USGS
science for a changing world

The U.S. Geological Survey Energy Resources Program

Energy resources are an essential component of modern society. Adequate, reliable, and affordable energy supplies obtained using environmentally sustainable practices underpin economic prosperity, environmental quality and human health, and political stability. National and global demands for all forms of energy are forecast to increase significantly over the next several decades. Throughout its history, our Nation has faced important, often controversial, decisions regarding the competing uses of public lands, the supply of energy to sustain development and enable growth, and environmental stewardship.

The U.S. Geological Survey (USGS) Energy Resources Program (ERP) provides information to address these challenges by supporting scientific investigations of energy resources, such as research on the geology, geochemistry, and geophysics of oil, gas, coal, heavy oil and natural bitumen, oil shale, uranium, and geothermal resources, emerging resources such as gas hydrates, and research on the effects associated with energy resource occurrence, production, and (or) utilization. The results from these investigations provide impartial, robust scientific information about energy resources and support the U.S. Department of the Interior's (DOI's) mission of protecting and responsibly managing the Nation's natural resources. Primary consumers of ERP information and products include the DOI land- and resource-management Bureaus; other Federal, State, and local agencies; the U.S. Congress and the Administration; nongovernmental organizations; the energy industry; academia; international organizations; and the general public.

The USGS Energy Resources Program provides information from impartial, scientific studies to advance the understanding of energy resources, contribute to plans for a sustainable and secure energy future, and facilitate responsible use of resources.

Program Mission

To advance the understanding of processes affecting the formation, accumulation, occurrence, and alteration of geologically based energy resources

To conduct scientifically robust assessments

To study the impact of energy resource occurrence and (or) production and use on environmental quality and human health

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The U.S. Energy Mix: Current and Future Energy Needs

The United States is one of the largest users of energy, consuming annually about one-quarter of the energy resources produced in the world. In 2008 alone, the United States consumed more than 7.1 billion barrels of oil, 23.2 trillion cubic feet of natural gas, and 1.1 billion short tons of coal. Forecasts indicate the Nation's need for energy resources will continue to grow, raising several questions, including:

- How might the U.S. energy mix change over time, and what energy resources could be added to the mix?
- How much domestic and foreign oil and gas resources are available to meet the growing domestic and global energy demands?
- Does the United States have coal deposits of sufficient quantity and quality to meet demand over the next century?
- What is the potential for increased use of, and impacts from, domestic renewable energy resources?
- Are there domestic uranium resources that could supplant reliance on imported uranium, and what are some important considerations of increased use?
- What factors affect linkages among energy resource production and use on the landscape, ecosystem processes, and environmental quality and human health?

Given the vast amounts of energy resources we use each year, an understanding of the volumes, quality, and availability of domestic and global energy resources is of critical national importance. To improve the understanding of energy resources, the ERP supports a research portfolio that addresses national and regional priorities, including those established through legislative directives such as the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 (EISA), internal and external strategic planning, and customer surveys and needs.

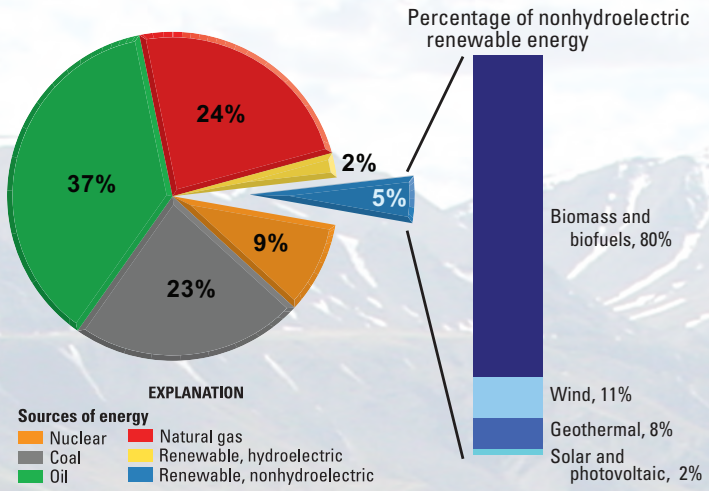


Figure 1. Pie chart depicting the percentage of contributions of energy resources to the total energy consumed in the United States in 2008. Data are from the U.S. Energy Information Administration (2009).

Coal Resources

The United States has one of the world's largest coal resource endowments. Presently, almost half of the electric power generated in the United States is derived from power plants using coal as a fuel source. In response to the increasing demands for coal and for cleaner electric power generation, USGS research focuses on modern geology-based, digital assessments of the quantity, quality, location, and accessibility of the Nation's coal resources. Estimates of the portion of the in-place coal resources that are currently technically and economically recoverable are important for understanding how coal can contribute to the Nation's energy mix. The USGS has recently refined its coal resource assessment methodology, which can now produce a systematic determination of the technically and economically recoverable coal resources on a regional basis, and it can be applied to all major coal-bearing areas in the Nation.

Gillette Coalfield (Powder River Basin)

The Powder River Basin (PRB) is the most important coal basin in the United States, supplying more than 40 percent of the total coal mined annually in the country. Utilizing new data, the USGS recently completed the most comprehensive evaluation to date of the Gillette coalfield. For the coalbeds evaluated, the technically and economically recoverable coal resources estimated for the Gillette coalfield are 10.1 billion short tons of coal at the current (as of January 2007) average estimated sales price of $10.47 per ton. This resource estimate changes, depending on coal sales price, but generally indicates that only a minor portion (6 percent) of the original in-place resource might realistically contribute to the energy mix.

Photograph showing the upper part of the Wyodak-Anderson coal zone in the Antelope mine, located in the Gillette coalfield.

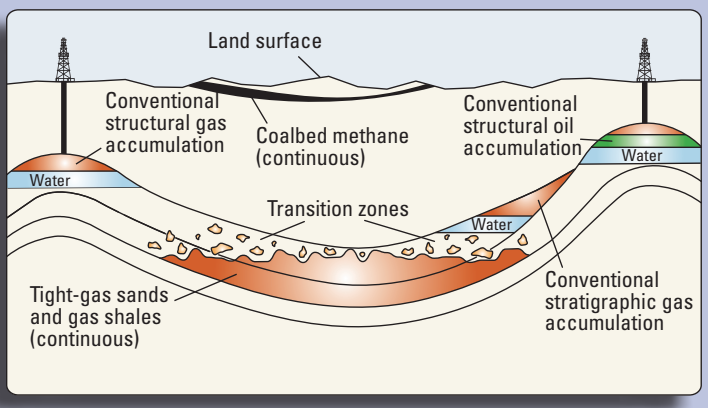
Oil and Natural Gas Resources

The Nation's future oil and gas supplies will likely come from a mix of domestic oil and gas fields, from imports, and potentially from such resources as natural gas hydrates. Efforts to systematically evaluate the major resources around the world provide essential information as a basis for informed discussions on global resource supplies, geopolitical issues, and energy policy. The USGS addresses this information need by conducting global research and assessments of undiscovered, technically recoverable oil and gas resources and of those within the U.S. onshore and underlying State-owned waters. These estimated resources are not yet discovered but, if found, could be recovered using existing technology.

The USGS continues to update its oil and gas resource assessments for the United States and the world using a consistent, peer-reviewed methodology as authorized in section 364 of the Energy Policy Act of 2005 (Public Law 109–58). The results from these activities, such as the USGS National Oil and Gas Assessment, provide information for a number of uses, including the development of domestic energy policies and the formulation of reasonably foreseeable development scenarios and resource management plans for multiple Federal land- and resource-management agencies.

"The most widely respected source of information on global conventional oil and gas resources is the U.S. Geological Survey."

International Energy Agency
World Energy Outlook 2009



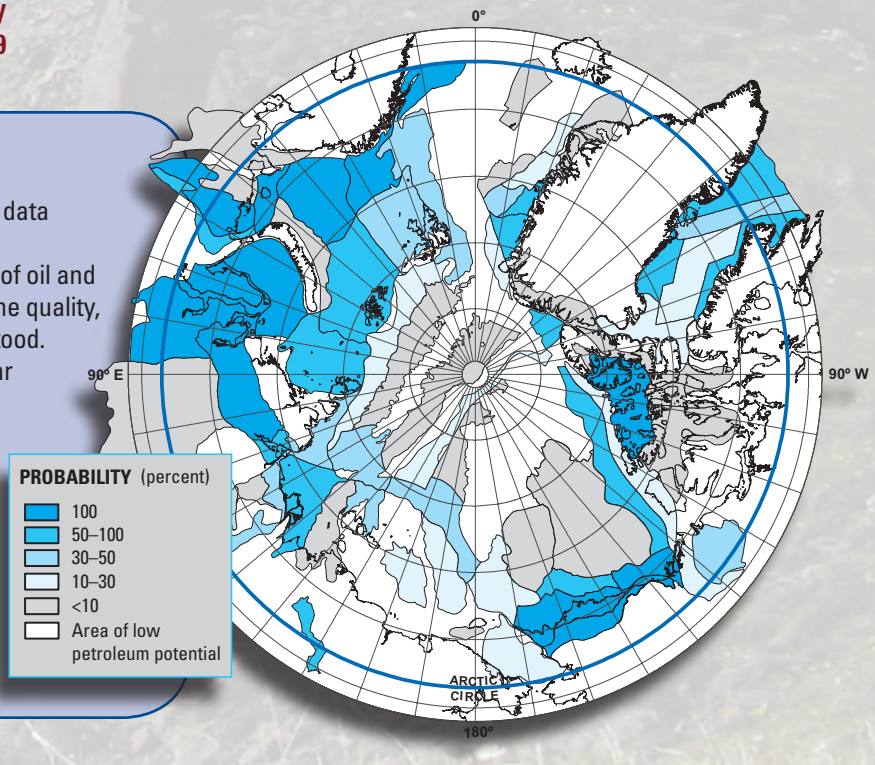
Conceptual figure depicting some geologic features of conventional and continuous resource accumulations.

Continuous ("Unconventional") Gas Resources

Geologic analyses and industry experiences indicate that a significant portion of the remaining undiscovered domestic onshore gas resource occurs in continuous accumulations, such as coalbed methane and gas from geologic units called "tight-gas sands" and "shale-gas" reservoirs. These resources are frequently referred to as unconventional gas resources in energy policy discussions. A better understanding of these unconventional gas resources—the fastest growing petroleum resources in terms of U.S. production—is critical, both in terms of responsible energy resource use and sustainability of domestic energy supplies. The USGS is conducting research on the geologic settings of these resources and has initiated a screening process for the presence and (or) absence of continuous resources (heavy oil, tight gas, shale gas, and coalbed methane) in priority basins of the world. This screening process will enable the USGS to assess continuous resources on a global basis, which would be the first assessment of its kind in the world.

Circum-Arctic Resource Appraisal

The Arctic is an area of high petroleum resource potential, low data density, high geologic uncertainty, and sensitive environmental conditions. A large portion of the remaining global endowment of oil and gas resources had long been thought to exist in this area, but the quality, quantity, and distribution of these resources are poorly understood. To address this knowledge gap, the USGS undertook a multiyear research effort, termed the Circum-Arctic Resource Appraisal (CARA), to produce a comprehensive, unbiased, probabilistic estimate of undiscovered conventional petroleum resources in the high northern latitudes. The CARA is the first publicly available petroleum resource estimate of the area north of the Arctic Circle in its entirety.



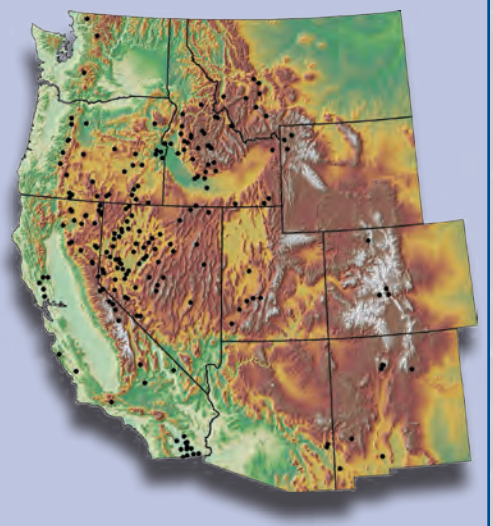
Assessment units (AUs) in the Circum-Arctic Resource Appraisal color coded by assessed probability of the presence of at least one undiscovered oil and (or) gas field with recoverable resources greater than 50 million barrels of oil equivalent.

Other Geologic Energy Resources

The forecast increase in future energy demand indicates all energy resources merit consideration to augment and diversify the Nation's energy mix. As one example, updated knowledge of the geologic setting, occurrence, and estimates of the magnitude of the undiscovered U.S. uranium resource endowment is needed for better informed planning efforts about the potential for domestic uranium supplies to sustain or increase the contribution of nuclear energy to the U.S. energy mix. As the Nation's energy mix evolves, the USGS will continue to support a research and assessment portfolio that includes a comprehensive suite of energy sources, including hydrocarbon- and nonhydrocarbon-based sources.

Geothermal Energy

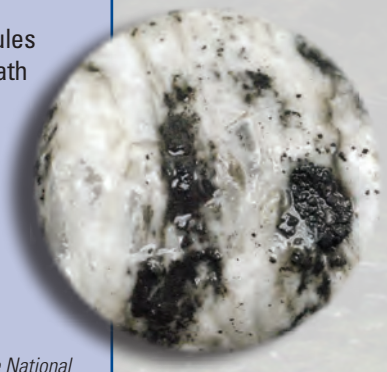
The USGS recently released an updated national geothermal resource estimate of the potential for geothermal power. The study results indicate that full development of conventional, identified systems alone could expand geothermal power production by approximately 6,500 Megawatts-electric (MWe), or about 260 percent of the currently installed geothermal total of more than 2,500 MWe. The provisional Enhanced Geothermal Systems (EGS; high temperature, but low permeability) resources estimate indicates that, if successfully developed, EGS could support an installed geothermal electric power-generating capacity equivalent to about half the currently installed U.S. electric power-generating capacity. The USGS is working in collaboration with other Federal and State partners to conduct research to better understand the geologic and hydrologic aspects of EGS and provide a detailed framework to underpin future assessments of EGS resource potential.



Map showing the location of identified moderate-temperature and high-temperature geothermal systems in the western contiguous United States. Each system is represented by a black dot.

Gas Hydrates

Gas hydrates are naturally occurring, ice-like solids in which water molecules trap natural gas molecules in a cage-like structure. Gas hydrates are widespread in Arctic regions beneath permafrost and beneath the seafloor in sediments of the outer continental margins, representing an immense natural gas resource that has the potential to make a significant contribution to both domestic and global energy mixes. Recently, the USGS completed the first-ever resource estimate of undiscovered, technically recoverable gas hydrates in northern Alaska. This study used a geology-based assessment methodology and culminated in a mean estimate of about 85 trillion cubic feet of undiscovered, technically recoverable gas resources. The USGS is continuing to collaborate with other Federal, industry, academic, and international partners to further the scientific understanding and potential viability of this energy resource.



Sediment core sample, collected from the offshore of India as part of the National Gas Hydrates Program Expedition 01, showing the presence of gas hydrate (white).

Geologic Carbon Dioxide Sequestration

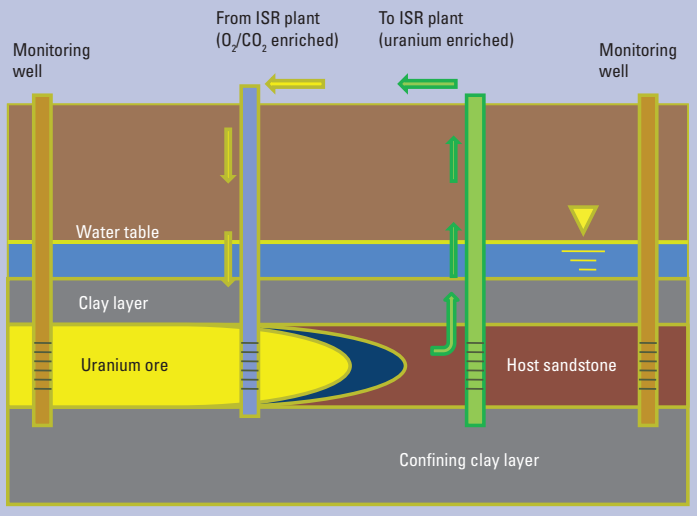
Energy resources are at the nexus of global change and environmental issues, particularly because of the linkage between energy use and greenhouse gas emissions. Fossil fuel combustion is a major source of carbon dioxide (CO_2), a greenhouse gas, to the atmosphere. Fossil fuels will likely continue to provide a significant portion of total energy needs in both industrialized and developing countries over the next several decades. Achieving an overall reduction of CO_2 emissions to the atmosphere will involve a combination of techniques, and sequestration of CO_2 in geologic reservoirs has the potential to make a significant contribution to such mitigation strategies.

The USGS is authorized in EISA to develop a methodology and conduct a national assessment of onshore geologic storage capacity for CO_2. The USGS has developed a methodology, which has undergone external peer review by technical experts, and is conducting an assessment of the Nation's resources for geologic carbon sequestration in oil and gas reservoirs and saline formations. The assessment focuses on the technically accessible CO_2-storage resource, which is based on present-day geological and engineering knowledge and technology for CO_2 injection into geologic formations.

Environmental Quality and Human Health Effects

Energy resources can contain toxic substances that, if mobilized so that exposure occurs, can adversely affect human health and environmental quality. The toxic substances include both organic and inorganic compounds, many of which are known or suspected of causing cancer and other diseases in humans. These toxic substances can be mobilized by natural processes or by human extraction and utilization. This exposure may lead to acute disease symptoms or to increased disease risk from long-term, chronic exposure. The USGS conducts research to address the potential linkages among geology, energy resources, and environmental quality and human health to enable land managers and environmental and medical officials to better assess human health and ecosystem effects, to develop cost-effective remedies, and to establish appropriate policies and regulations.

For example, over the past several years, interest in U.S. uranium supplies has grown as demand for nuclear energy has increased. This recent interest has also raised the visibility of legacy uranium mining impacts, which are widespread in the Western United States. Scientific investigations of legacy uranium mining and milling areas and historic and ongoing uranium mining operations are needed to develop a better understanding of the processes operating at such sites in order to determine the effects of such past operations on soils, surface water, and groundwater.



Conceptual figure showing the geologic setting and process for in-situ recovery of uranium from an underground orebody.

Uranium Environmental Research

Most uranium mining has shifted away from conventional underground mining and milling to a potentially more sustainable in-situ recovery (ISR) method. The ISR method utilizes solutions to dissolve uranium from ore in the subsurface, which is monitored for potential impacts on groundwater. USGS scientists are conducting laboratory- and reaction-modeling studies to understand the feasibility of using natural or introduced sulfide minerals, such as mackinawite, as a remediation medium for groundwater restoration following ISR mining and for in-situ remediation of uranium-contaminated groundwaters.

Characterization, Uses, and Impacts of Produced Waters

Development and production of oil and gas resources can also require and yield significant quantities of water. Produced water and fluids used and recovered during hydrofracturing (hydrofracing) are likely to play an expanding role in energy resource considerations because treatment and disposal costs for produced and hydrofracing waters vary markedly. Also, the potential beneficial use of produced waters is an area of expanding interest, particularly in areas with limited water resources. The USGS conducts research to provide information on the volume, quality, impacts, and possible uses of water produced during oil, gas, and coalbed methane production and development in the United States.

Examples of a coalbed methane well (inset) and a produced water impoundment from the Powder River Basin, Wyo.

Next Steps—Developing Multi-disciplinary Approaches To Address Energy Resource Issues

Two key issues affecting current and future energy resource availability are the effects of globalization, and the likelihood that land, water, and environmental changes from energy extraction and consumption will factor more strongly into how societies use resources (USGS, 2007). Our Nation endeavors to balance the land, water, and environmental effects of resource development and extraction within this broader perspective of sustainability. These trends—globalization and environmental impacts—point to a future United States with a more diversified energy mix (that is, less dependent on imported oil) and a life-cycle approach that evaluates the linkages between energy use and the broader effects of that use. A wide-ranging, multidisciplinary approach is needed to understand and evaluate how the complex energy resource "life cycle" of occurrence, formation processes, extraction methods, and use influence (or are influenced by) landscape, hydrology, climate, ecosystems, and human health. The USGS, with its multidisciplinary scientific expertise in hydrology, biology, geology, and geography, is developing better integrated approaches to address these challenges and provide a more systematic, holistic understanding of natural resources across the landscape.

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References Cited

International Energy Agency, 2009, World energy outlook 2009: Paris, France, International Energy Agency, 696 p.

U.S. Energy Information Administration, 2009, Annual energy review 2008: U.S. Energy Information Administration DOE/EIA–0384(2008), 446 p. (Also available at *http://www.eia.gov/FTPROOT/multifuel/038408.pdf*.)

U.S. Geological Survey, 2007, Facing tomorrow's challenges—U.S. Geological Survey science in the decade 2007–2017: U.S. Geological Survey Circular 1309, 81 p. (Also available at *http://pubs.usgs.gov/circ/2007/1309/*.)

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