

# The U.S. Geological Survey Energy Resources Program

The USGS Energy Resources Program provides impartial, scientifically robust information to advance the understanding of geologically based energy resources, to contribute to plans for a secure energy future, and to facilitate evaluation and responsible use of resources.



## The Need for Geologic Energy Resources Information

The United States uses tremendous amounts of geologic energy resources. In 2004 alone, the United States consumed more than 7.4 billion barrels of oil, 21.9 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:

- How much domestic and foreign petroleum resources are available to meet the growing energy demands of the Nation and world?
- Does the United States have coal deposits of sufficient quantity and quality to meet demand over the next century?
- What other geologic energy resources can be added to the U.S. energy mix?
- How do the occurrence and use of energy resources affect environmental quality and human health?

Mallik drilling site, located on the Mackenzie Delta in the Northwest Territories, Canada. The Mallik Project developed the first production test well for gas hydrates.

Unbiased information from robust scientific studies is needed for sound energy policy and resource management decisions addressing these issues.

## The USGS Energy Resources Program Addresses This Need

The U.S. Geological Survey (USGS) Energy Resources Program (ERP) provides information from impartial, comprehensive research investigations of geologic energy resources, including: petroleum (oil, natural gas, natural gas liquids), coal, gas hydrates, geothermal resources, oil shale, oil sands, uranium, and heavy oil and natural bitumen. This information advances the understanding of geologic processes and the economic, technical, and environmental factors affecting energy resource occurrence, availability, and recoverability. An improved understanding facilitates the development

of sound policies on domestic and foreign energy resources, and the responsible management of energy resources on Federal lands. The ERP has a clearly defined role:

### Program Mission---

- (1) to advance the understanding of processes affecting the formation, accumulation, occurrence, and alteration of geologically based energy resources;
- (2) to conduct scientifically robust assessments of onshore and state offshore U.S. energy resources (pre-development) and international energy resources;
- (3) to study environmental and human health effects associated with energy resource occurrence, production, and use.

To fulfill this unique role, the ERP supports a research portfolio that is responsive to national and regional priorities, including those established through legislative directives such as the Energy Policy Act of 2005, internal strategic planning, and customer surveys and needs. Primary consumers of information and products from this research portfolio include the U.S. Congress, the Department of the Interior land and resource management Bureaus, other Federal, State and local agencies, non-governmental organizations, the energy industry, academia, foreign organizations and the general public.



Geologist conducting field studies in Alaska.



## Oil and Natural Gas Resources

The USGS uses a systematic, peer-reviewed approach to evaluate oil and natural gas resource endowments in the United States and around the world. Research investigations culminate in geologically based assessments quantifying the volume, and likelihood of existence, of resources that have not yet been found, but if discovered, could be developed with currently available technology. These undiscovered, technically recoverable resources can include conventional as well as unconventional (continuous) oil and natural gas accumulations, such as coalbed methane and gas from low-permeability geologic units such as tight gas sands.

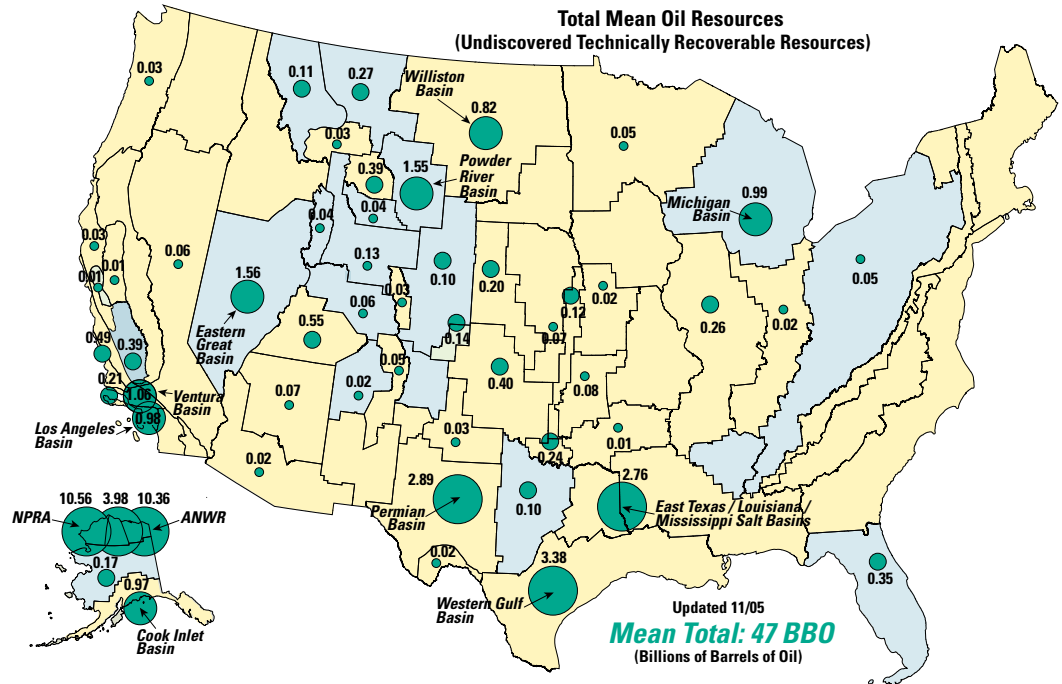
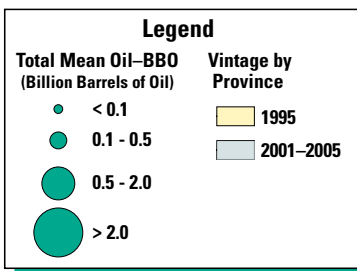
### Examples:

- The USGS conducts research in its organic geochemistry and seismic interpretation laboratories to refine the understanding of petroleum generation and occurrence. This information is essential to assessments of conventional and unconventional petroleum resources.

- Energy resource considerations figure prominently in Alaskan land management decisions and in energy policy development. Current USGS research activities in Alaska, through collaboration with Federal and State agencies and Native corporations, are improving the understanding of oil, natural gas, coal, and gas hydrate resources throughout Alaska.
- The USGS provides National Oil and Gas Assessment research and is participating in a Federal agency consortium to conduct an inventory, authorized in the Energy Policy and Conservation Act Amendments of 2000, of oil and natural gas resources beneath Federal lands. This inventory provides a tool for public land management agencies, principally the Bureau of Land Management (BLM) and the USDA Forest Service, to use in constructing domestic land management policies.
- The USGS conducts geologic studies in a world energy context to provide an understanding of the quantity, quality, and distribution of conventional petroleum resources on a global scale.



Drill core rock samples used in a USGS investigation of geology and energy resources in the Gulf Coast Region (Texas). These samples are an example of the framework that underpins USGS research efforts. These efforts produce information that can be used to address key energy resource issues facing the Nation.



National perspective — The USGS studies oil and gas resources in provinces, and integrates these to provide a national overview of resource endowment. This figure shows the distribution of oil resources throughout the United States. The sizes of the green circles vary according to the estimated amounts of mean, undiscovered, technically recoverable oil resources (in billions of barrels of oil; see Legend). The blue provinces indicate recently completed studies.



## Coal Resources

Presently, more than half of the electric power generated in the United States uses coal as a fuel source. In response to the increasing demand for coal and for cleaner electric power generation, USGS research efforts yield information on coal quality parameters and modern, digital assessments of the quantity, quality, location, and accessibility of the Nation's coal resources.

### Examples:

- The USGS National Coal Resource Assessment (NCRA) evaluates U.S. coal resources and delivers information –stratigraphic, geologic, and geochemical– from this effort in databases available to the public through the National Coal Resources Data System <http://energy.er.usgs.gov/coalres.htm>.
- USGS scientists working on the NCRA project have recently completed a methodology revision that has been vetted through external peer review – review available at <http://pubs.usgs.gov/of/2005/1076/>. Previous NCRA studies evaluated the total amount of coal resources in the ground. This revision enables future NCRA studies to provide specific information on the portion of the total coal resources that are technically and economically feasible to recover. These technically and economically recoverable coal resources constitute the coal reserve base, or, the coal that is most likely to be mined in the near future.

- USGS scientists are conducting research investigations of geologic processes affecting the occurrence and distribution of elements that are important from a coal quality perspective including chlorine, mercury, and sulfur. To support these investigations, the USGS maintains a state-of-the-art laboratory facility to conduct chemical analyses of coal samples. These analytical results support robust coal quality studies, and provide the basis for ongoing cradle-to-grave studies of coal use.

## Other Geologic Energy Resources

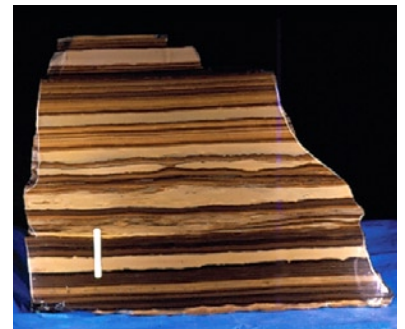
The forecast increase in future energy demand will likely generate interest in all energy resources to augment and diversify the Nation's energy mix. The USGS investigates geologic processes affecting the quality and distribution of other energy resources such as geothermal energy, and other fuels such as gas hydrates, uranium, oil shale, oil sands (tar sands), and heavy oil and natural bitumen. USGS studies of gas hydrates, geothermal resources, and oil shale support national priorities established in the Energy Policy Act of 2005.

### Examples:

- USGS oil shale research currently focuses on the Green River oil shale deposits of Colorado, Utah, and Wyoming. The USGS is undertaking efforts to make oil shale research and information products more accessible to the general public via the internet, including digital shale-oil

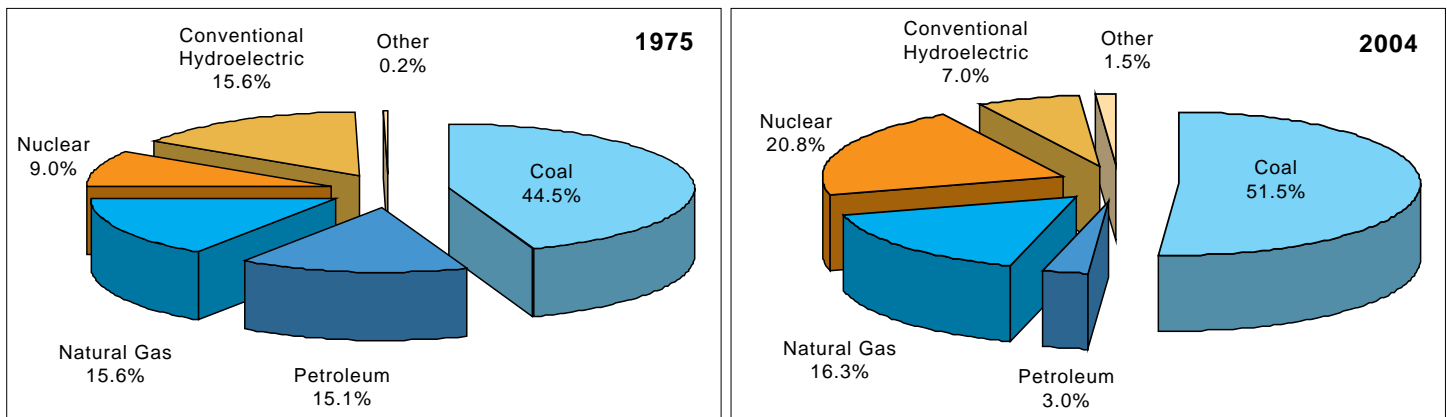


Steam plume from a geothermal well at Coso geothermal area, south-central California.



Specimen of Green River oil shale from the Mahogany zone in the Piceance Creek Basin, Colorado. This specimen is on display at the museum of the Geological Survey of Japan.

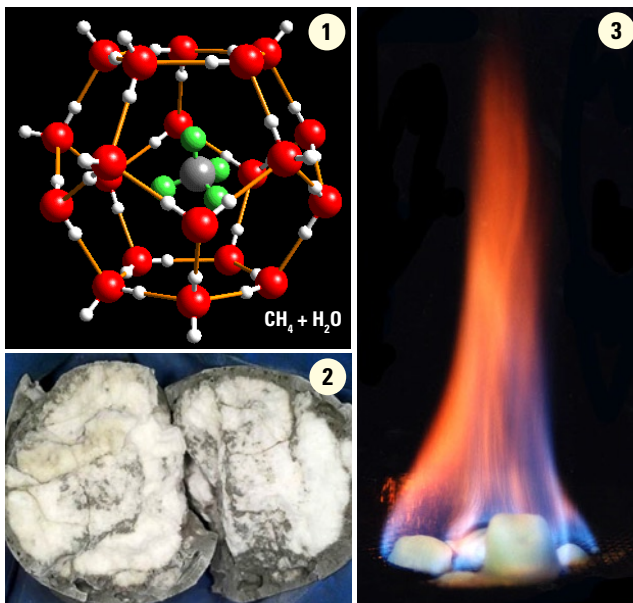
U.S. Electric Power Generation by Fuel Type - Years 1975 and 2004



The mix of energy resources used to generate electric power in the United States has changed over time. More than half of the electric power presently generated is derived from coal. The prominence of coal in the U.S. energy mix underscores the need for robust coal resource endowment and coal quality studies. (Data from the Energy Information Administration.)

analyses, stratigraphic and lithologic information, geologic maps, geophysical logs, and bibliographic references on oil shale geology.

- Gas hydrates represent an immense energy resource underlying large portions of the world's marine continental shelves and Arctic continental areas. The USGS participates in several international consortia of research, industry, and academic institutions—most recently in India. Previously, the Mallik Research Consortium drilled three test wells in Canada's Mackenzie Delta, and the results, demonstrating the producibility of this energy resource, were published in 2005. The USGS also has ongoing cooperative research efforts with the BLM, Minerals Management Service, State of Alaska, Department of Energy, industry, and Native Alaskan corporations to further the understanding of gas hydrate endowment and recoverability from Alaska's North Slope.
- The USGS is studying geothermal energy resources in the western United States. The objectives are to produce a detailed estimate of electric power generation potential, and evaluate the major technological challenges and environmental effects of increased use of geothermal resources.



1) A molecular model depicts the cage-like structure of gas hydrate, showing the association between water (red and white) and methane (green and gray). 2) This drill core sample shows that gas hydrates in nature appear as white, ice-like, crystalline solids. 3) These solids can be decomposed to release methane, which can be burned to provide a source of energy.

## Environmental and Human Health Effects

Energy resource commodities such as coal, oil, and natural gas contain toxic substances that, if mobilized, may adversely affect human health and the environment. The USGS is conducting research to address the linkages among geology, energy resources, and human health. This information will enable land managers and environmental and medical officials to better assess human health and ecosystem effects, develop cost-effective remedies, and establish appropriate policies and regulations.

### Examples:

- USGS scientists are investigating the legacy effects of historical oil and gas development operations, and the environmental and human health impacts of coal extraction, coal combustion, and coalbed methane production. Information from these efforts is used to address a suite of issues including coal combustion by-products, mine drainage and produced water disposal.
- The USGS has research partnerships with U.S. and international health organizations to study areas with documented health issues, including several Balkan countries in central Europe. These efforts are addressing how the occurrence of energy resources may

give rise to adverse health effects, and what measures can be taken to mitigate exposure. The information gained from these collaborations is being applied in the United States, where USGS scientists are investigating rural areas for possible connections among coal, drinking water supplies, and rates of disease.

## Digital Data and Websites

<http://energy.usgs.gov>

All recent USGS ERP products are available to the general public in digital format, including:

- National Oil and Gas Assessments  
<http://energy.cr.usgs.gov/oilgas/noga/>
- World Energy Project  
<http://certmapper.cr.usgs.gov/rooms/wel/index.jsp>
- Organic Geochemistry Database (over 65,000 records of analyses of crude oil, natural gas and rock samples from locations worldwide)  
<http://energy.cr.usgs.gov/prov/og/>
- USGS Produced Waters Database (contains locations and major ion compositions of waters pumped to the surface during oil and gas production)  
<http://energy.cr.usgs.gov/prov/prodwat/>
- National Petroleum Reserve, Alaska Legacy Data Archive (contains seismic and well log data)  
<http://nerslweb.cr.usgs.gov/>



USGS scientists collect samples from a water well in central Europe to investigate a possible connection among drinking water, coal, and deleterious human health effects in the region.

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