oftentimes the term is used to refer to the entire process of drilling and extraction. Yet fracking is simply the process of injecting a high volume of hydraulic fracturing fluid (water, sand, and chemicals that serve as antimicrobial agents), at a high pressure that forces the formation to crack and release the resources. This is only one step of the process of developing shale oil and gas. Recent advances in horizontal drilling combined with the technology for fracking have allowed us to extract resources that are otherwise unobtainable. In some parts of the United States, fracking activities have taken place in highly populated



Vaughan Turekian



Jonathan Fink



Sean J. O'Brien



Gretchen Goldman

areas, leading to increased public awareness, especially at the local level.

Ohio is an example of one state in which natural gas has been a game-changer locally and beyond. Five years ago, no Ohio resident would have considered the prospects of oil and gas shaping the state's economy. Today, fossil fuel extraction is a major issue of debate with significant impacts on the state's economy and environment. Economically, the state is creating jobs at high rates with significant investments flowing in from BP and other multinational corporations. Ohio is now actively addressing a wide range of security issues affecting the state as a result of the shale gas activities there. The state thus serves as a fitting case study for some of the technical, environmental, and political challenges that exist around gas extraction today.

Other states that do not have vast gas reserves turn their focus to the demand-side of natural gas. Oregon, for instance, is exploring ways in which energy consumption can be reduced on an individual and collective level, as this shift would have positive implications for climate change. Yet, as a port state, Oregon depends heavily on exports

for its economic development. Cheap gas supplies to fuel its manufacturing and export businesses are, consequently, a critical element in the state's economic strategy.

The Center for Science and Democracy released a report outlining the three largest challenges to policymaking with regards to natural gas. The first challenge noted is that researchers are often restricted in their ability to access the necessary information to make measurements and evaluate the environmental impacts of shale gas activities. Improved access and analysis would allow citizens and policymakers to be more accurately informed as they explore policy options surrounding shale gas development. It is crucial that science plays a key role in shaping policies that directly impact oil and gas activities and the local communities. Second, gas development has been regulated very little at the state level because states are allowing municipalities to set their own policy. This leads to a lack of comprehensiveness in overall governance towards gas issues. Finally, the third major challenge is related to public access to information. It has

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become increasingly difficult to distinguish reliable, technical information from inaccurate data. Ultimately, ensuring proper access to public information will empower communities to have a larger voice supported by an educated understanding of energy issues in their own backyard.

The report does not address, however, the deficiency in workforce development and training in the natural gas sector. Obtaining the knowledge and technical capacity needed to develop and operate drilling rigs requires highly specialized skills. Education is just one area in which there is a tremendous amount of opportunity to bolster policy coordination between federal, state, and local governments. As noted previously, states approach such opportunities in a variety of ways. In Ohio, the education

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system has recently recognized the importance of skill-building in these areas. Community colleges have taken initiative in addressing this challenge, with two-year degrees now offered in specific aspects of drilling such as welding. This change will have a major impact on employment in Ohio in the short-, medium-, and long-term. It will also translate into increased demand for such programs at universities nationwide.

In Texas, where there is a strong local precedence by which towns have exceptional power over what happens in their communities, a nuanced system of how to regulate energy extraction practices has developed. Other states that may not have such a regulatory

structure in place must, inevitably, rely on federal guidance. In Pennsylvania each township has a voice, much like in Texas, which has created a challenging environment for industries operating in the area. With regulations varying by district, it is difficult for companies to comply with each separate standard. In contrast, Ohio saw \$5.4 billion dollars in capital investments by industry in 2012, with \$4 billion as a result of shale activities and 43% of the state's economic development centered on the gas industry. Shale gas prospects offer an opportunity for state economies to grow at unprecedented rates, especially if colleges and universities increasingly provide the necessary skill sets for graduates to enter the energy sector.

Closing Remarks

Yasuo Tanabe
Vice President and Executive Officer
Hitachi, Ltd.

This forum has addressed many critical issues surrounding shale gas development

and its economic and geopolitical implications. With this multidisciplinary conference, we have learned about the crucial role that policy, technology, science, engineering, the environment, effective governance, and human resources inevitably play in shaping the future energy

security paradigm. This forum has confirmed the tremendous value of collaboration among such reputable organizations as Hitachi, AAAS, and Brookings.



Yasuo Tanabe

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