

**U.S. HOUSE OF REPRESENTATIVES  
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

**HEARING CHARTER**

***Tapping America's Energy Potential Through Research and Development***

Friday, November 30, 2012  
9:30 a.m. -11:30 a.m.  
2318 Rayburn House Office Building

**PURPOSE**

On Friday, November 30, 2012 at 9:30 a.m. in Room 2318 of the Rayburn House Office Building, the Science, Space, and Technology Subcommittee on Energy and the Environment will hold a hearing titled, "*Tapping America's Energy Potential Through Research and Development.*" The purpose of the hearing is to receive testimony on research needs and priorities relating to unconventional oil and natural gas resources. The Subcommittee will also receive testimony on H.R. 6603, the "*Tapping America's Energy Potential Through Research and Development Act of 2012.*"<sup>1</sup>

**WITNESS LIST**

- **Dr. Anthony Cugini**, Director, National Energy Technology Laboratory, Department of Energy
- **Mr. David Martineau**, Chairman, Texas Independent Producers and Royalty Owners Association
- **Dr. Daniel Hill**, Interim Department Head, Professor and Holder of Noble Chair in Petroleum Engineering, Texas A&M University
- **Mr. Michael Hagood**, Director of Program Development, Energy and Environment Science and Technology, Idaho National Laboratory

**BACKGROUND**

The United States currently ranks second and third in global natural gas and oil production, respectively.<sup>2</sup> The International Energy Agency (IEA) predicts the U.S. will overtake Saudi Arabia to become the world's largest oil producer by 2020 (Figure 1).<sup>3</sup> Domestic natural gas production is also projected to increase substantially, due to an anticipated 170 percent increase in shale gas production (Figure 2). America's resurgence as a leading global oil and gas producer can be credited in part to the development of specific enabling technologies, particularly the combination of horizontal drilling and hydraulic fracturing.

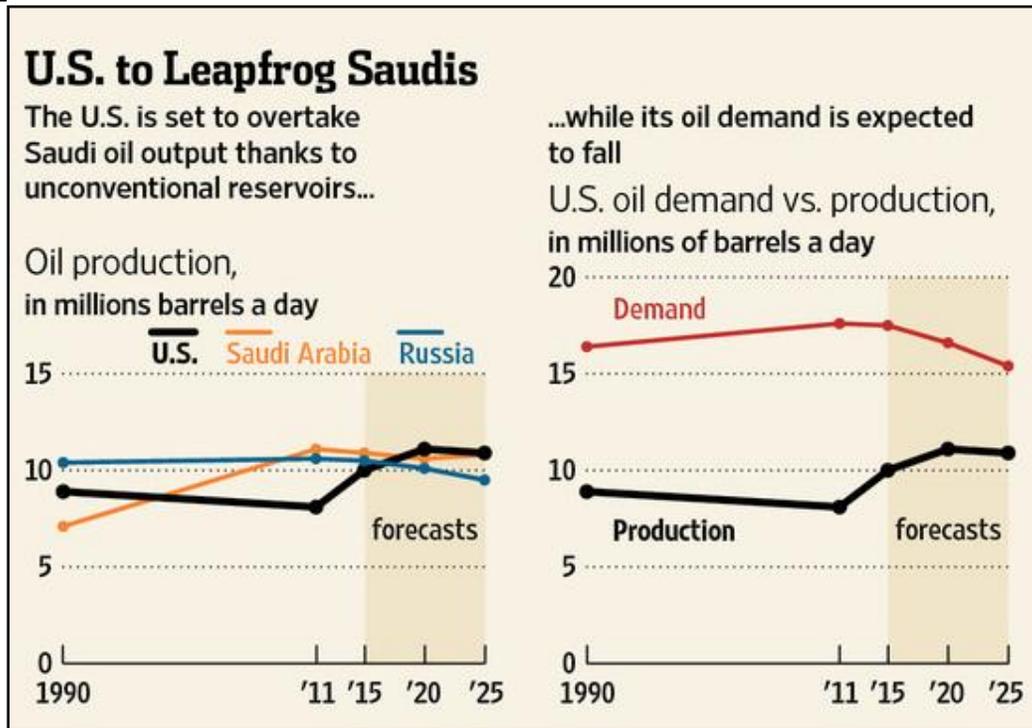
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<sup>1</sup> See Appendix A for the Section by Section Analysis of the "*Tapping America's Energy Potential Through Research and Development Act of 2012.*"

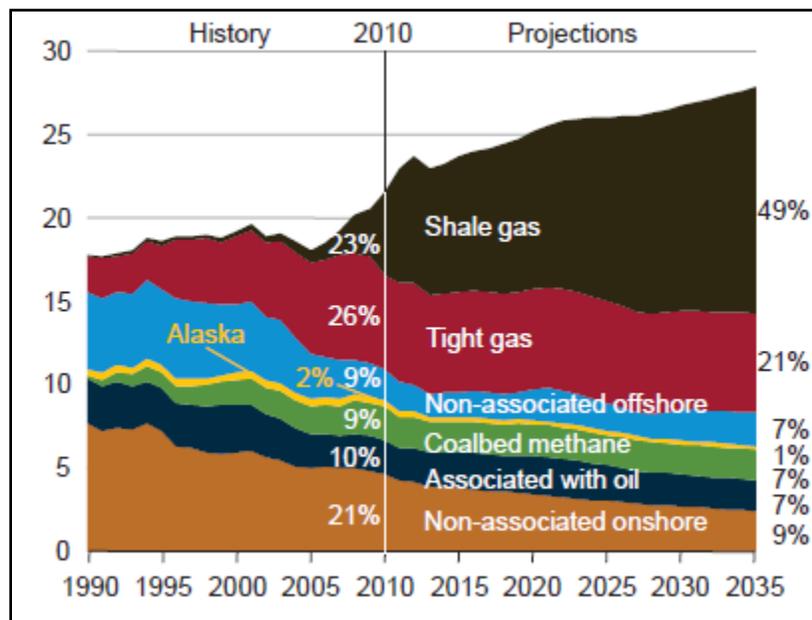
<sup>2</sup> CIA World Factbook. Accessible at: <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2249rank.html>

<sup>3</sup> International Energy Agency, World Energy Outlook 2012. Accessible at: <http://www.worldenergyoutlook.org/>

**Figure 1.** World Oil Production Outlook (source: Wall Street Journal; data from International Energy Agency).<sup>4</sup>



**Figure 2.** U.S. Natural Gas Production, 1990-2035 (trillion cubic feet).<sup>5</sup>



<sup>4</sup> <http://online.wsj.com/article/SB10001424127887323894704578114492856065064.html>

<sup>5</sup> <http://www.eia.gov/forecasts/aeo/er/pdf/0383er%282012%29.pdf>

Historically, conventional deposits have provided most of the oil and natural gas produced in the United States.<sup>6,7</sup> Conventional resources are generally considered to be resources recovered from a reservoir in which oil, natural gas, and water accumulate in a layered arrangement. Thus, unconventional resources can be defined as what they are not; they are those resources that cannot be produced, transported, or refined using traditional techniques. An unconventional deposit is one in which the distribution of oil and gas is throughout a geologic formation over a wide area, rather than within a discrete deposit. This category encompasses heavy oil, oil shale, and oil sands, as well as oil and natural gas produced from shale formations and methane hydrates.

- *Oil shale* refers to geologic deposits in which the petroleum component, kerogen, has not been fully transformed into oil or gas and must be heated to transform it into an upgraded hydrocarbon.
- *Tight oil or oil from shale formations (shale oil)* is produced using a combination of horizontal wells and fracturing to unlock hydrocarbons locked in low permeability and porosity siltstones, sandstones, and carbonates, or shale plays.
- *Shale gas or natural gas from shale formations* refers to natural gas trapped in fine grain sedimentary rock formations characterized by low permeability and porosity.

### **Department of Energy Unconventional Oil and Gas Programs**

The Department of Energy's (DOE) Office of Fossil Energy (FE) manages research, development, and demonstration (RD&D) activities for oil and gas technologies. Specifically, FE's Office of Oil and Natural Gas "supports research and policy options to ensure environmentally sustainable domestic and global supplies of oil and natural gas."<sup>8</sup> The National Energy Technology Laboratory (NETL) serves as the lead FE RD&D facility and manages much of FE's oil and gas technology research.

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<sup>6</sup> Whitney, Gene; Behrens, Carl E.; Glover, Carol. Congressional Research Service, "Us Fossil Fuel Resources: Terminology, Reporting, and Summary." November 30, 2010. Accessible at: [http://budget.house.gov/UploadedFiles/CRS\\_NOVEMBER2010.pdf](http://budget.house.gov/UploadedFiles/CRS_NOVEMBER2010.pdf)

<sup>7</sup> For more information on oil and gas resources, see Committee on Science, Space, and Technology Hearing Charter, "*Tapping America's Unconventional Oil Resources for Job Creation and Affordable Domestic Energy: Technology and Policy Pathways*," April 17, 2012, accessible at: <http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/HHRG-112-SY-20120417-SD001.pdf> and Subcommittee on Energy and Environment Hearing Charter, "*Supporting American Jobs and the Economy Through Expanded Energy Production: Challenges and Opportunities of Unconventional Resources Technology*," May 10, 2012, accessible at: <http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/HHRG-112-%20SY20-20120510-SD001.pdf>

<sup>8</sup> U.S. Department of Energy, Office of Oil & Natural Gas, updated May 7, 2012. Accessible at: <http://www.fossil.energy.gov/programs/oilgas/index.html>

**Table 1.** Department of Energy Unconventional Oil and Gas Funding (dollars in millions).

<b>Program</b>	<b>FY 2012 Enacted</b>	<b>FY 2013 Request</b>	<b>H.R. 5325, the “Energy and Water Development and Related Agencies Appropriations Act, 2013.”</b>	<b>S. 2465, “Energy and Water Development and Related Agencies Appropriations Act, 2013.”</b>
<b>Unconventional FE Technologies From Petroleum – Oil Technologies</b>	\$5.0	\$0	\$0*	\$5.0
<b>Natural Gas Technologies</b>	\$5.0	\$12.0	\$10.0**	\$12.0**
<b>Gas Hydrates</b>	\$10.0	\$5.0	\$5.0	\$10.0

\*House Appropriations committee mark recommended \$25 million “to be used to support both research to improve the economics of oil productions from shale oil, as well as to reduce the health, safety, and environmental risks associated with shale oil extraction”<sup>9</sup> By a vote of 208-207, the funding was removed during floor consideration.<sup>10</sup>

\*\* Funding to support DOE/EPA/USGS Interagency Collaboration. See “Interagency Effort on Shale Development.”

### **Federal Unconventional Oil Research and Development Activities and Legislative History**

Efforts to economically produce various sources of unconventional oil and gas were undertaken throughout much of the last century.<sup>11</sup> Recently, significant technology advances and high crude oil prices have regenerated interest in unconventional fuels production. The development of horizontal drilling permitted the use of hydraulic fracturing to economically produce shale oil and gas. Shale oil production enabled the development of the Bakken fields in North Dakota. North Dakota is now the second largest oil producing state, producing over 674,066 bpd, up from 45,000 bpd in 2007.<sup>12</sup>

<sup>9</sup> House Appropriations Committee Report, “Energy and Water Development Appropriations Committee Report, FY 2013.” P. 97. Accessible at: <http://appropriations.house.gov/UploadedFiles/EW-FY13-FULLCOMMITTEEREPORT.pdf>

<sup>10</sup> Roll no. 340 on House Amendment 1186

<sup>11</sup> INTEK, Inc., Prepared for the US Department of Energy, Office of Petroleum Reserves, “*Oil Shale Research in the United States: Profiles of Oil Shale Research and Development Activities in Universities, National Laboratories, and Public Agencies*,” Third Edition, September 2011. Accessible at: [http://www.unconventionalfuels.org/publications/reports/Research\\_Project\\_Profiles\\_Book2011.pdf](http://www.unconventionalfuels.org/publications/reports/Research_Project_Profiles_Book2011.pdf)

<sup>12</sup> North Dakota Petroleum Council, *North Dakota Oil and Gas Industry Facts and Figures*, September 17, 2012. Accessible at: [http://www.ndoil.org/image/cache/Facts\\_and\\_Figures\\_2012\\_9.17.pdf](http://www.ndoil.org/image/cache/Facts_and_Figures_2012_9.17.pdf)

## Energy Policy Act of 1992

Section 2012 of the Energy Policy Act of 1992 (EPACT '92) established a five year program to support research and development of oil shale extraction and conversion.<sup>13</sup> The program intended to support the development of economically competitive and environmentally acceptable technologies to produce oil shale in both the eastern and western oil shales. Section 2013 of EPACT '92 also created a five year program to increase the recoverable natural gas resource base through more intensive recovery of conventional natural gas, as well as the extraction of natural gas from tight gas sands, Devonian shales, or other unconventional resources.<sup>14</sup>

## Energy Policy Act of 2005

Section 369 of the Energy Policy Act of 2005 (EPACT '05) also contained provisions to facilitate the development of unconventional fuels.<sup>15</sup> For example, EPACT '05 directed the Bureau of Land Management (BLM) to begin leasing Federal lands for the purpose of oil shale and tar sands research and development (R&D) activities. The first round of research, development, and demonstration leases were awarded in 2006. A second round of leases were offered in 2009, resulting in two awards.

## Recent Federal Oil Shale-Related Activities

Section 369 of EPACT '05 declared oil shale and other unconventional resources as strategically important domestic energy resources that should be developed to mitigate the nation's dependence on foreign sources of oil and directed the Secretary of Interior to develop a commercial leasing program for these resources. Accordingly, in 2008, BLM formulated the Final Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS).<sup>16</sup> The final PEIS analyzed the environmental and socioeconomic impacts of amending 12 land use plans in Colorado, Utah, and Wyoming to designate public lands administered by BLM as available for commercial leasing and development.

In response to a 2009 lawsuit challenging the PEIS, BLM re-examined the land allocations, stating it would "reassess the appropriate mix of allowable uses with respect to oil shale and tar sands leasing and potential development in light of Congress's policy emphasis on these resources."<sup>17</sup> Following this review, BLM released a revised PEIS, which makes approximately 677,000 acres available for commercial oil shale leasing, and emphasizes R&D activities before the leases can be utilized for commercial development.<sup>18</sup> This new proposal amends ten BLM

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<sup>13</sup> P.L. 102-486

<sup>14</sup> Ibid.

<sup>15</sup> P.L. 109-58

<sup>16</sup> See Department of Energy, "Oil Shale and Tar Sands Programmatic EIS Information Center." Accessible at: <http://ostseis.anl.gov/>

<sup>17</sup> 2012 Final Oil Shale and Tar Sands Programmatic Environmental Impact Statement: Introduction. Accessible at: [http://ostseis.anl.gov/documents/peis2012/chp/OSTS\\_Chapter\\_1.pdf](http://ostseis.anl.gov/documents/peis2012/chp/OSTS_Chapter_1.pdf)

<sup>18</sup> Ibid.

resource management plans, and represents a significant reduction from the 2008 plan, which made available more than 2 million acres for commercial oil shale leasing.<sup>19</sup>

### Recent Federal Shale Oil and Gas Efforts

On April 13, 2012, President Obama issued an executive order establishing a “high-level, interagency working group to facilitate coordinated Administration policy efforts to support safe and responsible unconventional natural gas development.”<sup>20</sup> As outlined in the order, the interagency working group includes representatives from nine different agencies and four offices of the White House, and will work to support the safe and responsible production of domestic unconventional natural gas.

The group is tasked with coordinating agency policy activities and sharing scientific, environmental, and related technical and economic information. The group is also to engage in long-term planning and coordination among the appropriate Federal entities with respect to research, resource assessment, and infrastructure developments, and is required to consult with other agencies and offices as appropriate.

### Multi-Agency Collaboration on Unconventional Oil and Gas Research

To execute the Executive Order, the Environmental Protection Agency, Department of Interior and DOE signed a Memorandum of Understanding (MOU) in which they pledge to develop a multi-agency program directed toward a focused, collaborative interagency effort to address high priority challenges associated with unconventional shale gas and tight oil resources.<sup>21</sup> The stated goal of this effort is to:

“address timely, policy relevant science directed to research topics where collaboration among the three Agencies can be most effectively and efficiently conducted to provide results and technologies that support sound policy decisions by state and federal agencies responsible for ensuring the prudent development of energy sources while protecting human health and the environment.”<sup>22</sup>

The interagency program is also to address and respond to the White House’s 2011 “Blueprint for a Secure Energy Future” and recommendations made by the Secretary of Energy Advisory Board Subcommittee on Natural Gas.<sup>23</sup>

The agencies will identify research priorities and collaborate to sponsor work that improves understanding of the impacts related to development of our unconventional resources. The collaboration is intended to focus each Agency on its area of core competency, foster collaboration on research topics as appropriate, and bring coordination and consistency to the

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<sup>19</sup> Taylor, Phil, Oil Shale: Cheers, jeers for final Interior plan for Colo., Wyo., and Utah. E&E News PM. November 9, 2012. Accessible at: <http://www.eenews.net/eenewspm/2012/11/09/2>

<sup>20</sup> President Barack Obama, “Executive Order—Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources,” April 13, 2012. Accessible at: <http://www.whitehouse.gov/the-press-office/2012/04/13/executive-order-supporting-safe-and-responsible-development-unconvention>

<sup>21</sup> See Appendix B for the Memorandum of Understanding.

<sup>22</sup> Memorandum of Understanding, DOE, DOI, EPA, April 13, 2012. Accessible at: [http://www.epa.gov/hydraulicfracture/oil\\_and\\_gas\\_research\\_mou.pdf](http://www.epa.gov/hydraulicfracture/oil_and_gas_research_mou.pdf)

<sup>23</sup> Ibid.

annual budget process. The three agencies have established a steering committee and are currently in the process of formalizing a research plan, which is anticipated to be published in January of 2013.

The Administration requested \$12 million annually for three years for DOE's portion of the Interagency collaboration. The House Committee on Appropriations provided \$10 million in the Fiscal Year (FY) 2013 Energy and Water Appropriations bill to fund DOE's portion of the collaboration and the Senate Committee on Appropriations provided \$12 million in the FY 13 Energy and Water Appropriations bill.

## APPENDIX A

### Section-by-Section Analysis

**H.R. 6603** “*Tapping America’s Potential Through Research and Development Act of 2012*”

**Purpose:** To authorize research, development, and demonstration activities that increase energy security and affordability by enabling the safe and responsible production of the United States vast domestic unconventional oil and gas resources.

#### **Section 1: Short Title**

The Tapping America’s Energy Potential Through Research and Development Act of 2012.

#### **Section 2: Activities**

This section expresses the purpose of the activities authorized in the legislation.

#### **Section 3: Oil Shale Research and Development Activities**

Section 3(a) authorizes research, development, and demonstration (RD&D) activities to facilitate commercial application of energy technologies related to the exploration, development, and production of oil shale resources.

Section 3(b) states that RD&D objectives are to address scientific and technological barriers to enable economically feasible production of oil shale and minimize potential associated environmental impacts.

Section 3(c) directs the Secretary of Energy to provide Congress an implementation plan that details constraints and opportunities affecting oil shale development, identifies strategies to enable such development, and identifies and prioritizes research, development and demonstration activities and requires the Secretary to transmit this report to the House Committee on Science, Space, and Technology, and the Senate Committee on Energy and Natural Resources 9 months after enactment.

Section 3(d) allows the Assistant Secretary for Fossil Energy to conduct research and directs the Assistant Secretary to make awards to eligible entities for RD&D activities in areas that include (1) oil shale resource characterization; (2) modeling and simulation of oil shale exploration and production technologies including advanced diagnostics and imaging systems and advanced computing applied to the physics and chemistry of oil shale production; (3) minimization and re-use of water, including benchmarking of current water use rates for multiple production methods, potential reduction in water volume needed for operations, and recovery utilization, reduction, and improved management of produced water from exploration and production activities; (4) efficient use of energy in exploration and production activities; (5) utilization and exploration and production methods and materials that reduce the potential impact of such activities on the environment, including improved production methods for in-situ mining and ex-situ mining.

Section 3(e) requires the Secretary of Energy to provide Congress a report on the progress of oil shale research and development activities to the House Committee on Science, Space, and Technology and Senate Committee on Energy and Natural Resources 3 years after enactment.

Section 3(f) authorizes \$10,000,000 is authorized for each fiscal year from 2013 through 2017 for activities described in this Section.

#### **Section 4: Shale Gas Extraction Research and Development Activities**

Section 4(a) authorizes RD&D activities to facilitate commercial application of energy technologies related to the exploration, development, and production of oil, natural gas, and other liquid resources from shale formations.

Section 4(b) states that RD&D objectives are to maximize the benefits of the United States' shale oil and natural gas resources by advancing safe and responsible exploration, development, and production of shale oil and gas resources; minimize surface impacts from activities related to shale oil and natural gas production; focus on areas that provide benefits to the public and to industry; and advance the scientific and technological foundation available to producers, federal and state government agencies, and other stakeholders in identified research areas.

Section 4(c) allows the Assistant Secretary for Fossil Energy to conduct research and directs the Assistant Secretary to make awards to eligible entities for RD&D activities in areas that include (1) water use and demand, which may include potential reduction in the volume of water utilized for shale oil and natural gas production, and alternative materials, substances, or ingredients for use in shale oil and natural gas operations that could mitigate the need for or volume of water used; (2) water sourcing, which may include expanding options for sources of water used in shale oil and natural gas operations, and alternatives to groundwater or freshwater, such as but not limited to water recovered from other industrial or agricultural operations, brackish water, or surface water unsuitable for human or agricultural use in areas with water supply concerns; (3) materials used in shale oil and natural gas operations which may include increasing the efficiency of these operations by minimizing fluid use, improving the understanding of the relationship between additives used in fracturing and the chemical and physical properties of different shale formations, and enhancing permeability through improved proppants and other materials; and (4) diagnostic imaging and monitoring, which may include increasing understanding of the propagation of fractures within target zones, and advancing fundamental technologies that enable improved tracking and enhanced understanding of fracture movements.

Section 4(d) authorizes \$12,000,000 for each fiscal year from 2013 through 2015 for the activities described in this Section.

#### **Section 5: Produced Water Utilization Research and Development Activities**

Section 5(a) authorizes RD&D activities for environmentally sustainable utilization of produced water for agricultural, irrigational, recreational, power generation, municipal, and industrial uses, or other environmental sustainable resources.

Section 5(b) allows the Assistant Secretary for Fossil Energy to conduct research and directs the Assistant Secretary to make awards for RD&D activities, including improving safety and minimizing environmental impacts of activities, in areas that include (1) produced water recovery, including research for desalination and demineralization to reduce total dissolved solids in the produced water; (2) produced water utilization for agricultural, irrigational, municipal, and industrial uses, or other environmentally sustainable purposes; and (3) Re-injection of produced water into subsurface geological formations to increase energy production.

Section 5(c) authorizes \$5,000,000 for each fiscal year 2013 through 2017 for activities described in this Section

### **Section 6: Eligible Entities**

Section 6 specifies entities eligible to receive funding for activities authorized by the bill. Those entities include an institution of higher education, a national laboratory, a private sector entity, a nonprofit organization, or a consortium thereof.

### **Section 7: Program Administration**

Section 7 provides authority to the Secretary of Energy to enter into an agreement with a consortium to carry out research, development, and demonstration activities.

### **Section 8: Coordination**

Section 8 requires the Secretary of Energy to coordinate with, and avoid duplication of, research, development, and demonstration activities with other DOE and Government programs.

### **Section 9: Cost Sharing**

Section 9 requires all activities funded through the legislation follows cost sharing guidelines established by Section 988 of the Energy Policy Act of 2005.

### **Section 10: Limitations**

Section 10(a) prohibits the Department of Energy from funding research, development, and demonstration activities in technology areas that industry by itself is not likely to undertake because of technical and financial uncertainty.

Section 10(b) prohibits any activities funded through the legislation from supporting the establishment of regulatory standards or requirements.

### **Section 11: Definitions**

Section 11 provides definitions, including: Assistant Secretary, Institution of Higher Education, National Laboratory, Oil Shale, Produced Water, Secretary, and Shale Oil and Natural Gas.



MEMORANDUM

APR 13 2012

TO: Assistant Secretaries, National Laboratories  
 Department of Energy

Assistant Secretaries, Bureau Directors  
 Department of the Interior

Assistant Administrators, Regional Administrators  
 Environmental Protection Agency

FROM: Arun Majumdar, Acting Under Secretary of Energy  
 Department of Energy

David J. Hayes, Deputy Secretary  
 Department of the Interior

Bob Perciasepe, Deputy Administrator  
 Environmental Protection Agency

SUBJECT: Multi-Agency Collaboration on Unconventional Oil and Gas Research

**OVERVIEW:** In March 2011, the White House released a "Blueprint for a Secure Energy Future" (Blueprint) - a comprehensive plan to reduce America's oil dependence, save consumers money, and make our country the leader in clean energy industries. The Blueprint supports the responsible development of the Nation's oil and natural gas, with the specific goals of promoting safe practices and reducing energy imports. The Department of Energy (DOE), the Department of the Interior (DOI), and the Environmental Protection Agency (EPA) each will have a critical role to play in this mission.<sup>1</sup>

To this end, the DOE, DOI, and EPA will develop a multi-agency program directed toward a focused collaborative Federal interagency effort to address the highest priority challenges associated with safely and prudently developing unconventional shale gas and tight oil resources. The goal of this program will focus on timely, policy relevant science directed to research topics where collaboration among the three Agencies can be most effectively and efficiently conducted to provide results and technologies that support sound policy decisions by state and Federal agencies responsible for ensuring the prudent development of energy sources while protecting human health and the environment. This program responds to the Blueprint and to relevant recommendations of the Secretary of Energy Advisory Board Subcommittee on Natural Gas.<sup>2</sup>

<sup>1</sup> The 31 March 2011 *White House Blueprint for a Secure Energy Future* instructed the Federal Government to "conduct research to examine the impacts of fracking on water resources," directing the EPA and DOE to sponsor research ..."

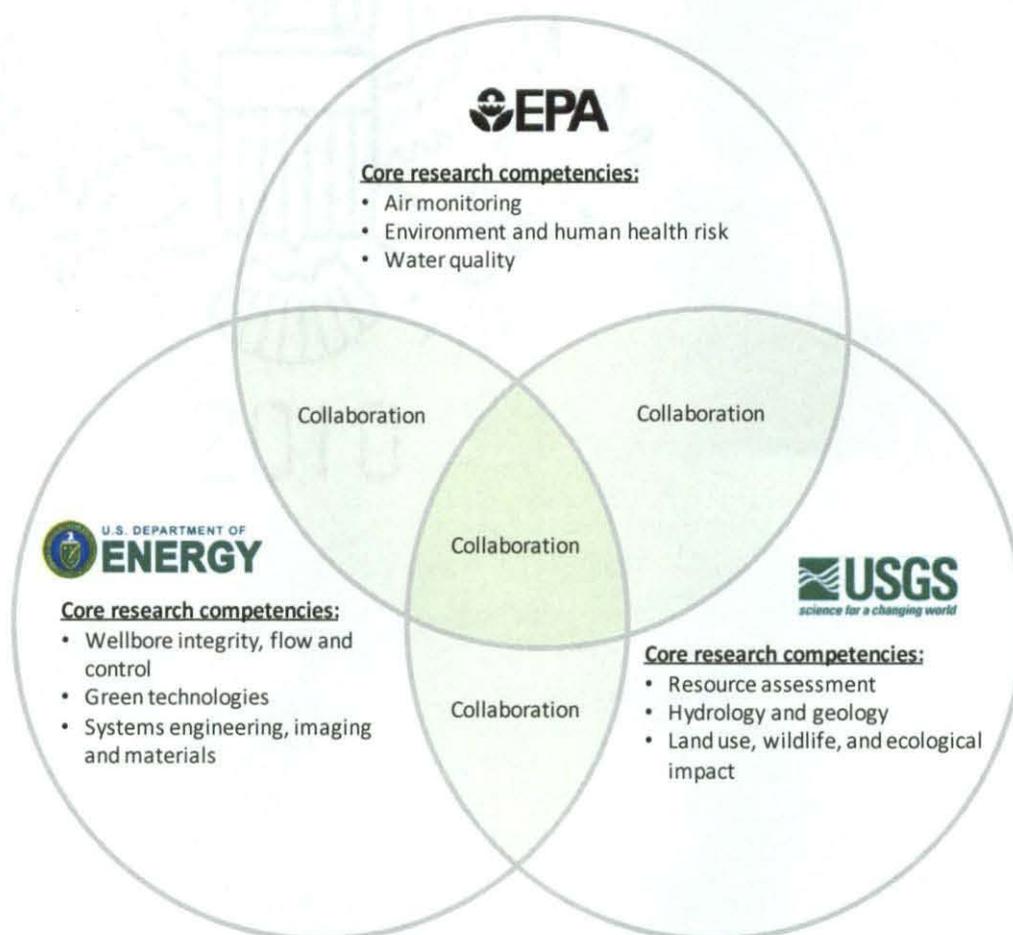
<sup>2</sup> The Secretary of Energy Advisory Board recommended that "the federal government has a role especially in basic R&D, environment protection, and safety" and recommends that the DOE, DOI and EPA "all have mission responsibility that justify a continuing, tailored, Federal R&D effort." [http://www.shalegas.energy.gov/resources/081811\\_90\\_day\\_report\\_final.pdf](http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf)

## Interagency Collaboration

The DOE, DOI, and EPA will identify research priorities and collaborate to sponsor research that improves our understanding of the impacts of developing our Nation's unconventional oil and gas resources and ensure the safe and prudent development of these resources. Through enhanced cooperation, the Agencies will maximize the quality and relevance of this research, enhance synergies between the Agencies' areas of expertise, and eliminate redundancy. The Agencies remain responsible for implementing their own authorities and internal priority-setting processes.

The goals of this interagency collaboration are as follows:

1. Focus each Agency on its area of core competency. Each Agency has a different combination of experiences, research strengths, personnel, resources, and mission mandates leading to complementary research core competencies.



The Venn diagram summarizes the core research competencies of each of the three Agencies. Further details can be found in the appendix to this memorandum.

2. Collaborate on research topics as appropriate. While each Agency will focus on its areas of core research competency, there will be tasks for which the combined capabilities of more than one Agency will be necessary to address a particular research topic.

An example of collaboration is research on water use for hydraulic fracturing, in which the EPA focuses on the impacts and effectiveness of current technology, DOE focuses on improvements that future technological innovations may yield, and USGS focuses on stream gage and groundwater monitoring to determine water availability, use, and groundwater flow modeling. Another example is the ongoing prospective case study in the Marcellus Shale that the three Agencies are currently collaborating on in support of the EPA's congressionally mandated study on hydraulic fracturing. Where practical and advisable, efforts will be made among the Agencies to apply common and/or consistent monitoring, sampling, and analytical protocols. These and other topic areas are represented by the green areas in the Venn diagram and will be further defined in the research plan discussed in the section below.

3. Bring coordination and consistency to the annual budget process. Effective research requires a sustained, well-planned effort. The three Agencies will work to ensure that the annual budget process is part of a coordinated multi-year effort with targeted results.

### **Forming the Partnership**

The three Agencies will take the following steps:

Interagency management structure: The three Agencies will create a Steering Committee to coordinate the Agencies' activities for unconventional oil and gas research. Each Agency will contribute two members to the Steering Committee: one member focused on policy and one member focused on research and technology. The Office of Science and Technology Policy (OSTP) will also provide a member to serve on the Steering Committee. The lead agency of the Steering Committee will rotate annually among the three Agencies in alphabetical order: DOE, DOI, EPA. The Steering Committee will provide leadership, coordinate the activities of the three participating Agencies, and reach out to other relevant Federal, state and local organizations.

Formalizing a research plan: Within 9 months of formation, the Steering Committee will publish a formal multi-year Research Plan that will:

- a. analyze and synthesize the state of knowledge of unconventional oil and gas research to assist in identifying and prioritizing new research directions;
- b. identify, categorize, and prioritize research topics relevant to the safety and environmental sustainability of unconventional oil and natural gas exploration and production;
- c. identify gaps in available data and appropriate activities to address these topics;
- d. identify research milestones and deliverables;
- e. describe steps to promote transparency and maximize stakeholder participation and notification;
- f. establish specific mechanisms for cooperative relationships among the three member Agencies in planning and conducting research and reviewing the results; and
- g. determine future plans, goals and objectives.

Within 6 months of formation the Steering Committee will have a draft of the research plan prepared for public comment.

As part of establishing the research plan, the Steering Committee will solicit comments from the scientific community, public and relevant stakeholders and will hold periodic workshops for this purpose, as appropriate.

Ongoing collaboration: The Steering Committee, augmented by appropriate staff, will meet on a quarterly basis to discuss research efforts being conducted under the research plan, track key milestones, identify and address any implementation challenges, and ensure that work in the priority areas is carried out efficiently and effectively.

Initial engagement: The Steering Committee will hold its inaugural meeting within one month of the effective date of this memorandum. In this meeting, the three member Agencies will nominate members to serve on the Steering Committee, and will further refine as necessary the steps outlined in this memorandum.

Progress Report: The three Agencies will issue an annual public progress report in conjunction with the budget process providing an update on the status of research under way in the previous year, including significant findings, progress toward milestones set forth in the research plan, and any changes in research direction or focus planned for the following year.

## Appendix: Agency Roles and Core Competencies

- Department of Energy

The DOE has research experience and capabilities in wellbore integrity, flow and control; green technologies; and complex systems, imaging, materials, earth science and engineering. Practices employed by companies engaging in exploration and production of shale gas evolve rapidly. An understanding of these technologies and practices is critical if the Federal Government is to accurately quantify the risks of these activities.

*Wellbore integrity, flow and control:* The DOE capabilities in this area include experience and expertise in quantifying, evaluating, and mitigating potential risks resulting from the production and development of the shale gas resources, to include multi-phase flow in wells and reservoirs, well control, casing, cementing, drilling fluids, and abandonment operations associated with drilling, completion, stimulation and production operations. The DOE has experience in evaluating seal-integrity and wellbore-integrity characteristics in the context of protection of groundwater.

*Green technologies:* The DOE has experience and expertise in the development of a wide range of new technologies and processes, to include innovations which reduce the environmental impact of exploration and production such as greener chemicals or additives used in shale gas development, flowback water treatment processes and water filtration technologies. Data from these research activities assists regulatory agencies in making a science-based cost-benefit analysis of requiring producers to adopt new technologies to mitigate environmental risks.

*Systems engineering, imaging and materials:* The DOE specializes in the development of complex, engineered systems, high-speed computing and predictive modeling, and has experience in quantifying and mitigating low-frequency, high-impact risks. This includes evaluating human factors which potentially contribute to failures. The DOE has developed and evaluated novel imaging technologies for areal magnetic surveys for the detection of unmarked abandoned wells, and for detecting and measuring fugitive methane emissions from exploration, production, and transportation facilities. The DOE also has experience in understanding of fundamental interactions caused during the drilling process, such as the equation of state research that investigates the relationship between pressure, temperature, and viscosity of multi-phase fluids at the high temperatures and pressures associated with deep drilling and hydraulic fracturing. The DOE's experience in engineered underground containment systems for CO<sub>2</sub> storage brings capabilities that are relevant to the challenges of safe shale gas production, such as evaluating cement-casing integrity in corrosive environment to characterize long-term wellbore integrity for CO<sub>2</sub> sequestration.

- Department of the Interior:

The United States Geological Survey (USGS) has research experience and capabilities in resource assessments; natural systems, geology, hydrology; and evaluation of effects on land use, wildlife and ecological systems.

*Resource Assessment:* The USGS conducts research and assessments of the undiscovered, technically recoverable oil and gas resources of the United States (exclusive of the Federal Outer Continental Shelf). The USGS assessments use a geology-based assessment methodology that characterizes the total petroleum system considering source rock richness, petrophysical properties, thermal maturation, petroleum generation, migration, and reservoir rock as important factors in evaluating the hydrocarbon accumulation. Assessments incorporate uncertainty, are fully risked, and are reported as statistical estimates of gas, oil, and natural hydrocarbon liquids content. They support analyses to determine those resources that are economically recoverable. These assessments play an important role in Federal policymaking and land management and also support decision making at tribal, state and local levels.

*Geology and Hydrology:* Understanding the stratigraphy, physical trapping mechanisms, petroleum geochemistry, and stress conditions of unconventional basin gas and oil-bearing formations is critical to determining local and regional variations in gas and oil abundance, composition, and quality that identify rock formation targets and guide operational plans for drilling and hydrofracturing, and for understanding and forecasting the composition of produced waters. The USGS expertise in earthquake seismology, geothermal systems, and geologic carbon sequestration is appropriate for induced seismicity evaluation. Down hole rock composition, native and flowback fluid composition, borehole temperature and pressure, and in situ stress levels are used to generate groundwater flow models and geochemical models that provide estimates of solute transport and rates and the potential fate of injected waters and their constituents. The USGS operates more than 7,700 of the Nation's surface water streamgages and groundwater monitoring wells each of which provide data critical for assessing and modeling water availability and water quality important to understanding water use, contaminant occurrences, flood hazards, and ecological flows. Cooperative agreements with state and local agencies provide additional data. Water quantity and quality are potentially affected by energy production activities. The USGS maintains an extensive, nationwide water monitoring capability and conducts assessments of surface and groundwater availability throughout the Nation, including both fresh and brackish groundwater resources.

*Land Use, Wildlife, and Ecologic Impact:* The USGS has diverse capabilities to evaluate potential impacts to biological resources and the water resources available to sustain them due to activities associated with shale gas and tight oil production. Landscape scale research is important to quantifying the response of key species and habitats to land disturbance, contaminants, and other potential impacts resulting from development of shale gas and tight oil resources and to develop best management practices to mitigate impacts. Remotely sensed airborne imagery is used to assess forest fragmentation and effects of shale gas activities on land use patterns, wetlands, and migratory bird populations. The USGS also assesses the effects of habitat change on key aquatic species including endangered species affected by hydrocarbon production.

- Environmental Protection Agency:

The EPA has research experience and capabilities across a wide range of scientific and technical disciplines that support the Agency's mission of protecting human health and safeguarding the environment. This includes core competencies in the areas of environmental and human health risk assessment, air quality, and water quality. The EPA has the unique ability to conduct research that spans the characterization of sources and emissions, to pollutant fate and transport, to ecosystem and human exposures, health effects and risk assessment, and to the prevention and management of environmental risks.

*Environmental and Human Health Risk:* The EPA has extensive capabilities to characterize the effects of contaminants and environmental stressors on ecosystem integrity and human health for air and water contaminants and mixtures associated with gas extraction practices. Ecological research capabilities that support risk assessments focus on evaluating potential physical, chemical, and biological changes to ecosystems, disruptions of ecological flows in headwater rivers, and impacts on terrestrial wildlife, stream macrobenthos, and fish. The Agency also has the expertise to evaluate landscape pattern changes in terms of available habitat and changes in vulnerability for rare or unique ecosystems. The EPA research capabilities that support human health risk assessments include conducting field measurements and other types of studies to characterize exposures, performing laboratory and computational toxicology studies for hazard identification and dose response assessments, and developing and applying risk assessment methods to evaluate human health risks posed by environmental contaminants.

*Air Quality:* The EPA possesses expertise in the measurement and modeling of air pollutants from sources related to all phases of gas extraction, processing, storage, and distribution. This includes using mobile and fixed air monitoring systems to estimate local, regional, and national exposures to air pollutants.

*Water Quality:* Groundwater protection research capabilities at the EPA include quantifying the effects of exploration and production activities on ground water quantity and quality, conducting subsurface hydrogeological and geochemical modeling, evaluating well integrity issues, and assessing the potential for releases to groundwater from wells or surface impoundments during drilling, completion, operation or post closure.