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Mr. Chairman and Members of the Committee, thank you for the opportunity to appear here today to discuss with you the U.S. Geological Survey's role in studying, understanding, and assessing domestic energy resources.

Role of the U.S. Geological Survey in Energy Resource Assessments

The USGS conducts scientific investigations and assessments of geologically based energy resources, including conventional resources (oil, gas, and coal), emerging resources (gas hydrates), underutilized resources (geothermal), and unconventional resources (shale gas, shale oil, tight gas, tight oil, coalbed methane, and heavy oil). The USGS also conducts research on the effects associated with energy resource occurrence, production, and (or) utilization. The mission of the USGS Energy Resources Program is: (1) to understand the processes critical to the formation, accumulation, occurrence, and alteration of geologically based energy resources; (2) to conduct scientifically robust assessments of those resources; and (3) to study the impact of energy resource occurrence and (or) production and use on both environmental and human health. The results from these scientific studies are used to evaluate the quality and distribution of energy resource accumulations and to assess the energy resource potential of the Nation (exclusive of Federal offshore waters) and the petroleum resource potential of the world.

The results from these studies provide impartial, robust scientific information about energy resources that directly supports the U.S. Department of the Interior's (DOI's) mission of protecting and responsibly managing the Nation's natural resources. USGS information is used by policy and decision makers, land and resource managers, other federal and state agencies, the energy industry, foreign governments, nongovernmental groups, academia, other scientists, and the public. Recent examples of USGS domestic research and assessments include the first-ever estimate of undiscovered, technically recoverable gas from natural gas hydrates and the first national geothermal assessment in more than 30 years.

It is important to note the distinction between the terms "resource" and "reserves." Resource is a concentration of naturally occurring solid, liquid, or gaseous hydrocarbons in the Earth's crust, some of which is, or potentially is, technically and (or) economically extractable. Reserves specifically refer to the estimated quantities of identified (discovered) petroleum resources that, as of a specified date, are expected to be commercially recovered from known accumulations under prevailing economic conditions, operating practices, and government regulations. Primarily, the USGS conducts assessments of undiscovered, technically recoverable oil and gas resources. The USGS also conducts select assessments of economically recoverable resources. These resources include coal and oil and gas in frontier areas such as Arctic Alaska. Economically recoverable resources are a subset of technically recoverable resources and are generally less than the technically recoverable amount.

USGS National Research and Assessment Activities

USGS National Oil and Gas Resource Activities

One important goal of USGS domestic energy activities is to conduct research and assessments of undiscovered, technically recoverable oil and natural gas resources, both conventional and unconventional, of the United States (exclusive of the Federal outer continental shelf). These are resources that have yet to be found (drilled), but if found, could be recovered using currently available technology and industry practice.

The purpose of USGS assessments is to develop robust, geology-based, statistically sound, well-documented estimates of quantities of petroleum resources having the potential to be added to reserves and thus contribute to the overall energy supply. The USGS uses resource assessment methodologies that are thoroughly reviewed and externally vetted so as to maintain the transparency and robustness of the assessment results. To further the transparency and understanding of what we do, the USGS petroleum resource assessment methodology is published and is available online at http://energy.cr.usgs.gov/oilgas/noga/methodology.html.

The USGS distinguishes between conventional and unconventional petroleum accumulations for purposes of research and resource assessment (Figure 1), as they are very different types of resources with very different geologic and physical characteristics. Briefly, a conventional gas accumulation is one that is defined by discrete field boundaries and is typically outlined by dry or uneconomic wells. An unconventional accumulation is one in which gas saturation is regional in extent, is in extremely low permeability rock, and typically requires stimulation (fracturing) to produce the gas. Estimated ultimate resource recoveries are typically lower in unconventional wells than in conventional wells. Many shale gas, tight gas, and coalbed gas accumulations can be described using these characteristics.

The amount of undiscovered, technically recoverable resources changes over time. There are several reasons for this, including: (1) technological developments and advances regarding the discovery and production of petroleum resources, (2) scientific advances regarding geologic understanding, and (3) reserve growth. Advances in geologic understanding, as well as changes in technology and industry practices, necessitate that resource assessments be periodically updated to take into account such advances. One example of this change is the USGS assessment of the Bakken Formation in the U.S. portion of the Williston Basin. This assessment, released in 2008, shows an estimated 3.0 to 4.3 billion barrels of undiscovered, technically recoverable oil, compared to the USGS 1995 mean estimate of 151 million barrels of oil. Our geologic understanding of this basin evolved since 1995, but significant technological advances redefined what was technically recoverable in 2008 as compared to 1995. This phenomenon is equally true for natural gas assessments such as that of the Barnett Shale and others, which have shown significant increase in the volumes of technically recoverable gas resources. Much of the technology developed for production of gas in the Barnett Shale was used to develop the oil in the Bakken Formation. The Barnett Shale Newark East field now ranks first in the United States in estimated 2009 proved reserves and is first in total production, having recently surpassed the San Juan Basin[1].

Another example of significant changes in assessments over time is the USGS assessment of gas hydrates on the Alaskan North Slope. Gas hydrates are a crystalline solid formed of water and gas; they look and act much like ice, but they contain huge amounts of methane, which may be a potential energy resource. Substantial investments in gas hydrate research now support categorizing some accumulations of gas hydrates as technically recoverable. As a result of advances in our understanding of this resource, the USGS assessment estimates a mean of 85.4 trillion cubic feet of technically recoverable gas from gas hydrates on the Alaska North Slope (this total is included in the mean conventional gas estimates outlined below). Research challenges remain to determine if this technically recoverable resource will be

economically recoverable, but current multi-organizational (including the USGS) and multi-disciplinary efforts are focused on overcoming these obstacles.

Reserve growth is a well-documented phenomenon in the United States and is a major component of the updates to the Nation's remaining oil and natural gas resources, especially in conventional fields. In fact, most additions to world oil reserves in recent years are from growth of reserves in existing fields rather than new discoveries. Reserve growth occurs for a variety of reasons, including: (1) extensions of existing fields, infill drilling and new field discoveries and (2) application of new recovery technologies and improved efficiency. The assessment of the resource endowment, which includes both undiscovered resources and reserves from discovered fields and reservoirs, requires estimation of reserve growth. The USGS has recently developed a state-of-the-art methodology and approach for better quantifying domestic and global contributions of reserve growth to the petroleum resource endowment and is actively engaged in estimating this important component of the resource endowment

The current USGS mean estimates for technically recoverable oil and gas resources of the onshore and State waters portion of the United States are as follows[2]:

Mean technically recoverable conventional oil resources – 31.7 billion barrels
Mean technically recoverable unconventional oil resources – 6.1 billion barrels
Mean technically recoverable conventional gas resources – 356.9 trillion cubic feet
Mean technically recoverable unconventional gas resources – 399.4 trillion cubic feet

The Department of the Interior's Bureau of Ocean Energy Management, Regulation, and Enforcement has responsibility for evaluating resources in the Federal Outer Continental Shelf; their current oil and gas estimates for the U.S. Outer Continental Shelf are as follows[3]:

Mean technically recoverable conventional oil resources:
- Alaska – 26.61 billion barrels
- Atlantic – 3.82 billion barrels
- Gulf of Mexico – 44.92 billion barrels
- Pacific – 10.53 billion barrels

Mean technically recoverable conventional gas resources:
- Alaska – 132.06 trillion cubic feet
- Atlantic – 36.99 trillion cubic feet
- Gulf of Mexico – 232.54 trillion cubic feet
- Pacific – 18.29 trillion cubic feet

USGS National Coal Resource Activities

The USGS is conducting a systematic inventory of the technically and economically recoverable coal resources of the significant minable coal beds in the United States, to provide a comprehensive estimate of how much of the Nation's coal endowment is actually accessible for development and available under certain market conditions and mining constraints. The first basin being assessed is the Powder River Basin in Wyoming and Montana.

Within this effort, the USGS completed an assessment of the technically and economically recoverable coal resources in Wyoming's Gillette coalfield, the most prolific coalfield in the Nation and a part of the Powder River Basin. By utilizing an abundance of new data from coalbed methane development in the

region, the USGS was able to produce the most comprehensive assessment to date of this area. The Gillette area accounts for nearly 40 percent[4] of the Nation's current coal production, making it the single most important coalfield in the United States. The USGS assessment indicates that there is a total of 165 billion tons of original coal resources in the six coal beds included in the evaluation. Original coal resource is the total amount of coal in-place before production. Of that original resource, 10.1 billion tons (6 percent) can be classified as economically recoverable resources at the current average estimated sales price. However, about 67 billion additional tons are estimated to be recoverable assuming increased market prices will support the higher costs needed to recover deeper coal. The USGS has just released the assessment of the Northern Wyoming Powder River Basin, an area north of the Gillette coalfield. The total original coal resource in the Northern Wyoming Powder River Basin assessment area for 24 coal beds assessed was calculated to be 285 billion tons. Available coal resources are estimated at about 263 billion tons (about 92.3 percent of the original coal resource). Available coal resource is the amount of the original resource that is accessible for mine development under current regulatory and land-use constraints. Recoverable coal was determined for seven coal beds to total about 50 billion tons. The economically recoverable portion of the coal resources was determined to be about 1.5 billion tons of coal (about 1 percent of the original resource total) for the seven coal beds evaluated. The analysis and results for the Southwestern Wyoming Powder River Basin area is currently in review, and the analysis of the Montana portion of the Powder River basin has begun.

The USGS assessment of the Powder River Basin will be the most thorough and comprehensive inventory of the Nation's most significant coal basin to date. This inventory, with the others on the schedule, will provide policy makers a valuable planning tool needed to develop long-term energy strategies and provide decision makers with important information about what coal resources are currently or potentially technically and economically recoverable.

USGS National Geothermal Resource Activities

In addition to petroleum and coal resources, the USGS also evaluates renewable resources such as geothermal energy. The USGS recently completed a national geothermal resource assessment, the first one in more than 30 years. The USGS evaluated 241 moderate- and high-temperature geothermal resources capable of producing electricity. The USGS assessment[5] estimates the following domestic geothermal resources:

> (1) 9,057 Megawatts-electric (MWe) of power potential from conventional, identified geothermal systems,
> (2) 30,033 MWe of power generation potential from conventional, undiscovered geothermal resources, and
> (3) a provisional estimate of 517,800 MWe of power generation potential from unconventional Enhanced Geothermal Systems (EGS) resources.

The USGS assessment results indicate that full development of the technically recoverable conventional, identified systems could expand geothermal power production by approximately 6,500 MWe, or about 260 percent of the currently installed geothermal total of more than 2,500 MWe in the United States. The provisional resource estimate for unconventional EGS is more than an order of magnitude larger than the combined estimates of both identified and undiscovered conventional geothermal resources and, if successfully developed, could provide an installed geothermal electric power generation capacity equivalent to about half of the currently installed electric power generating capacity of the United States.

Because of the significant potential of unconventional geothermal resources to contribute to domestic energy resources, ongoing research at the USGS focuses on refining our understanding and characterization of EGS and improving the assessment methodology to incorporate the latest advances in EGS technology. The USGS is also working with the Department of Energy to characterize geothermal resources in sedimentary basins, particularly low temperature resources that were not included in the most recent assessment. Additionally, the USGS is working with the Bureau of Land Management to acquire new data and develop a more refined understanding of geothermal potential on Federal lands.

Conclusion

Energy resources research and assessments are a traditional strength of the USGS. As the Nation's energy mix evolves, the USGS will continue to seek ways to expand its research and assessment portfolio to better include a comprehensive suite of energy sources, including hydrocarbon-based (for example, unconventional gas from coal, oil and gas from shale, and gas from hydrates) and nonhydrocarbon-based sources (for example, geothermal resources and uranium) and to address the effects of such resources on land use, ecosystem health, and human health. USGS resource assessments and research can provide valuable information for the public and government discourse about the energy resource future of the Nation. The USGS looks forward to working with Congress as it examines these challenges and opportunities.

Thank you for this opportunity to provide an overview of USGS research and assessments of geologically based energy resources. I would be happy to answer your questions.

References

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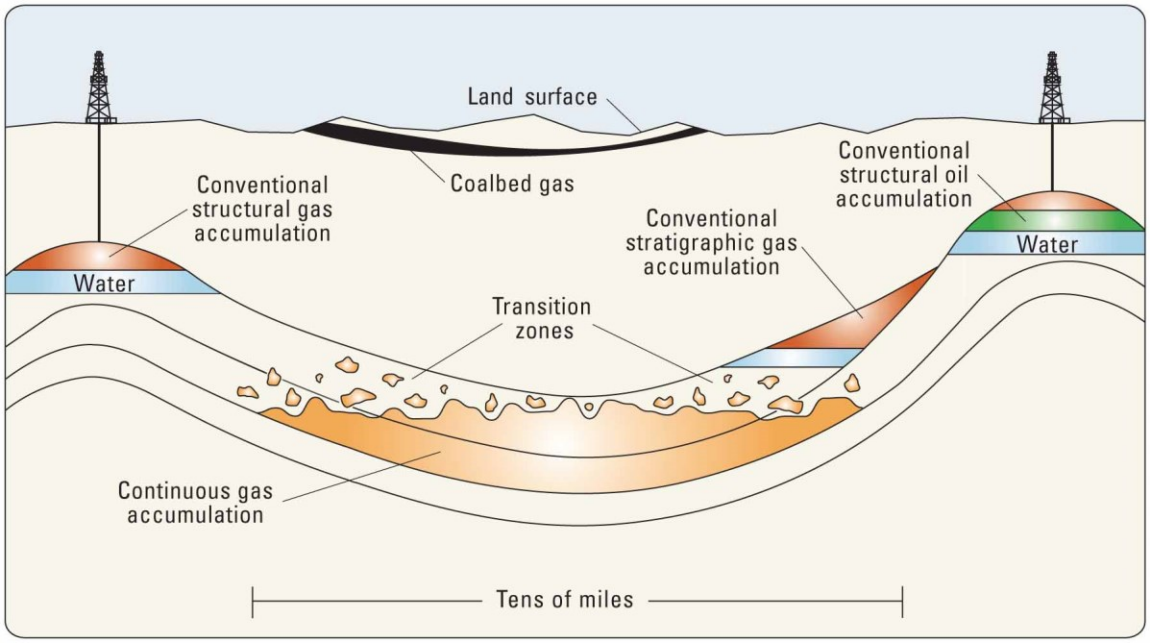

Figure 1. Conceptual diagram illustrating the different geologic settings between conventional and unconventional (sometimes called "continuous" because they are continuous across the basin) resource accumulations (http://pubs.usgs.gov/fs/fs-0113-01/fs-0113-01.pdf).