Statement of
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Chairman Harris, Ranking Member Miller, and members of the Subcommittee, I appreciate the opportunity to discuss the role that the Department of Energy's Office of Fossil Energy's National Energy Technology Laboratory continues to play in the safe and responsible development of the Nation's unconventional oil and natural gas resources.

As you know, since 2008, U.S. oil and natural gas production has increased each year. In 2011, U.S. crude oil production reached its highest level in nearly a decade. Natural gas production grew in 2011 as well – the largest year-over-year volumetric increase in history. Overall, oil imports have been falling since 2005, and our dependence on imported oil declined from 57 percent in 2008 to 45 percent in 2011 – the lowest level since 1995.

One of the factors enabling us to make such progress is that our country enjoys a bounty of oil and natural gas resources. Over the past century, Americans have applied their ingenuity towards extracting these resources, which in turn have helped to fuel our Nation's economic prosperity.

Domestic Unconventional Oil and Natural Gas Resources

There are a number of unconventional resources with the potential to support the president's all-of-the-above energy strategy and to help reduce U.S. reliance on foreign oil. These include U.S. oil reservoirs amenable to carbon dioxide enhanced oil recovery (CO_2 EOR), heavy oil, oil shale, shale oil, and natural gas resources including methane hydrates.

Studies have shown that 24 billion barrels of residual oil may be economically recoverable[1] with the application of current CO_2-EOR technologies and another 36 billion barrels with widespread application of "next generation" CO_2 EOR technology[2]. For perspective, the U.S. currently uses about 5.4 billion barrels of crude oil per year and has proved reserves of about 23 billion barrels[3]. In addition to the post-waterflood residual oil left behind in producing oil reservoirs, there are significant amounts of oil in "residual oil zones" or ROZs, the portion of an oil reservoir *below* its estimated oil-water contact. These zones can extend for hundreds of feet and

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[1] Economically recoverable at a price of $85 a barrel and $40 metric ton of CO2.

[2] V. Kuuskraa, T. Van Leeuwen, and M. Wallace. June 2011. Improving Domestic Energy Security and Lowering CO2 Emissions with "Next Generation" CO2 Enhanced Oil Recovery. DOE/NETL report # 2011/1504 Table EX-3.

[3] EIA production for 2011, http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm
EIA reserves for end of 2010, http://www.eia.gov/dnav/pet/pet_crd_pres_dcu_NUS_a.htm

could hold large volumes of previously undocumented oil amenable to recovery via CO_2 EOR. The National Coal Council estimates that 33 billion barrels of ROZ oil is recoverable at a crude oil price of $85 per barrel[4].

In addition to the residual oil and ROZs, oil shale, heavy oil, oil sands and shale oil (conventional oil in shale formations) offer a huge potential in the US. Taken together, these four unconventional oil resources total more than 3000 billion barrels of liquid hydrocarbons in place[5]. Even if one were to assume that only 10 percent of this oil could be recovered economically, it would mean a significant increase in the Nation's domestic energy supply.

The United States is equally well-endowed with unconventional natural gas resources. Production of natural gas from unconventional rocks, tight sands, coal seams, and organic shales, has risen sharply during the past two decades. Production of natural gas from shale source rock in 2012 in the U.S. is roughly 25 times what it was in 2000[6]. This rapid growth in shale gas production is recognized to be the result of the combined application of horizontal drilling and large-volume hydraulic fracturing technologies. EIA's 2012 Annual Energy Outlook estimates that 482 trillion cubic feet (Tcf) of unproven but technically recoverable natural gas exists in eleven major shale gas plays, more than 1.75 times the current total for U.S. dry gas proved reserves and more than 20 times the 2011 annual marketed dry natural gas production (23 Tcf).

Even more abundant than shale gas is natural gas from methane hydrate. In 2008, the U.S. Bureau of Ocean Energy Management, Regulation and Enforcement, released a preliminary assessment of the in-place gas hydrate resource in the Gulf of Mexico. The assessment, which does not consider whether the resource is technically or economically recoverable, estimated a mean value of 21,400 Tcf of methane-in-place in hydrate form. The assessment also determined that about 6,700 Tcf of this resource occurs in relatively high concentration accumulations within sandy sediments; the sort of reservoirs that would be more likely to permit gas flow. To put these enormous methane hydrate resources in perspective, the DOE EIA reports that the US consumed a little more than 24 Tcf of gas in 2011.

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[4] National Coal Council, 2012, *Harnessing Coal's Carbon Content to Advance the Economy, Environment, and Energy Security*, p. 4

[5] NETL, 2011, "Domestic Unconventional Fossil Energy Resource Opportunities and Technology Applications Report to Congress," September, Table 3-4, p. 15 http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/2011-005539-unc-fe-report-congress-final-oct-2011.pdf

[5] NETL, 2011, "Domestic Unconventional Fossil Energy Resource Opportunities and Technology Applications Report to Congress," September, p. 13 http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/2011-005539-unc-fe-report-congress-final-oct-2011.pdf

[5] USGS, 2012, "Isopach and Isoresource Maps for Oil Shale Deposits in Eocene Green River Formation for the Combined Uinta and Piceance Basins, Utah and Colorado," http://pubs.usgs.gov/sir/2012/5076/

[5] EIA, Annual Energy Outlook 2012, Table 16, p.58 http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf

[6] EIA, Annual Energy Outlook 2012 Online Data, Table A-14, http://www.eia.gov/analysis/projection-data.cfm#annualproj for 2012 estimate of 7.67 Tcf per year and "Shale Gas and the Outlook for U.S. Natural Gas Markets and Global Gas Resources," a presentation by Richard Newell from June 21, 2011 http://www.eia.gov/pressroom/presentations/newell_06212011.pdf for a 2000 estimate of 0.3 Tcf per year

Also in 2008, the United States Geological Survey estimated that there is approximately 85 Tcf of undiscovered, technically recoverable natural gas resource within gas hydrates on the North Slope of Alaska. If methane hydrates can be proven to be technically and economically producible, this onshore resource located near existing oil and gas production infrastructure is likely to be the first methane hydrate deposit to be tapped.

Current Status of Research and Technical Challenges

Unconventional resources are much larger in volume than are our conventional resource stores. These resources, however, generally exist in more geologically complex settings or in more remote or environmentally sensitive areas and require more intensive production methods. The safe and responsible development of unconventional domestic fossil resources creates jobs and provides economic benefits.

Federal coordination and collaboration is critical to successfully addressing the environmental and safety challenges associated with unconventional oil and gas development so that the benefits highlighted above can be realized. To this end, the President signed an Executive Order on April 13, 2012, creating a new Interagency Working Group to Support Safe and Responsible Development of Unconventional Domestic Natural Gas Resources. On the same day DOE, the Environmental Protection Agency, and the Department of the Interior's U.S. Geological Survey signed a related Memorandum of Agreement initiating a Multi-Agency Collaboration on Unconventional Oil and Gas Research. The objective of this collaborative effort is to better understand and address the potential environmental, health, and safety impacts of shale gas activities, although the research is also applicable to the development of other unconventional oil and gas resources. Through the collaboration, a robust Federal R&D plan will be developed, taking into account high priority recommendations of the Secretary of Energy Advisory Board (SEAB) Natural Gas Subcommittee. DOE's role in this initiative will focus on priorities identified by the interagency collaboration in a research plan to be formed within its area of core research competencies.

The Department is carrying out research directed at quantifying and understanding the environmental and safety risks of shale gas and shale oil development, as well improving our understanding of emerging and developing shale plays, lowering the cost and increasing the efficiency of technologies for treating hydraulic fracturing flowback water, and optimizing the recovery of shale gas resource. These efforts are funded through Title IX, Subtitle J, Section 999 of the Energy Policy Act of 2005, the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Program.

DOE's current CO_2 EOR research portfolio is focused on developing and demonstrating next generation technologies designed to accelerate the application of CO_2 EOR in those basins where it has not yet been applied, and in those reservoirs within areas with existing CO_2 EOR that have not been viewed as economic candidates.

While technology exists for producing heavy oil, there are challenges that still require research, although given the economic benefits from producing efficiently, industry has incentive to do most of this research themselves. A key challenge is mitigating the environmental and safety risks inherent with heavy oil and oil sands development. Recent DOE efforts have been focused on heavy oil deposits in the Ugnu Formation on the North Slope; understanding the formation's geological complexity; and developing water soluble polymers suitable for waterflooding Ugnu heavy oil reservoirs.

Oil shale was a major topic of public and private research in the 1980s, but interest declined when other less expensive sources of oil became available. In 2007 and 2009 the Bureau of Land Management (BLM) leased Federal minerals in Colorado and Utah to private companies to permit them to conduct oil shale research projects, with the possibility that the projects could be followed by a commercial leasing program. At least seven companies are utilizing these leases or other privately held oil shale properties to test both surface retorting of mined shale and *in situ* retorting technologies. A key research challenge associated with oil shale is the need to develop and evaluate technologies for reducing or controlling the potential for surface and subsurface water contamination and other environmental impacts.

With regard to methane hydrates, the DOE has successfully finished a pilot production well. Because of this effort and past DOE efforts, hydrates have moved from a scientific curiosity in 2000 to a known resource today.

DOE Capabilities and Expertise

The DOE's Office of Fossil Energy (FE) with support by the National Energy Technology Laboratory (NETL) remains well-positioned to address appropriate research challenges related to environmental sustainability and safe development of these unconventional oil and natural gas resources. FE and NETL have a long history of successfully engaging industry and academia, forming collaborative partnerships that leverage individual strengths to achieve useful results. FE and NETL engage with a wide array of experts when formulating research plans, including Federal Advisory Committees, industry experts, members of NETL's academic research consortium, authorities at other National Laboratories, and on-site scientists and engineers.

NETL's 1970- and 1980-era contributions to the fundamental research that resulted in the current shale gas "revolution" have been reported in the press, but three examples of DOE research highlight recent contributions made by DOE.

First, as mentioned above, the Ignik Sikumi well on the North Slope of Alaska represents an unprecedented test of technology to safely extract a steady flow of natural gas from methane hydrates. DOE partnered with ConocoPhillips and the Japan Oil, Gas and Metals National Corporation to conduct a test of natural gas extraction from methane hydrate using a unique production technology, developed through laboratory collaboration between the University of Bergen, Norway, and ConocoPhillips. Between February 15 and April 10, 2012, the team injected a mixture of CO_2 and nitrogen into a hydrate bearing zone and demonstrated that this mixture could promote the production of natural gas. This test was the first-ever field trial of a methane hydrate production methodology whereby CO_2 was exchanged *in situ* with the methane molecules within a methane hydrate structure, and the 30 day-long production test was five times as long as any previous test.

Second, in 2010 DOE partnered with Altela Inc. to test the AltelaRain® fracturing water treatment process at a well site in western Pennsylvania. Over a 9-month period, 77 percent of the produced hydraulic wastewater was successfully treated onsite, resulting in distilled water as the effluent. Following the DOE-sponsored demonstration project, four AltelaRain modules were sold and installed at a facility in Williamsport, Pennsylvania, for treating Marcellus shale wastewater. Building on the success of this application, in 2012 Altela Inc. and its partners are opening two new wastewater treatment facilities in western Pennsylvania. Each facility is able to process up to 12,000 barrels of wastewater a day—about 500,000 gallons per facility. The purified water can then be reused for any number of purposes.

Third, DOE is currently collaborating with Petroleum Recovery Research Center at New Mexico Tech to develop a nanoparticle-stabilized CO_2 foam system that can improve the sweep efficiency of injected CO_2 in EOR projects. The research team has demonstrated for the first time that adding a small amount (30-50 parts per million) of surfactant to a silica nanoparticle solution significantly improves CO_2 foam generation and foam stability. Using nanosilica particle stabilized CO_2 foam rather than a straight CO_2 and water mixture, the researchers were able to recover up to 80 percent of the residual oil that remains after waterflooding. DOE and New Mexico Tech are continuing to quantify the performance of these foams in core flooding experiments under a variety of conditions and concentrations, but it is clear that cutting edge technologies utilizing next-generation materials like nanoparticles can dramatically improve oil recovery.

These three examples illustrate the range of approaches—international collaboration, field tests on new technologies with industry partners, laboratory experiments with academic researchers—that are reflected in DOE's unconventional oil and natural extramural gas research program.

Conclusion

The U.S. contains significant hydrocarbon wealth that can be extracted and used to provide economic benefits for all Americans. Developing our unconventional oil and natural gas resources in an environmentally sustainable and safe manner will require new technologies. DOE has demonstrated its ability to engage industry and academia to perform research that can help catalyze the development and application of these new technologies.

The research challenges are significant. Producing unconventional oil and natural gas requires that industry expend more energy, use more water, contact larger portions of the reservoir, and counteract more physical forces than when producing conventional oil and natural gas resources. It is important that we understand and minimize the unwanted consequences of unconventional fossil resource development. But as they have in the past, new technologies can provide ways to reduce or eliminate these barriers.

The Department of Energy is committed to developing, where appropriate, the science and technology that will allow the Nation to use its abundant fossil energy resources in a way that balances the energy needs for sustaining a robust economy with continued environmental responsibility. As we move forward on a multi-agency, collaborative research program with DOI and EPA, the Office of Fossil Energy will pursue its mission with the same commitment to excellence and innovation.

Mr. Chairman, this completes my prepared statement. I look forward to addressing any questions that you or other members of the Subcommittee may have. Thank you.