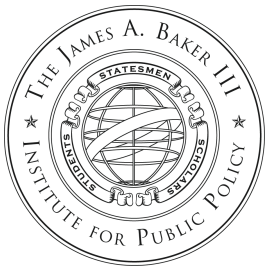

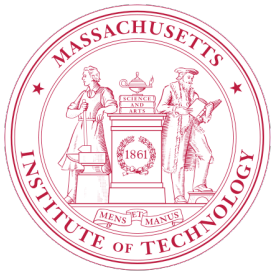

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Grasping Opportunity: Why It Is Important and What Should be Done

by

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Introduction

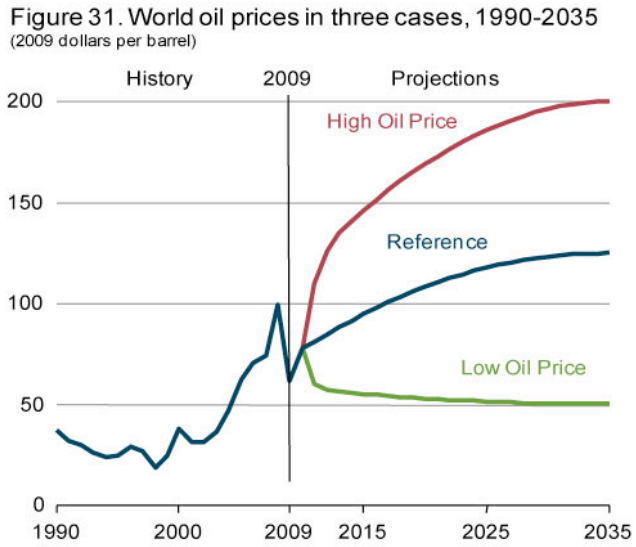
The size of the energy infrastructure and the scale of investment needed to shift the composition of energy supply or the nature of energy demand leads us to anticipate slow, if not imperceptible, change in energy markets. However, from time to time there can be a development—a shift in policy or expectations—that has a significant effect on energy trends. We are here at the North American Resources Summit to discuss such a development today[1]: the unexpected massive increase in the estimate of economically recoverable natural gas, and to a lesser extent oil, especially from shale deposits in North America, and by implication, from other shale bearing regions elsewhere in the world.

This morning I wish to make three points to frame the discussion. First, the potential positive impacts of this increase are enormous but as yet not fully appreciated by the public, business, and the nation's political leadership. Second, we should be cautious in assuming that the appearance of such an opportunity will necessarily lead to a favorable outcome. There are significant environmental challenges to the successful and responsible widespread shale gas deployment. Absent serious action to reduce the environmental impact, not just talk about the need for such action, we run the risk of losing the public's confidence in this technology and delaying or prohibiting its growth. Third, the U.S. government should adjust its policies, and industry should adjust its practices, to maximize the benefits of this welcome new energy opportunity. Unfortunately, my impression is that neither government nor business is doing what needs to be done, and therefore we are implicitly assuming that past practices are adequate to deal with this entirely new opportunity.

International Implications

The benefits of a large shift in the global supply curve for oil and gas are both political and economic. There is the prospect that the demand from the rapidly growing, large emerging economies of Asia can be met at lower prices. The U.S. Energy Information Administration (EIA) International Energy Outlook 2011 reference case projects the world oil price to increase gradually throughout the period 2010 to 2035 to about $125 per barrel. However, I would urge

you not to overlook the EIA low price case that projects a gradual decrease in oil prices during this period to $50 per barrel.[2] This is a very wide range but perhaps a realistic representation of the uncertainty in oil markets for the next several decades.



Increase in the supply curve creates the opportunity for two additional significant changes. First, the historic separation of the North American, European, and Asian natural gas markets with widely different gas prices [$4/million cubic feet (MCF) in the United States, $14/MCF in Tokyo or Shanghai] could be replaced over time by a global gas market, enabled by expansion of liquefied natural gas (LNG) trade and the inexorable extension of pipelines. Second, there presently is an unprecedented difference between the energy equivalent cost of natural gas and oil in North America (over 4x) that is expected to persist over time. Such a large disparity presents a tremendous economic incentive to substitute natural gas for oil in a variety of uses: for electricity generation, for industrial operations, and eventually as a transportation fuel for light- or heavy-duty vehicles.

These market factors—more abundant resources, low cost oil and gas supply, possible evolution to a global natural gas market, and substitution of natural gas for oil in the transportation sector—have tremendous geopolitical implications for North America.

The geopolitical implications are far-reaching, and the linkage between domestic and international implications should not be forgotten. First, global reserves of natural gas are growing at the expense of traditional major natural gas resource holders—for example, Iran, Russia, and Qatar.[3] These traditional suppliers will lose market power to set prices (a welcome change in gas trade negotiations for German and other Eastern European importers of Russian gas), and there will be a large adverse wealth effect for traditional resource holders (Iran, Qatar, Algeria). Expensive natural gas development and pipeline projects undertaken at a time when natural gas was expected to be in short supply and prices high will need to be reexamined, and indeed some of these investments may be underwater. The United States, just four years ago projected to be a significant importer of LNG, is now seriously considered to be a potential exporter of natural gas, although a significant level of exports would surely create significant domestic political opposition.[4] The conclusion is that massive increase in world natural gas (and, of course, oil) reserves outside the Persian Gulf region and the diversity of supply reduces the market power of the traditional Middle East resource holders and lowers expected market prices—all factors that reduce, but certainly do not eliminate, energy security concerns.

Implications for the United States

There are multiple benefits from increased production of natural gas and oil from shale. Most importantly, domestic production means jobs, rather than payments for imports, that contribute to the country's balance of payments deficits. The cost of production tends to be lower than most conventional oil and gas plays and less than offshore or production from extreme areas, so consumers benefit from lower prices.

If North America and the United States are entering a period of relative plenty for oil and gas, it is interesting to speculate about how much our import dependence might be reduced. This requires an assessment of the liquids budget of the region in the near to mid term. What are the prospects for a significant reduction in the region's dependence on imported oil and gas? A useful starting point for considering this question is the EIA Annual Energy Outlook (AEO) 2011 projection of the U.S. liquids fuel supply and disposition budget out to 2035 [for the reference case (Table A-11)]. For 2025, the EIA projects that the United States will be importing

43 percent of its total liquid fuel consumption from net imports of crude oil and petroleum products compared to 52 percent in 2009.

There are several reasons to believe that this projection is too conservative. This is not the occasion to analyze the many different factors that must be considered,[5] but suffice it to say that there are several reasons for greater optimism that the percentage of the region's liquid fuel needs can be met from regional sources:

- The EIA considers Canadian supply as imports. Canada supplied about 2.0 million barrels per day (b/d) of crude and product in 2010, and this amount could increase by 500,000 b/d or more by 2025.[6]
- The EIA has historically been conservative in its estimates of U.S. domestic oil production. Given the prospects for greater production of shale oil, it is quite possible that domestic oil production will be 500,000 b/d or more above the EIA estimate by 2025, although domestic oil production expansion is uncertain because of regulatory and political uncertainties.
- The EIA projects a robust expansion of biofuels production at an annual rate of 4.7 percent to 1.92 million barrels of oil equivalent per day (boe/d) in 2025 based on current policy. More aggressive Renewable Fuel Standards, other government policy measures and subsidies, as well as progress in reducing the production cost of biofuels, could increase the biofuels contribution by several hundred thousand barrels per day by 2025.
- The United States exports about 1.9 million b/d of petroleum products. Measures could be taken to restrict these exports and redirect this supply stream to domestic consumption. Such a policy would be controversial and, of course, would require U.S. trading partners to find alternative sources of supply that would offset the benefit of import reduction in the broader collective security context.

Finally, I stress the potential of natural gas over time to substitute for liquid fuels in the transportation sector either as compressed natural gas (CNG) in light duty vehicles (LDVs) or as gas-to-liquids (GTLs).

Therefore, I adjust the EIA projections accordingly: Treat Canadian imports as domestic (i.e., regional) production and assume an additional 1 million b/d source of domestic liquid fuels

above the EIA 2025 projection.[7] Under these circumstances, the import dependence of the United States falls to 29 percent, within striking range of the 20 percent target that is put forward as an appropriate target for energy independence.[8]

There are two main points: The United States and North American oil and gas supply will be an increasingly important factor in world markets. The past image of the United States as helplessly dependent on imported oil and gas from politically unstable and unfriendly regions of the world no longer holds. Second, the anticipated increased supply and lower production cost of natural gas means greater use of natural gas, first in the power sector, and then in the transportation sector, challenging the traditional view that there is little opportunity to substitute domestic gas for imported oil. These developments benefit both the U.S. consumer because of lower energy prices, and energy security because of a more stable source of supply.

The Challenges

Realizing the benefits of conventional shale gas and oil requires continued expansion of exploration, development, and production. In the past few years shale gas activity in the United States has expanded rapidly and moved into regions of the country that are not traditional oil field areas, e.g., the Marcellus. Shale gas production has developed hydraulic fracturing as a large-scale industrial process. While this activity certainly has brought economic benefit, as discussed above, the speed and extent of the activity also creates concerns for the public, especially from those in the community who do not directly benefit economically from work or a financial interest in producing property but still bear some negative repercussions from the activity. However, of all the factors that motivate opponents, unquestionably adverse environmental impact is the most important.

The greatest public concern remains the risk that hydraulic fracturing fluids will contaminate drinking water. Fracturing fluid is well over 95 percent water and sand, and it is injected into oil- and gas-bearing shale layers many hundreds to thousands of meters below the water table. The chance of migration from the level of insertion to the water table is extremely remote, and indeed there are few, if any, documented examples of migration taking place by this pathway. If

fracturing fluids appear in a neighboring well, it is almost certainly due to leakage from poor cementing and casing in the well completion or a result of surface spillage. This issue rose to prominence because of industry's unfortunate initial decision to refuse full disclosure of the composition of the fracturing fluid on the dubious grounds of protecting intellectual property. Whatever the theoretical merit of the argument, the effect on public confidence has been significant, and the question of fracturing fluid composition disclosure remains very much alive, even as industry and state regulators have moved to requiring full disclosure.

Faced by genuine but exaggerated public concern about the effects of hydraulic fracturing on water supplies, industry has responded with three arguments: The economic benefits of hydraulic fracturing outweigh the environmental cost; tens of thousands of wells have been fractured with little adverse effect indicating the present fracturing activity is safe; and state regulation on private lands adequately protects the public health and safety. Each of these arguments fails to meet the public concern: The issue is not the economic benefit, but reducing environmental impact and risk of the production. Current use of hydraulic fracturing is on a vastly larger scale and more sophisticated than in the past, so past fracturing experience has limited relevance. Finally, although many of the state regulatory agencies are diligent in protecting the public interest, their rule-making, inspection, and enforcement activities could be more transparent, and avoid the tremendous regulatory complexity, overlapping jurisdictions, and bickering between state agencies and the U.S. Environmental Protection Agency (EPA).

Shale gas and oil production have significant environmental impact that go beyond hydraulic fracturing to affect the entire production process. The environmental impacts can be divided into four broad categories: water quality, air quality, community impacts, and managing the longer-term consequences of the economic development that the anticipated expansion of shale production will bring to a region. In his March 2011 *Blueprint for A Secure Energy Future*,[9] President Barack Obama directed Secretary of Energy Steven Chu to form a Subcommittee on Shale Gas Production of the Department of Energy's Energy Advisory Board (SEAB), which I chaired, to recommend steps that should be taken to reduce the environmental impact of this activity. The subcommittee released its unanimous report in August 2011, presenting 20 recommendations for reducing the environmental impact of shale gas production.[10]

I do not intend this morning to describe or discuss the specific recommendations that addressed all aspects of environmental impact and safety of shale gas production. Let me just say that the recommendations addressed the need for a systems approach covering all aspects of water management from acquisition to storage, to disposal (the EPA has a study underway scheduled to be completed in 2014 on the water quality impacts of hydraulic fracturing); measurement and control of air pollutants, especially methane (a potent greenhouse gas), from hydraulic fracturing sites; and several measures that would increase the transparency of public information about hydraulic fracturing as well as more effective tools for state regulators.

The subcommittee was unanimous in the view that the environmental challenges of hydraulic fracturing were serious, and that given the expectation of a vast expansion in this activity, more attention was needed toward reducing environmental impact. Public concern about fracturing is not abating; indeed it is my impression that public concern is increasing; advocacy groups are more active in seeking to delay development; and more issues are being raised, e.g., induced seismicity, impaired visibility. It is highly uncertain that unconventional shale gas and oil development will be able to increase as projected, unless effective and comprehensive measures are taken to manage environmental impact.

What Needs to be Done?

Successful regulation requires two steps. The first step is to set allowable performance standards. The process for setting such standards involves regulators, industry performers, and public interest groups. Ultimately, this is a political process that weighs economic benefits against the cost of mitigating environmental damage. All agree that there needs to be a strong and transparent regulatory capacity to set these standards if the public interest is to be protected and a reasonable balance reached. More attention should be given to assuring that quality technical and economic information is available to inform the standard setting process. The current typical rule making process is often procedural and not based on a direct system analysis of how best to address the environmental problem, thus there is procedural rather than substantive resolution of environmental issues.

The second necessary action concerns compliance with performance standards. Compliance can be done by inspection and enforcement of regulators or by certification by permit holders, subject to strict penalties if violations are discovered.

Both the setting of performance standards and the procedures for determining compliance should be dynamic so as to allow for a process of continuous improvement based on field experience. This is especially important for shale gas and oil production because the techniques of hydraulic fracturing and production are advancing rapidly. Happily, many of the advances motivated by commercial considerations are accompanied by significant environmental advantages. An example is the move from single well drilling to drilling multiple wells from a single pad, reducing by up to 60 percent the amount of surface activity, such as truck traffic, needed to reach the desired production level. In the future, the use of near real time monitoring to guide the injection of fracturing fluid could reduce fluid requirements by a factor of two or four, resulting in a corresponding reduction in the amount of flow-back and produced water that must be managed on the surface. There is good reason to believe that technical advances will offer significant opportunity to reduce the environmental burden of production, and hence the prospect of continuous improvement should be an integral part of any regulatory strategy.

What are the options that might place greater emphasis on reducing environmental impacts? There are three choices: First, one might choose to "muddle through," retaining confidence that the existing pattern of regulation and industry practices will adapt to the anticipated expansion of activity in a balanced, efficient, and timely way. Some would say this is the only realistic option because of the difficulties in making current practices more constructive. I infer that this choice best describes the current situation.

Second, one might choose to adopt a more comprehensive and aggressive regulatory regime to oversee activity. This option would require a difficult and acrimonious debate about sharing of responsibility for regulation on private lands between the EPA, at the national level, and states. There are few advocates for federal preemption, and even fewer believe that the current political climate would reach this result. Accordingly, this choice would require a mechanism to be

crafted to give states the incentive to strengthen their regulatory activity and perhaps to define broadly the range of activities to be regulated.

The third choice is for industry to take a much more proactive role than it has done in the past. The SEAB Shale Gas Subcommittee stressed the importance of continuous improvement in environmental performance based on measurement and disclosure of key indicators in field engineering and environmental operations. The subcommittee saw virtue in this approach compared to prescriptive regulation, because it acknowledges that a single "best practice" or "minimum acceptable" performance standard is difficult to define and does not place an incentive on doing better over time. This approach focuses on system performance, such as comprehensive water management at an operating site, rather than segmented regulatory procedures, and allows for the variability encountered in engineering practices in the widely different shale plays.

While defining key indicators requires involvement of industry operators, state and federal regulators, and public interest groups, the design and execution of an "improvement by measurement" process in the field necessarily need to be done by industry operators. Importantly, this approach also serves the company's interest of learning how to improve the efficiency and hence the profitability of operations.

I believe that if industry becomes more proactive in its commitment to reduce environmental impact by establishing a policy of "improvement by measurement," there is a good prospect of establishing better trust and confidence with both regulators and the public. I recognize that there are many hurdles to establishing an effective, proactive, industry wide policy: There is a wide range of capability and practices among oil field companies and a tremendous diversity in resource conditions. Nevertheless, a successful initiative, even on a selective basis, could demonstrate significant progress in environmental performance. This would be a welcome change to the worn out image of industry seeking to achieve its ends by means of lobbyists and Washington attorneys.

I want to stress strongly that the suggestion that industry take a more proactive role based on "improvement by measurement" is not a suggestion that industry regulate itself. The activities to be measured, the required level of performance, the pace at which critical measures should improve would be set by regulators as would compliance. My suggestion shifts greater responsibility to industry for demonstrating progress in reducing the environmental impact of its activity.

What is Being Done?

Federal officials, industry leaders, and regulators share a common appreciation of the potential benefits of shale production. They also share a keen appreciation of the growing opposition from environmental groups and the growing concern among the public about the pace and scale of this activity. Few responsible observers suggest that slowing the pace of the activity is the answer; all observers are keen to find practical and effective measures for reducing environmental impacts from shale production. Companies are exploring different ways to work with regulators and the public. A constructive example is the Marcellus Shale Coalition where industry is working at the regional level with regulators, communities, and public interest groups to address local development issues.[11] State regulators have formed groups, notably STRONGER (State Review of Oil and Natural Gas Environmental Regulations)[12] and the multi-stakeholder Ground Water Protection Council[13] to share information about shale production regulatory practice and experience, but these efforts have been hampered by lack of resources. At the federal level, attention is dominated by budget stringency and the upcoming election with little concerted action: EPA proceeds to carry out its responsibilities, but at a very slow pace. The Department of Interior's Bureau of Land Management is expected to issue to requirements on disclosure of hydraulic fracturing composition but not much more; the United States Geological Service continues its excellent, but modest, research effort on shale oil and gas resource issues. The Department of Energy's modest R&D effort has almost ground to a halt by budget constraints.

Taken as a whole, one cannot characterize the country's response to unconventional oil and gas opportunity as either effective or enlightened. In the distant past, another promising energy technology, nuclear power, stumbled because of lack of attention to the issues of waste

management and safety that concerned the public. In the recent past, another deep offshore oil production came close to extinction because of poor engineering practice and regulatory oversight. I do not want to see this happen to unconventional oil and gas production in North America. And the best way I know to avoid this possibility is for industry, highly capable and certainly motivated by financial return, to step up and do its job better.

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[1] Interestingly, there are two other significant energy developments that have occurred to change the energy outlook. This first is the March 2011 accident at the Japanese Fukushima-Daiichi nuclear power station that has significantly slowed the expected expansion of nuclear power around the world. The second is the failure of the 17th Conference of the Parties (COP) meeting in Durban, South Africa, during November 2011 to agree on a way forward to reduce the dangers of climate change or extend the Kyoto protocol.

[2] U.S. Department of Energy, Energy Information Administration, International Energy Outlook, 2011; available at: http://www.eia.gov/forecasts/ieo/liquid_fuels.cfm.

[3] The CIA World Fact Book lists the top eleven as: Russia, Iran, Qatar, Saudi Arabia, the United States, Turkmenistan, the United Arab Emirates, Nigeria, Venezuela, Algeria, and Iraq. https://www.cia.gov/library/publications/the-world-factbook/rankorder/2179rank.html.

[4] Disclosure: I am a director of Cheniere Energy, which is an LNG importer and aspires to be an exporter of LNG.

[5] Robin West and his colleagues at PFC Energy are undertaking a careful analysis of this question.

[6] See EIA's report on U.S. oil imports by country: http://www.eia.gov/pub/oil_gas/petroleum/data_publications/company_level_imports/current/import.html.

[7] Amy Myers Jaffe correctly notes that there are several industry projections that significantly exceed the 2025 EIA production estimates.

[8] R. James Woolsey, "Turning Oil into Salt," *National Review,* September 25, 2007, at http://energy.nationalreview.com/post/?q=OTlmMjFjYWRjOWI3ZGI0MzUxZDJjYTBlMmUzOTc2Mzc= .

[9] The president's March 30, 2011, energy plan is available at http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf.

[10] The SEAB Subcommittee initial report of August 18, 2011, and final report of November 18, 2011, are available at the subcommittee website: http://www.shalegas.energy.gov/.

[11] See: http://marcelluscoalition.org/.

[12] See: http://www.strongerinc.org/.

[13] See: http://www.gwpc.org/home/GWPC_Home.dwt.