



The U.S. Geological Survey Energy Resources Program 5-Year Plan

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Key to Abbreviations

AAPG	American Association of Petroleum Geologists	NaCQI	National Coal Quality Inventory
ABC/M	Activity-Based Cost/Management	NERSL	National Energy Research Seismic Laboratory
ANWR	Arctic National Wildlife Refuge	NGO	Nongovernmental organization
BLM	Bureau of Land Management	NOAA	National Oceanic and Atmospheric Administration
CBM	coal bed methane	NPRA	Naval Petroleum Reserve Alaska
CCPs	coal combustion products	NRC	National Research Council
CERT	Central Energy Resources Team	NRL	Naval Research Laboratory
CRADA	cooperative research and development agreement	NSF	National Science Foundation
DOI	Department of Interior	OCS	outer continental shelf
DOD	Department of Defense	OFA	outside funding assistance
DOE	Department of Energy	OMB	Office of Management and Budget
EERT	Eastern Energy Resources Team	PART	Program Assessment Rating Tool
EIA	Energy Information Administration	QA/QC	quality assurance/quality control
EIS	environmental impact statement	UEO	ultimate end outcome
EPCA	Energy Policy Conservation Act	USAID	United States Agency for International Development
ERP	Energy Resources Program	USGS	United States Geological Survey
ESD	Earth Surface Dynamics	USTDA	United States Trade and Development Agency
FACA	Federal Advisory Committee Act	WEHZT	Western Earthquake Hazards Team
FWS	U.S. Fish and Wildlife Service	WoCQI	World Coal Quality Inventory
GDP	gross domestic product	WRD	Water Resources Discipline
GEODE	Geo Data Explorer		
GIA	geographic information system		
IEA	International Energy Agency		
LNG	liquefied natural gas		
MMS	Minerals Management Service		
MOU	memorandum of understanding		

The U.S. Geological Survey Energy Resources Program 5-Year Plan

Executive Summary

The Nation faces simultaneous challenges from an increasing demand for energy, including a growing dependence on energy resources imported from other countries, and a concomitant need to minimize environmental effects associated with energy resource development and utilization. The U.S. Geological Survey (USGS) Energy Resources Program (ERP) addresses these challenges by promoting and supporting scientific investigations of geologically based energy resources, e.g., research on the geology of oil, gas, and coal resources, emerging resources such as gas hydrates, underutilized resources such as geothermal, and research on the effects associated with energy resource occurrence, production, and (or) utilization. The results provide impartial, robust scientific information about energy resources and directly support the U.S. Department of Interior's (DOI's) Mission of protecting and responsibly managing the Nation's natural resources. Collectively, this information advances the scientific understanding of energy resources, contributes to plans for a balanced and secure energy future, and facilitates the strategic use and evaluation of resources.

The Mission of the 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. In fulfilling this mission, the ERP promotes and supports research resulting in original, geologically based, non-biased energy information products for policy and decision makers, land and resource managers, other federal and state agencies, the domestic energy industry, foreign governments, nongovernmental groups, academia, and other scientists. Specifically, the ERP supports research efforts that are aligned with seven, long-term Program Goals:

1. Improve the understanding of the oil and natural gas endowment of the United States and the conventional oil and gas endowment of the World;
2. Improve the understanding of the coal endowment of the United States;
3. Improve the understanding of the occurrence and distribution of, and conduct research in support of, making natural gas hydrates a technically producible resource (i.e. a reserve);
4. Improve the understanding of the distribution and resource base of other geologically based energy resources of the United States such as geothermal resources;
5. Improve the understanding of the environmental and human health effects of energy resource occurrence and utilization;

6. Maintain state-of-the-art data management and data distribution systems in order to organize, provide ease of use, archive, and deliver critical ERP information both internally and externally; and

7. Partner with other organizations, including donor organizations, to address domestic and international issues regarding geologically based energy resources.

An understanding of the fundamental processes that lead to the formation and accumulation of fossil fuels and other geologically derived energy resource accumulations provides the scientific foundation and credibility for all ERP products and provides the foundation for future ERP energy research and resource assessment activities.

External reviews have concurred that the role of the ERP is clearly defined, appropriate for a Federal agency, and unique from other Federal, State, local, or private entities. To fulfill this unique role, the ERP, through program staff, regionally-based scientific research teams, emeriti, internal and external partnerships, and contractual support, maintains a core of energy resource capabilities and expertise to sustain prolonged research efforts. However, the ERP remains flexible enough to respond to short- and long-term changes in customer and stakeholder needs for energy resources information. The ERP framework and research portfolio is responsive to national priorities established through legislative directives, internal strategic planning, important and unanticipated global events, customer surveys and needs, and the guiding principles of objective and impartial science. These priorities are used to establish guidelines for determining the direction of the research efforts, the geographic areas to be studied, and the appropriate funding and staffing levels to be allocated to those efforts.

Program funding is directed at achieving program goals, and the ERP systematically and proactively collaborates with intended beneficiaries, soliciting input and feedback to provide the best information necessary to the broadest array of stakeholders in a highly useable content and context. The ERP focuses efforts on geographic areas, commodities, or studies that will further its short-term and long-term goals the most – generally in areas where there is relatively little known about the commodity and on those resources with the greatest potential for meeting the Nation's energy needs.

Baselines and targets for individual ERP projects are listed in the Geologic Discipline (GD) Annual Science Plans, in annual project work plans and proposals, and in annual Federal budget justifications. Each ERP-funded project is reviewed annually to evaluate short- and long-term relevance, focus, cost, and potential impact, and to ensure consistency with ERP, USGS, and DOI science priorities and goals. The ERP Program Council conducts these reviews and, when necessary, recalibrates project direction. In doing so, the ERP Program Council carefully monitors the entire program, enabling the ERP to continue supporting research in appropriate directions to expand the understanding of energy resources, and maintain a high degree of relevance and impact for ERP deliverables, even in the face of changing technological, socioeconomic, political, or regulatory factors.

The core elements of ERP-supported activities – those of studying and assessing geologically based energy resources – provide a consistent, long-standing foundation upon which ERP research directions are based. Specific research endeavors by ERP-funded scientists build on this foundation and grow with time to address current scientific issues or societal needs, and evolve the understanding of energy resources, changes in technology, and advances in knowledge. The ERP planning framework accommodates this evolving need for energy information driven by national and international factors. As observed in the recent past, accurate energy resource predictions are very difficult to make; note, for example, the recent volatility in natural gas prices, or the marked increase in coalbed methane's

contribution to the natural gas production in the U.S. These variations serve to underscore the fact that the definition of what constitutes an “energy resource” has changed over time and will continue to do so. To meet the current and future challenges facing a changing world, the ERP will continue to evolve the manner in which the fundamental, geoscientific expertise is applied so as to improve the understanding of both current and future energy resources of the Nation and the World. To this end, the ERP will monitor and, as needed, support efforts to grow the general expertise and capabilities of the ERP and ERP-supported research teams so as to respond to future needs and requirements with the same degree of prominent, cutting-edge energy research and societally relevant products of the quality currently delivered. One such example is the growth of a geothermal effort within the ERP to improve the understanding and assess this underutilized energy resource in the U.S.

The confluence of flat budgets, increasing costs in the form of overhead expenses and salaries, as well as an aging workforce, require the ERP to judiciously leverage available resources (both monetary and human) to fulfill current and future responsibilities. As funding flexibility has constricted, the national research perspective of the ERP has helped maintain high-caliber research through the coordination of staffing decisions (for example, project staffing, new hires, and retraining throughout the energy-funded teams), the centralization of high-cost laboratory functions and seismic processing facilities, and the geographic phasing of major project activities. The ERP must continue to carefully consider not only the breadth of scientific activities currently undertaken, but also those activities that may be possible (and necessary) in the future. In this context, the ERP will continue to seek partnerships, where appropriate, with colleagues from the USGS (that is, through interdisciplinary research) and others external to the USGS, including federal agencies, state agencies, academia, and industry consortia, to leverage funding, expertise, and facilities. In doing so, the ERP will maximize the impact of the science accomplished and the products delivered. The ERP must also consider those scientific research activities for which it is uniquely poised to undertake. Such activities include, for example, research into unconventional resources and the development of associated methodologies to assess these future resources. Through careful evaluation of all these elements, the ERP will continue to fulfill Program Goals and respond to issues that arise regarding geologically based energy resources, be they local, regional, national, or international in scope.

Introduction

Overview

Energy is one of the most important components of the World's economy. A country's demand for energy resources (that is, consumption) is tied to its gross domestic product (GDP), and therefore the quality of life for its population (fig. 1). Adequate, reliable, and affordable energy supplies that are obtained using environmentally sustainable practices are essential to economic prosperity, environmental and human health, and political stability. National and global energy demand and resource consumption are forecast to increase significantly over the next 20 to 30 years; most of these increases will manifest themselves through increased production of fossil fuels (Energy Information Administration, 2005). The U.S. depends on fossil fuels for more than 85 percent of its total energy needs (fig. 2). The U.S.' net energy resource imports have risen over the last two decades, and total energy resource consumption is expected to increase more rapidly than domestic production, requiring additional increases in net energy resource imports (fig. 3A). As a result, the Nation faces simultaneous challenges from an increasing demand for energy, including a growing dependence (fig. 3B) on oil imported from diverse regions of the world with varying levels of political stability, and a concomitant need to minimize environmental effects associated with energy resource development and utilization. The U.S. will also experience a growing dependence on unconventional and imported natural gas resources (such as liquefied natural gas – LNG), particularly to sustain gas-fired electricity generation plants. Throughout its history, the Nation has faced important, and often controversial, decisions regarding the competing uses of public lands, the supply of energy to sustain development and enable growth, and the environmental consequences of resource development. The availability and cost – both economic and environmental – of energy and its utilization are important to the optimal and responsible use of energy resources.

The USGS Energy Resources Program (ERP) addresses these challenges by promoting and conducting scientific research culminating in a better understanding of both the fundamental geologic processes by which energy resources are generated, accumulated, and preserved, as well as the environmental and human-health effects associated with energy resource occurrence and use. The ERP supports scientific studies of geologically based energy resources, including: oil, natural gas, coal, coalbed methane (CBM), gas hydrates, geothermal resources, uranium, oil shale, and bitumen and heavy oil. The results from these geoscientific 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 World. Through various means, the ERP conveys results from these studies to land and resource managers and policymakers in support of the Department of the Interior's (DOI) strategic goal of managing resources to enhance public benefit, promote responsible use, and ensure optimal value. Collectively, this information is used to advance the scientific understanding of energy resources, to contribute to plans for a secure energy future, and to facilitate the strategic use and evaluation of resources. The ERP geologically based energy resource assessments are considered authoritative and defensible because these products use sound science, and utilize ERP scientists' expertise in geology, geochemistry, geophysics, and geographic information systems (GIS). Major consumers of ERP products include the DOI land and resource management bureaus, such as the Bureau of Land Management (BLM); other land and resource management agencies such as the U.S. Forest Service (USFS); Federal energy, environmental, and national security agencies; State agencies and geological surveys; foreign governmental organizations; non-governmental organizations; industry; academia; and the general public.

As described in the Office of Management and Budget (OMB) Program Assessment Rating Tool (PART) review, the ERP role is clearly defined and unique from other Federal, State, local, or private entities. The ERP was reviewed in 2003 as an independent, stand-alone Program, and received a PART score of 84. The PART findings demonstrate that the ERP generates and provides objective, science-based energy information essential for shaping policies regarding domestic and foreign energy resources, making sound decisions regarding Federal land use, and maintaining a healthy domestic energy platform.

These PART findings mirror other external perspectives regarding ERP research activities, including those from the National Research Council (NRC), Energy Information Administration (EIA), and the International Energy Agency (IEA). For example, the NRC review of ERP, entitled “Meeting U.S. Energy Resource Needs,” found that “the products of the USGS Energy Resources Program are important to the economic, environmental, and security future of the United States” (National Research Council, 1999). The EIA has stated that “the USGS petroleum assessments provide an important foundation for geologic, economic, geopolitical, and environmental studies. With many of the world’s economies intrinsically linked to energy resource availability, such studies provide essential long-term strategic guidance.”

This ERP 5-Year Plan is aligned with seven major long-term Program Goals:

1. Improve the understanding of the oil and natural gas endowment of the United States and the conventional oil and gas endowment of the world;
2. Improve the understanding of the coal endowment of the United States;
3. Improve the understanding of the occurrence and distribution of, and conduct research in support of, making natural gas hydrates a technically producible resource (that is, a reserve);
4. Improve the understanding of the distribution and resource base of other geologically based energy resources of the United States (dependent upon funding);
5. Improve the understanding of the environmental and human health effects of energy resource occurrence and utilization;
6. Maintain state-of-the-art data management and data distribution systems in order to organize, deliver, and archive critical ERP information for use both internally and externally; and
7. Partner with other organizations, including donor organizations, to address domestic and international issues regarding geologically based energy resources.

These seven goals, combined, support the ERP mission: (1) to understand the processes critical to the formation, accumulation, occurrence, and alteration of geologically based energy resources; (2) conduct scientifically robust assessments of those resources; and (3) study the impact of energy resource occurrence and (or) production and use on both environmental and human health.

Authorizations

43 U.S.C. 31 et seq. The Organic Act of 1879. The Organic Act established the United States Geological Survey and directed the USGS to examine the geologic structure, mineral resources [including energy minerals], and products within and outside the national domain.

42 U.S.C. 4321 et seq. The National Environmental Policy Act of 1969, as amended. The USGS reviews Environmental Impact Statements (EIS) prepared by other agencies under the authority of this Act. The USGS is called upon to provide technical review or inputs to resource-related actions proposed by other Federal agencies.

30 U.S.C. 201 The Federal Coal Leasing Amendments Act of 1976 provides that no lease sale may be held on Federal lands unless a comprehensive land use plan has been conducted; the USGS provides data and information needed by BLM to meet the requirements of the coal leasing program.

30 U.S.C. 1121 The Geothermal Energy Research, Development and Demonstration Act of 1974 provides that DOI is responsible for evaluation and assessment of the geothermal resource base.

43 U.S.C. 1701 et seq. As part of the **Federal Land Policy and Management Act** of 1976, BLM enlists USGS expertise regarding coal resources and reserves on and beneath Federal lands.

16 U.S.C. 3141-3150, 3161 The Alaska National Interest Lands Conservation Act of 1980. The Alaska National Interest Lands Conservation Act of 1980 Section 1008 authorizes the Secretary of Interior to conduct studies, or collect and analyze information obtained by permittees, of the oil and gas potential of non-North Slope Federal lands; Section 1001 requires the USGS to assess the oil and gas potential of Federal lands on the North Slope of Alaska; Section 1010 directs DOI (delegated to USGS) to assess oil and gas potential of all public lands of Alaska.

42 U.S.C. 8910 et seq. The Clean Air Act Amendments of 1998 (P.L. 101-549) called for continuation of the National Acid Precipitation Assessment Program (NAPAP) that was established under the Acid Precipitation Act of 1980. The USGS is an active participant in the research program and coordinates interagency monitoring of precipitation chemistry. The Environmental Protection Agency uses USGS coal data and information for baselines on coal quality and to estimate amount of air pollution derived from coal combustion.

30 U.S.C. 1028 The Energy Policy Act of 1992 supports recurring assessments of undiscovered oil and gas resources of the United States.

P.L. 106-193 Methane Hydrate Research and Development Act of 2000 authorizes appropriations for the establishment of a methane hydrate research and development program within the Department of Energy. DOE is directed to carry out this program in consultation with the USGS, U.S. Navy, Minerals Management Service, and National Science Foundation, through grants, contracts, and cooperative agreements with universities and industrial enterprises. The purpose of the Act is to study the use of methane hydrate as a source of energy. This Act complements ERP research activities in this area.

P.L. 106-469 The Energy Policy and Conservation Act Reauthorization 2000, Section 604, “Scientific Inventory of Oil and Gas Reserves,” instructs the Secretary of Interior, in consultation with the Secretaries of Agriculture and Energy, to conduct and update regularly an inventory of all onshore Federal lands, and specifically directs the use of USGS estimates of oil and gas resources underlying Federal lands.

Recent Authorizations -- P.L. 109-58

A number of provisions contained in the recently enacted Energy Policy Act of 2005 have direct or indirect implications for the ERP research activities. Appendix B contains a summary table of Energy Policy Act 2005 highlights, including provisions calling for a national geothermal assessment, a national coal inventory, a national oil shale assessment, and the reauthorization of the Methane Hydrate Research and Development Act. All of these provisions are directly aligned with the mission and long-term goals of the ERP, and will therefore have a direct bearing on ERP research activities. For example, the ERP will commence geothermal assessment activities in FY 2006. Understanding the coal endowment of the U.S. is a Program priority, and the coal inventory effort will be conducted jointly with BLM. Oil shale has not recently been a high-level priority within the ERP, thus ERP is investigating ways in which to meet the charges promulgated in the Energy Policy Act of 2005. Methane hydrate research is a Program priority, and ERP will continue to partner with the many research groups to focus on and develop our scientific and technical understanding of this unconventional, but potentially huge resource.

Recent Accomplishments

Recent ERP energy research accomplishments include, but are not limited to, the following:

1. The evolution of resource assessment methodologies for oil, gas, coal, and geothermal resources: (a) ERP's oil and gas assessments have evolved from an exploration, play-based approach to a holistic petroleum systems approach; (b) ERP's coal assessment methodology has evolved from determining in-ground resources to determining the reserve base (technically and economically recoverable coal) on a basin scale; (c) ERP's geothermal assessment has evolved as our understanding of geothermal systems and the technology used to generate electricity from these resources has evolved.
2. ERP domestic and international oil and gas assessments have been used in policy decisions, land use documents, Environmental Impact Statements, and as baselines for many organizations including other Federal government agencies, foreign government agencies, the energy industry, and environmental groups.
3. Participation as a scientific co-lead on the Mallik International Research Consortium, a cooperative research project with numerous international partners; the Mallik Research Consortium is the only project to date to demonstrate, via depressurization and thermal heating experiments coupled with real-time formation monitoring, the technical feasibility of methane hydrate production.
4. Continuation of state-of-the-art organic geochemistry research to address questions such as oil and gas typing (necessary to fully understand the origin of petroleum products), and punctuated by the completion and public release of the Organic Geochemistry Data Base, which contains more than 65,000 records of chemical analyses of crude oil, natural gas, and rock samples from thousands of locations worldwide <http://energy.cr.usgs.gov/prov/og/>.
5. Research on the phenomenon of reserve growth, which accounts for more than 80 percent of the additions to oil reserves in the U.S. in recent decades (for example, Ahlbrandt and others, 2003; Klett, 2003; Klett and Schmoker, 2003; Verma and others, 2004).

6. The recently completed Coal Analytical Laboratory Audit, which utilized the same evaluation approach that is being adopted worldwide by major organizations whose primary function is to establish standard laboratory procedures and accreditation measures.
7. The preservation and archiving of information, maps, and data that might otherwise have disintegrated or been destroyed.
8. Continuing to keep an expertise and presence in oil shale and uranium, including the rescue and archiving of historical data (for example, Finch, 2003).
9. Providing science in support of BLM land management activities: in response to a BLM request for USGS assistance for properly evaluating coalbed methane resources in the Powder River Basin, the ERP delivered to the BLM data pertaining to coal, gas and the related geologic framework, thus enabling the BLM to complete the EIS and Proposed Plan Amendment.
10. Continuing to provide science in support of the National Park Service (NPS): the ERP developed three simple, real-time, field-assessment techniques for prioritizing oil and gas production sites on public lands that have been tested at two NPS units with NPS personnel.
11. The Environmental Systems Research Institute (ESRI) recognized an ERP-supported website with a Special Achievement Award in GIS because of the content and utility provided to the GIS community, the natural resource industry, and the public as a whole, because the web site provides access to oil and gas assessment information, geologic maps and reports, and other geologic data by province for the U.S. and the World, and is kept up to date and served to the public. <http://www.esri.com/industries/petroleum/stories/sag-awards.html>,

Future Initiatives and Science Directions

ERP research endeavors are continually evolving to address current needs, knowledge, and technology. ERP research targets are ambitious:

- to accelerate delivery of high priority products through streamlining of research and assessment projects:
the successful evaluation and delivery of products associated with the Energy Policy and Conservation Act of 2000 legislation is a testament to ERP efforts in this regard;
- to develop sophisticated assessment methodologies;
- to study energy resources in frontier areas from both a geographic (for example, Alaska) and a thematic (for example, coalbed methane production from low-rank coals) context;
- to study and assess unconventional energy resources – those resources that are poorly understood and for which there are few data in the public domain:

ERP research in gas hydrates and other unconventional resources is cutting edge and ERP is recognized as a world leader in this field through its advances in improving the understanding of the chemical and physical properties of methane hydrates that will ultimately enable the

assessment of the future potential of this extremely abundant, but currently unproducible resource;

- to conduct interdisciplinary research linking coal quality parameters to human medical conditions;

The principal work of the disease case studies is linking epidemiology to environmental geochemistry. In a few key geographic regions, ERP scientists in coordination with government and academic medical experts, are studying disease models to test the hypothesis that the etiology of certain diseases such as cancer is linked to the leaching of toxic organic compounds from low rank coal deposits acting as aquifers which provide drinking water to affected areas.

- to investigate ways to strengthen and expand ERP's current, small efforts in other energy resources such as geothermal, oil shale, and uranium.

With new funding, ERP will start efforts in FY2006 to gather the information necessary for a new national geothermal assessment of the United States – assessing those geothermal resources capable of producing electrical power.

The ERP planning framework is based on the above research targets and accommodates the evolving need for energy information that is driven by both national and international factors. As observed in the recent past, accurate energy predictions are very difficult to make – witness the prediction that natural gas would displace coal for most of the Nation's electrical needs. The EIA's Annual Energy Outlook 2004 forecast (Energy Information Administration, 2004b) stated that “[a]lthough only a few years ago, natural gas was viewed as the fuel of choice for new generating plants, coal is now projected to play a more important role, particularly in the later years of the [20-year] forecast period;” The ERP, through program staff and scientific research teams, maintains a core of energy resource capabilities and expertise in order to sustain prolonged efforts within energy resources, yet remains flexible enough to respond to short- and long-term changes in customer and stakeholder needs for energy resources information. Using this approach, ERP research activities continue to expand the understanding of energy resources, and ERP deliverables maintain a high degree of relevance and impact despite changing technological, socioeconomic, political, or regulatory factors. For example, ERP provided the scientific research and information communication needed for sound decision-making with respect to coalbed gas development in the western U.S. In like fashion, the USGS is a leading science agency in investigating and understanding natural gas hydrates, an energy resource that by its very size may change future energy landscapes worldwide.

The ERP provides the framework and coordination that enable its research teams to face the challenge of maintaining a healthy balance among these core capabilities – for example, by (1) conducting research on the framework geology of oil, gas, and coal; (2) developing and improving assessment methodologies; (3) addressing emerging scientific issues related to energy resources, such as gas hydrates; and (4) determining environmental and human-health effects associated with energy resource occurrence and utilization. However, the confluence of flat budgets, increasing costs in the form of overhead expenses and salaries, as well as an aging workforce, require that the ERP judiciously leverage available resources (both monetary and human) to fulfill current and future responsibilities. The ERP must carefully consider the breadth of scientific activities currently undertaken, while looking forward to what activities may be possible and desirable in the future. The ERP must also take into account those new or expanded scientific research activities for which, within the scope of the Federal government, it is uniquely poised to undertake, such as, research into unconventional resources and the development of associated assessment methodologies. A national perspective has helped maintain high-caliber research by sharing expertise, coordinating staffing decisions throughout the ERP-funded teams

(project staffing, new hires, retraining, and so on), by centralizing high-cost laboratory functions and seismic processing facilities, and by geographic phasing of major project activities.

Program Mission and Long-Term Goals

The USGS ERP fits under the President's Business Reference Model, the DOI Strategic Plan (USDOJ, 2003), the USGS Strategic Plan (USGS, 1999), and the USGS Geologic Discipline Science Strategy (USGS, 1998). The DOI's Mission is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities. The USGS' mission is to serve the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect quality of life. The ERP Mission is aligned with the following missions and goals of the DOI Strategic Plan, the USGS Strategic Plan, and the USGS Geologic Discipline Strategy:

- DOI Strategic Plan: the mission and goals under Mission Area "Resource Use" – Manage or influence resources to enhance public benefit, promote responsible use, and ensure optimal value – Energy; DOI Strategic Goal "Manage natural resources to promote responsible use and sustain a dynamic economy;"
- USGS Strategic Plan: mission goal to "Provide science for a changing world in response to present and anticipated needs to expand our understanding of the environment and natural resource issues on regional, nation, and global scales and enhance predictive/forecast modeling capabilities;" and,
- Geologic Science Strategy: goal 3 – Advance the understanding of the Nation's energy and mineral resources in a global geologic, economic, and environmental context. The NRC review of the ERP specifically states that the role of the ERP is clearly defined, fulfills a mission essential to the federal government, and is unique from that of other federal agencies.

The Mission of the Energy Resources Program is to: (1) understand the processes critical to the formation, accumulation, occurrence, and alteration of geologically based energy resources; (2) conduct scientifically robust assessments of those resources; and (3) study the impact of energy resource occurrence and (or) production and use on both environmental and human health. Understanding of the fundamental processes that lead to the formation and accumulation of fossil fuels and other geologically derived energy resource accumulations provides the scientific foundation and credibility for all ERP products and provides the foundation for future energy research and resource assessment activities. The ERP staff and research teams provide energy resource information and expertise based on research into the fundamental processes that form energy resources and geologically based resource assessments. The NRC review of ERP states: "the mission of ERP – to provide up-to-date and impartial assessments of geologically based energy resources of the nation and the world – is fully appropriate for a federal earth-science agency. The information and data are essential to the management of federal lands, to the understanding of the environmental impacts of the extraction and use of energy resources, and to the planning of national energy policy." The NRC review also stated that "research and assessment are thoroughly entwined and that high-quality assessment must involve high-quality research" (National Research Council, 1999).

The ERP's mission concentrates on energy research that results in original, geologically based, non-biased energy information products for policy and decision makers, land and resource managers, other federal and state agencies, the domestic energy industry, foreign governments, nongovernmental groups, academia, other scientists, and the general public. Program funding is directed at fully achieving Program Goals, and the ERP systematically and proactively collaborates with intended beneficiaries, soliciting input and feedback in order to provide the best information possible to the broadest array of stakeholders in a readily accessible context.

This ERP Mission is supported by seven long-term scientific goals:

1. Improve the understanding of the oil and natural gas endowment of the United States and the conventional oil and gas endowment of the world;
2. Improve the understanding of the coal endowment of the United States;
3. Improve the understanding of the occurrence and distribution of, and conduct research in support of making natural gas hydrates a technically producible resource (in other words, a reserve);
4. Improve the understanding of the distribution and resource base of other geologically based energy resources of the United States;
5. Improve the understanding of the environmental and human health effects of energy resource occurrence and utilization;
6. Maintain state-of-the-art data management and data distribution systems in order to organize, deliver, and archive critical ERP information for use both internally and externally; and,
7. Partner with other organizations, including donor organizations, to address domestic and international issues regarding geologically based energy resources.

In terms of overall funding for programmatic goals in the ERP, the Bureau Budget Justification and Performance Information Book (the USGS "Greenbook") reports the ERP budget as follows: 55 percent of the Program's efforts are directed toward national oil and gas efforts, including conventional and unconventional resources, coalbed gas efforts, and gas hydrate research; 11 percent of the Program's efforts are directed toward scientific study of the national coal endowment; 8 percent of the Program's efforts focus on world oil and gas studies; and 26 percent of ERP's efforts are concentrated on energy information and the environment. Although the funds are currently directed at Program priorities, the percentages listed may change as the Energy Policy Act of 2005 is implemented and commensurate funding is or is not received to comply with the new legislation.

A sound, scientific knowledge base is needed to assess available resources and the impact of using those resources. This information must also be put into context, thereby enabling decision makers to understand and weigh the costs, risks, and benefits of energy usage, and to maintain a viable portfolio of domestic energy resource options. The ERP addresses these challenges by generating and providing objective, science-based energy information essential for shaping policies regarding domestic and foreign energy resources, making sound decisions regarding Federal land use, and maintaining a healthy domestic energy industry. The ERP provides information that can be used to determine current versus future resource options. In the 1999 NRC review of ERP, it was stated that "many of the issues addressed in

that [1988 review] report are still timely, and the need for accurate information about energy resource options is every bit as great. The fact that the 1988 review considered many issues that are still relevant today is an indication that the time scales for changes in the energy mix are long...”

ERP focuses its efforts on geographic areas, commodities, or studies that will further short-term and long-term goals the most – generally in areas where there is relatively little known about the commodity and on those resources with the greatest potential for meeting the Nation's energy needs. Emphasis is placed on traditional resources of oil, gas, and coal, unconventional resources such as tight gas sands, shale gas, and coalbed methane, potential future resources such as gas hydrates, and to a limited but growing extent on resources such as geothermal, oil shale heavy oil, and (or) uranium. These latter resources are studied at a level generally consistent with their current and anticipated future contributions to the U.S. energy mix, taking into consideration the finite resources (both monetary and human) of the ERP. In that light, ERP will increase its efforts in the geothermal arena, because of renewed and growing interest in domestic geothermal resources. ERP will support this effort with studies designed to improve geologic understanding of the nation's geothermal resources and to provide a national geothermal assessment. The knowledge gained from studying gas hydrates will substantially benefit the nation, especially as start-up time for economic (that is, field-scale) production of similar, new commodities is usually 10-20 years. Research is needed now to prepare for when the technology and economics are conducive to development. The ERP also focuses its efforts in geographically frontier areas, such as Alaska, where little information exists, but where there are huge potential resources, in order to provide the basic scientific information needed to make sound policy decisions.

Results of scientific studies conducted in the ERP address key aspects of the Program's long-term goals, including:

1. The basic understanding of conventional and unconventional resources, petroleum systems in basins throughout the U.S. and the World, and the processes that result in energy resources formation, migration, accumulation, and preservation—research that is no longer being conducted at most industry and academic laboratories.
2. Regional-, national-, and global-scale assessments of the potential for undiscovered oil and gas resources and coal deposits, thus delineating the potential resource supply endowment upon which national and international decisions can be made with respect to the amount of resource, land access, transportation scenarios, maintenance of energy supplies, need for research on alternative and (or) potential fuels.
3. Public access to reliable and consistent research and assessment methods and databases of geochemical and geophysical analyses related to oil, gas, coal, gas hydrates, and geothermal resources.
4. Improved understanding of the environmental and human health effects of energy use.
5. Reliable, long-term, raw and interpreted baseline data at regional- to national-scale against which to measure environmental impacts of energy occurrence and use.

Energy Resources Program 5-Year Goals

Descriptions of specific ERP 5-year goals (below) are meant to be cross-referenced with other Bureau documents, particularly the USGS Budget Justifications (the “Greenbook”) and the detailed project proposals and descriptions found in Basis+. The USGS Greenbook contains details of Programs’ performance measures, overall goals for the next year, and detailed accomplishments from the previous year. The project proposals in Basis+ give yearly details about project goals, objectives, and accomplishments. Project proposals are revised annually, based on feedback from the ERP Program Council, discussions with the project chief, and progress on the specific research or scientific topic. The project proposals are designed to be flexible enough to show changes in direction and development of the science as the project progresses.

1. Improve the understanding of the oil and natural gas endowment of the United States and the conventional oil and gas endowment of the world

1A. Systematically conduct geoscientific studies and assessments of oil and natural gas resources in sedimentary basins of the United States

The U.S. has a long history of oil and gas exploration and production, and is one of the most maturely explored countries in the world. However, large volumes of undiscovered oil and gas remain throughout the U.S., especially in areas such as Alaska and the Gulf Coast. There is a perception, also, that a large volume of undiscovered oil and gas resources underlies lands administered by the Federal government, and these resources are perceived by some to have been historically unavailable for development. The overall goals of this effort are to: (1) conduct geoscientific studies in various regions where petroleum occurs; (2) assess the oil and natural gas endowment (including coalbed methane), reserve growth potential, and economics of these resources where appropriate, of the onshore and state-water portions of the U.S.; and (3) determine the volumes of undiscovered oil and gas that may underlie Federally administered lands.

Findings from these geoscientific studies will be synthesized, using a consistent methodology and a total petroleum system approach, to yield assessments of undiscovered, technically recoverable oil and natural gas resource endowments. Individual assessment studies will be prioritized according to the level of resource richness and the distribution of resources on public lands. Study areas will be reevaluated and reassessed as significant new data become available and/or our understanding of the geologic processes or frameworks evolves. Where appropriate (for example, Alaska), economic analyses will be incorporated into the assessment synthesis efforts.

The success of many research, geologic, and assessment projects, especially those in frontier areas such as Alaska, or those targeting new commodities such as gas hydrates, depends upon the availability of detailed subsurface structural and stratigraphic information. Such information is essential to provide the foundation for geologic-based hydrocarbon resource estimations, petroleum-reservoir characterization, basin analysis, fluid-flow modeling, geologic framework studies, and definition of petroleum systems. Whereas some of these data may be provided by borehole information, newer technology using two-, three-, and four-dimensional multichannel seismic-reflection data are becoming the best subsurface imaging tools in use today, being employed throughout the petroleum exploration

world and, therefore, are providing ERP geologists and geophysicists the best possible subsurface information. Accordingly, it is important to enhance and maintain a fully integrated seismic-reflection data processing, interpretation, visualization, archiving, and distribution capability.

Coalbed methane (CBM) now accounts for almost 10 percent of the natural gas production in the U.S.; yet much remains to be studied about this important energy source. The ERP will continue to support efforts where CBM occurs, especially in areas such as (1) the Powder River Basin, the largest and still expanding producer of coalbed methane in the world, with concomitant environmental concerns; (2) the Gulf Coastal Plain, where little is yet known about the CBM potential in this prolific oil and gas region; and (3) rural Alaska, where the need for affordable energy sources is particularly acute because costly diesel fuel must be delivered by barge or plane, and tank leakage and pollution associated with diesel fuel pose significant health concerns. The ERP coalbed methane activities in the Powder River Basin are complementary to, supported by, and conducted in partnership with the BLM, State agencies, and local industry consortia. Similar activities in the Gulf Coast are conducted with a number of Cooperative Research and Development Agreements (CRADAs) with other interested parties, and with State agencies and academia. To facilitate the development of environmentally friendly, affordable energy resources to sustain remote communities, the ERP endeavors to secure funding to support research activities evaluating CBM resources in rural Alaska. To build support for these efforts over the next five years, the ERP will seek to augment existing collaborative partnerships with the BLM, relevant Native Corporations, and the State of Alaska. The ERP is also exploring the viability of incorporating geothermal activities into the overall rural energy program partnership with the BLM and the State of Alaska.

1B. Systematically conduct geoscientific studies and assessments of oil and natural gas resources in sedimentary basins of the world

The U.S. currently consumes about 25 percent of the energy resources produced in the World; thus, the volumes, quality, and availability of domestic and foreign energy resources are of critical national importance. Indeed, the problems related to global oil and gas supply, and particularly U.S. supply, have never been more critical. ERP research efforts provide basic information needed to address these issues. The IEA stated that “[t]he most authoritative source of data in global oil resources, including both proven reserves and undiscovered resources, is the U.S. Geological Survey’s World Petroleum Assessment 2000” (International Energy Agency, 2001). In addition, results from efforts to systematically evaluate the major conventional resources around the world provide information for discussions on North American gas supply and sources of natural gas imports for the U.S., the peaking of world oil, concerns of global oil supply, and global security issues. Particular focus will be paid to the Arctic, which contains an approximated 20 to 30 percent of the remaining undiscovered oil and natural gas resources in the World, and to the Middle East. Regions will be re-evaluated and reassessed when significant new data become available, our understanding of the geologic processes or framework evolve, or there is significant customer or partner interest.

1C. Study the origin, evolution, occurrence, and distribution of oil and natural gas in order to better geologically evaluate these resources

Historically, assessments of undiscovered petroleum resources have been based on statistical evaluations and geological analogues of discovered oil and gas resources. Current USGS assessments, however, are based upon the total petroleum systems approach. Organic geochemistry is critical to the understanding of the petroleum system, and is used to determine the source of the petroleum and the ultimate quantities of oil and gas that might be available from the source rocks. Therefore, the ERP supports research efforts and a research laboratory to provide organic geochemical data and interpretations for petroleum systems and environmental studies. Geochemical research helps explain how petroleum (oil and gas) is generated, migrates, accumulates, and is preserved in the reservoir rock. An understanding of the factors affecting these petroleum processes, as well as the quantity and quality of the resource, is critical to making accurate and scientifically sound domestic and international oil and gas resource assessments. Yet, a quantitative understanding of these processes remains to be established. Research efforts will be directed toward establishing oil and gas typing methods for identification of petroleum-system assessment units, developing quantitative understandings of thermogenic gas generation, and establishing an understanding of the origin and controls on microbial gas generation.

1D. Continue to evolve the geologic understanding of and assessment methodology for unconventional (continuous) resources such as basin-centered gas

This effort is tied closely to 1A, 1B, and 1C (above). As the utilization of natural gas in the U.S. energy mix increases, questions have been raised as to the ability of U.S. domestic production to expand from its current rate to meet projected needs in just a few years. Estimates show that the largest remaining undiscovered domestic resources occur in what are termed by ERP scientists as “continuous” gas accumulations (others refer to these accumulations “unconventional”) that form most commonly in low permeability sandstone (“tight gas sands”) and shale reservoirs. In addition to having low permeability, characteristics of these widespread, continuous gas accumulations differ from conventional accumulations in that they occur downdip from water-saturated rocks, seem to lack obvious seals, have pressures that differ from buoyancy conditions, and occur close to source rocks (fig. 4). Research efforts on tight gas sands will focus on the physical and chemical characteristics of the hydrocarbon and associated water accumulations in basins dominated by sequences of fine-grained siliciclastic rocks with an emphasis on fluid and pore space properties and interactions. Research efforts on shale gas will focus on investigating the controls on shale gas reservoir quality and evaluating the effects of mineralogy, total organic carbon content, and organic matter type on shale gas content. The ERP will provide a greater understanding of the fundamental mechanisms responsible for shale gas accumulations. Efforts on all continuous gas accumulations will be used to construct a framework for future assessments of this important and growing domestic resource.

1E. Conduct systematic studies of reserve growth

In recent decades, growth of proved reserves in existing fields has accounted for more than 80 percent of the additions to oil reserves in the U.S. This growth has resulted from extensions of existing fields, infill drilling and new pool discoveries, as well as application of new recovery technologies, and bookkeeping revisions based on price/cost analyses. Reserve growth varies significantly from region to

region within the U.S., depending on local conditions of geology, infrastructure, and environmental setting. Knowledge of the geologic, engineering, and economic factors affecting reserve growth is critical to fully understanding the role of reserve growth in the future domestic energy supply of the U.S.

Internationally, reserve growth has been documented in individual fields, but little effort has been devoted to the development of reliable, regional models. Based on the remarkable changes in reserve estimates observed in the U.S., it is reasonable to expect that reserve growth may come to significantly affect world oil and gas production as well. For this reason, the mechanisms of reserve growth are also of crucial importance to the World Energy Project.

Many significant questions with respect to reserve growth remain:

- *Do oil fields grow differently than gas fields?*
- *Do heavy oil reservoirs grow differently than conventional reservoirs?*
- *What volumes of oil and (or) gas can be expected to be available for U.S. supply from reserve growth?*
- *What are the main economic controls on reserve growth?*

Given the potential significance of these unresolved issues, the ERP recognizes a need for systematic studies to improve the understanding regarding the physical mechanisms responsible for reserve growth in the principal petroleum-producing regions of the Nation and the World.

2. Improve the understanding of the coal endowment of the United States

2A. Systematically conduct geoscientific studies to assess the coal reserve base of the United States

Coal accounts for more than 50 percent of the electricity generated in this country. Because electricity consumption is tied directly to a country's GDP, coal has been and will continue to be critical to the U.S. standard of living. With fluctuating prices and questions about natural gas sources, coal will continue to provide a relatively inexpensive, domestic resource for electricity generation. Although we know where the coal deposits are in the U.S., and know the relative in-ground resources of the deposits, at least of the major coal beds, we do not have a firm understanding of how much of those in-place resources are technically and economically recoverable. The USGS has just revised its coal resource assessment methodology to determine the subset of in-place resources that is technically and economically recoverable on a basin-wide scale. The ERP will fund efforts to work with agencies that have land and resource responsibilities, such as the BLM and Office of Surface Mining (OSM), and those agencies that use USGS resource projections for their mission work, such as EIA, so as to incorporate the needs of these customers into ERP products.

Energy Resources Program efforts will focus on finalizing revisions of the new coal assessment methodology in order to assess the U.S. coal reserve base, that is, those resources that are technically and economically recoverable. (The ERP's previous methodology assessed the in-ground coal resources.) After finalization of the methodology revision, the ERP will support efforts to systematically evaluate the major coal-bearing basins in the U.S., using the new assessment methodology, and produce a national view, basin by basin, of the amount of technically and economically recoverable coal that is available in the U.S. Prioritization of the major coal-bearing basins will take into account the amount of resource, data availability, amount of public land, and needs of customers and stakeholders.

2B. Conduct systematic coal quality studies

Studies of coal quality parameters have been a core component of the ERP research portfolio. The ERP will continue to support studies improving the understanding of the quality of the U.S. coal endowment. Collectively, this latest effort will focus particularly on “cradle-to-grave studies” of elements in coal that can have potential adverse impacts on environmental quality and (or) may be slated for regulation. This effort may also consider trace elements of interest both in strata associated with coal (and therefore disturbed by mining operations) and in waste materials and by-products (elements associated with coal utilization).

Given the increasing attention on the impacts of coal utilization, coal-quality research must address a more comprehensive suite of coal quality-related issues beyond the fundamental coal quality parameters such as ash yield, sulfur content, and heating value. This more comprehensive approach is vital to future assessments and future use of coal in this country. Furthermore, integrating basin framework geology with the occurrence and distribution of coal quality parameters will serve to describe and explain trends, and may ultimately allow for the development of predictive capabilities. Research relating the fundamental coal properties to characteristics affecting the behavior of coal during beneficiation and combustion are also needed. For example, emissions of trace elements, for example, mercury, from coal-fired power plants will be regulated in the future. Past ERP research efforts such as the National Coal Quality Inventory (NaCQI) provided quality data on feed coal on both as-mined and washed or beneficiated coals.

The ERP will focus research efforts to support investigations into the current issues pertaining to coal production, beneficiation and/or conversion, and the environmental impact of the coal combustion process and coal combustion products (CCPs). Studies that examine the feed coal(s) and CCPs from individual coal-fired power plants (commonly referred to as “cradle-to-grave” studies) are a key component. To develop the possibility for a predictive capability addressing the effect of variations in spatial occurrence and coal utilization processes on environmental quality, multiple studies are needed from individual coal basins. These process studies will be integrated with available analytical, geographic, and stratigraphic data to provide more extensive evaluations of coal quality parameters in high priority coal-bearing basins. The ERP will promote research efforts on the fundamental coal characteristics that affect the behavior of coal during beneficiation and combustion and provide information/data on a variety of coal quality parameters including sulfur, nitrogen, major-, minor-, and trace-elements, and coal mineralogy.

1. Maintain high analytical standards (QA/QC) for the Coal Analytical Laboratory

The visibility and importance of accurate laboratory results are underscored by the increased emphasis to understand the effects of mercury, arsenic, and other toxic elements on the impacts of coal production and usage. Because of the importance of analytical laboratory analyses to many of ERP’s projects, the ERP recently conducted an outside laboratory audit to optimize lab performance by evaluating: (1) the ability to produce high quality data, (2) approaches to minimize operational costs, and (3) the ability of the working environment to optimize staff involvement in quality improvement. The

outcomes of this audit will be used to enhance the laboratory's position as a recognized, competent practitioner of performance-based testing. Results of the laboratory audit indicated excellent results for some procedures and analyses but also identified a need for improvement on others. The ERP will continue ongoing efforts to improve those areas, and will also implement a rigorous QA/QC practice in order to assure laboratory users of the validity of the results. Reliable, consistent, and defensible laboratory results are critical to research on sensitive issues such as coal quality parameters, especially when many elements of concern are being regulated.

2. Expand, maintain and serve (deliver) databases of coal quality

The ERP has previously developed, as outcomes from different projects, several databases in which coal quality parameters reside. Future ERP efforts will be directed toward integrating these disparate databases so that it can deliver a comprehensive, coordinated set of coal quality parameters to both internal and external customers.

3. Improve the understanding of the occurrence and distribution of, and conduct research in support of making natural gas hydrates a technically producible resource (that is, a reserve)

Gas hydrates represent a potentially huge energy resource, but any real contributions to the world's energy supply will depend upon the availability, producibility, and cost of extracting methane from the hydrate phase. The overall size and producibility of hydrate at any one site is still very much in question. The ERP will continue its partnership with international consortia to study gas hydrates, both as permafrost-associated hydrates in the Arctic and as accumulations in marine sediments. Energy Resources Program research efforts will continue to assess the recoverability and production characteristics of permafrost-associated hydrates and associated free-gas accumulations on the North Slope of Alaska. The ERP, in conjunction with BLM, will also conduct a technically recoverable resource assessment for that region – the first one of its kind. The ERP methane hydrate research efforts are conducted in partnership with the USGS Coastal and Marine Geology Program, especially in studying the offshore hydrate occurrences. The ERP also works in partnership with the BLM, DOE, the State of Alaska, and industry research organizations on the North Slope of Alaska. The USGS was also part of an international consortium – the Mallik Gas Hydrate Consortium – a group of researchers from Japan, Canada, U.S., Germany, and India. An especially noteworthy outcome of this consortium was the production of natural gas from gas hydrates, the first and only time to date that such production has been documented. The ERP continues to receive solicitations from foreign governments regarding collaboration on methane hydrate research, the most recent request coming from India. The ERP will continue to work closely with the Minerals Management Service (MMS) in its efforts to characterize methane hydrate occurrence and quantity in the Federal OCS (Outer Continental Shelf), and with industry consortia in the Gulf of Mexico.

4. Improve the understanding of the distribution and resource base of other geologically based energy resources of the United States

4A. Geothermal

Based on current projections, the U.S. faces the need to increase its electrical power-generating capacity by 40 percent (approximately 300,000 megawatts-electrical or MWe) over the next 20 years (Energy Information Administration, 2005). A critical question for the near-term is the extent to which geothermal resources can contribute to this increasing demand for electrical power-generating capacity. Geothermal energy constitutes one of the nation's largest sources of renewable and environmentally benign electrical power, yet the installed capacity of 2,860 MWe falls far short of estimated geothermal resources.

Because the last national assessment was conducted in the late 1970s, a new assessment is needed to incorporate recent advances in technology and in our understanding of the thermal, chemical, and mechanical processes leading to formation of productive geothermal systems. A new geothermal assessment would provide State and Federal government policymakers with the information necessary to estimate the potential contribution of geothermal energy to the Nation's energy mix. Many western states have either adopted or are considering renewable portfolio standards that require a minimum percentage (typically 5 to 10 percent) electric power be derived from renewable sources. A necessary element in both the establishment and fulfillment of these standards is a reliable estimate of the distribution and size of the domestic geothermal resource. Debates on related issues, such as the extent of access to public lands for energy development, will also benefit from updated information on geothermal resources.

To address these issues, the ERP intends to support a new assessment of geothermal resources, with a focus on the western U.S., including Alaska and Hawaii. This new assessment effort will provide collaborative opportunities with other USGS programs (such as Earthquake Hazards and Volcano Hazards) and disciplines (such as Water Resources), and also with external entities, including the BLM, DOE, national laboratories, universities, state agencies, and the geothermal industry.

4B. Uranium

Because of recent renewed interest in nuclear power, both in the U.S. and the world, the ERP will support a modest effort in uranium research to begin developing a GIS database and webpage structure of the massive uranium mine dataset in USGS files. The ERP will also cooperate with State and Federal agencies with digital uranium databases already in place or with specific needs for such a database. Where appropriate, ERP will pursue CRADAs with interested companies, to obtain unique data sets or share work efforts toward building a digital database of uranium data.

Use of uranium raises important environmental concerns, as witnessed in the past, and which will continue in the future. The mountains immediately west of Denver, for example, are an area of historical uranium mining. Uranium mine waste and drainage from old workings is present at many sites within this area, including the Schwartzwalder mine and many other associated smaller properties; only a portion of these sites have been remediated. This area also contains residential communities undergoing

substantial development. As a result, the ERP will support modest efforts to gather and analyze baseline and mining impact data to distinguish between natural radioactivity and mining-enhanced radioactivity.

4C. Oil shale

Like uranium, there has been recent, renewed interest in oil shale, highlighted by a provision in the Energy Policy Act of 2005 that calls for a national assessment of oil shale resources. The ERP has anticipated the need for an improved understanding of this energy resource, and is prepared to respond to this provision. Over the last couple years prior to the enactment of this legislation, the ERP has maintained a modest oil shale research effort that included: (1) providing an annual summary of the status of this fuel as a potential alternative to conventional fossil fuel sources; (2) maintaining contacts with other government agencies and industry regarding this commodity; and (3) providing a central clearing house of available USGS information related to oil shale. Given the recent call to expand its activities, the ERP is prepared in the short term to build on this foundation by constructing and delivering an updated national database of existing oil shale information. In the longer term, the ERP anticipates beginning a new assessment of oil shale resources either as additional funding becomes available or as efforts pertaining to other mandates (for example, EPCA) are completed within the next several years. These expanded research efforts on oil shale would be focused initially on resources within Utah, Wyoming, and Colorado.

5. Improve the understanding of the environmental and human health effects of energy resource occurrence and utilization

5A. Geologic carbon dioxide sequestration

The ERP is just finalizing unique research to assess the sources and potential geologic sequestration options for carbon dioxide, a greenhouse gas emitted during combustion of fossil fuels. The long-term objective of these efforts was to develop methods to assess the volume of carbon dioxide that can be safely stored in the subsurface for hundreds to thousands of years or longer. To provide the scientific foundation for the assessment methods, the ERP conducted research on the solubility of carbon dioxide in brines at subsurface temperatures and pressures, evaluated gas fields containing naturally high carbon dioxide concentrations as analogues to carbon dioxide storage locations, and evaluated some of the environmental issues associated with storing carbon dioxide in coal beds.

Funding for this work was cut in the FY2006 budget. As a consequence, ERP will terminate the development of an assessment methodology for geologic sequestration of carbon dioxide, and efforts in this venue will be relegated to a technical advisory role in support of other international and Federal efforts. Under this scenario, the ERP may explore other funding opportunities (for example, reimbursable efforts, to continue this line of work but most, if not all, base efforts will cease.

5B. Effects of energy resource extraction and utilization

1. Subsidence

Subsidence resulting from hydrocarbon production at shallow depths has been documented in most major producing basins of the world. Despite widespread recognition of this phenomenon, the potential for significant subsidence as a result of moderate to deep hydrocarbon production has generally been disregarded. USGS findings from recent efforts in the Gulf Coast have led to a major reevaluation of the degree of wetland loss, the role that subsidence may play in this loss, and the fundamental causes of that loss.

The ERP, in conjunction with the Coastal and Marine Geology Program, supports this work to address a broad spectrum of questions relating to the mechanisms of recurrent fault movement, subsidence, and attendant changes in land characteristics. Future work is anticipated to evaluate recent rates of subsidence documented by NOAA and to establish three synoptic time history series in south Louisiana for comparison – wetland loss, subsurface fluid production, and subsidence. Documenting and mapping the subsidence rates will provide a potentially powerful predictor for evaluating the vulnerability of some of the proposed coastal restoration projects. There are several cooperators and customers interested in the results of these efforts, including the Army Corps of Engineers, Fish and Wildlife Service, and State and local offices of Louisiana and Texas.

2. Field assessment techniques for evaluating impacts

In addition to studies of subsidence, ERP plans to focus on developing simple, real-time, field assessment techniques for evaluating and prioritizing remediation efforts of former oil and gas production sites on public lands. Public land managers in oil- and gas-producing areas generally have a large inventory of sites of historical oil and gas production, many of which are abandoned and in need of remediation. Such sites have visible impacts that can be readily discerned and mapped, but many also have impacts that are not so visible (such as subsurface hydrocarbon plumes, or dissolved hydrocarbons seeping into nearby streams). Techniques will be developed and tested to allow land managers and field staff to: (1) fully evaluate the extent of impacts; and (2) prioritize sites for reclamation, as well as sites for testing the success of a reclamation program once completed. This work will be conducted in close cooperation with land management agencies.

3. Produced waters

Since the early 1800s, about 3 million oil and gas wells have been drilled in the U.S. Much of this drilling and resultant production was accomplished before modern environmental regulations were in place. The result is a legacy of impacts and a potential for future impacts on soil, ground water, surface water, and ecosystems that are not yet well understood.

Likewise, many coal-bearing areas of the U.S. are now being investigated for CBM resources, with exploration and development extending into new areas of potential. Production of CBM yields large quantities of formation water, the quality of which in many basins is poorly documented thus emphasizing the need for additional coalbed water quality studies to assess possible environmental issues in prospective CBM areas.

Given the increased competition among agriculture, industry, and human consumption for surface and ground-water resources, understanding the national, regional, and local impacts of produced-water releases on surface-water and ground-water quality has become increasingly important. The ERP endeavors to promote studies that lead to: (1) evaluating these impacts at national, regional, and local scales; (2) developing information that will enable land managers and environmental officials to better assess human health and ecosystem effects; (3) correctly distinguishing between natural and anthropogenic effects; (4) developing cost-effective remedies; and (5) establishing appropriate policies and regulations. The ERP aims to further the development and expansion of an online produced-waters database so that this information may be readily disseminated to interested partners, customers, and stakeholders.

4. Human health implications

Energy resource commodities, such as coal, oil, and natural gas, commonly contain toxic substances that can, if mobilized so that exposure occurs, 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 may be mobilized by natural processes (for example, leaching of coal deposits by groundwater) or by human extraction and utilization (for example, produced waters from CBM extraction, indoor burning of coal and oil, or disposal of coal ash from power plants). This exposure may lead to acute disease symptoms in extreme cases, or to increased disease risk to cancer or other illness from long-term, chronic exposure. Energy resources (especially coal) are potential sources of toxic substances and the increasing use of coal in the U.S. and the world may increase human exposure to toxic substances derived from fossil fuel use.

To address the linkages among geology, energy resources, and human health, the ERP fosters research activities enhancing the understanding of the natural variability of coal quality, and the ramifications of such variability on environmental quality and human health. This research area provides opportunities for outside funding, and the ERP endeavors to explore such opportunities where appropriate and aligned with mission priorities. For example, the ERP has supported scientists (in conjunction with external funding sources) studying Balkan Endemic Nephropathy (BEN), a disease thought to develop from long-term exposure of susceptible individuals to low levels of toxic organic compounds, derived from coal, that are present in rural drinking water supplies in the Balkans. USGS scientists have also studied the health effects of elevated concentrations of elements of concern, such as mercury in Ukraine and fluorine, arsenic, mercury, and selenium in China, present in the indigenous coal resources. The ERP plans to build on the successes and the expertise developed during the BEN and similar studies by evaluating potential linkages in the U.S., where the confluence of specific human diseases and toxic compounds from coal may occur.

The ERP is a member of the Bureau Human Health Coordinating Committee, which is an oversight committee that also includes program managers from the Toxic Substances Hydrology Program, National Wildlife Health Center, Mineral Resources Program, Geographic Analysis and Mapping Program, Cooperative Water Program, Wildlife and Terrestrial Resources Program. The mission of the Human Health Coordinating Committee group is to: (1) increase collaboration and strengthen partnerships with public health agencies, to increase coordination among USGS natural science activities that are relevant to human health science and decisionmaking; (2) foster scientist-to-scientist linkages across scientific disciplines; (3) identify and implement priority areas of research and associated areas for additional funding and growth; (4) increase the visibility and use of USGS scientific

contributions to protecting public health; and (5) monitor progress towards these ends. The ERP will continue participation in this committee and seek to identify opportunities for partnerships, both internal and external, that are aligned with activities in the ERP research portfolio so as to leverage resources and increase the impact and visibility of the science conducted.

6. Maintain state-of-the-art data management and data distribution systems in order to organize, deliver, and archive critical ERP information for use both internally and externally

The ERP will continue to pursue state-of-the-art means of data management, data distribution, and data archival and preservation activities. Energy Resources Program products are consistently based on GIS platforms to sustain transparency and security in serving public data of high quality. This uniform use of GIS platforms enables the ERP to disseminate results to the widest possible audience by providing the information digitally, both on-line and in portable format (compact discs). The ERP will continue to promote the development and on-line release/delivery of additional data sets to increase the ability to disseminate information to the public. The Organic Geochemistry Database represents one successful outcome of these efforts, and, over the next five years, the ERP will augment both the quantity and type of data delivered on-line.

The ERP also endeavors to improve the efficacy with which data are delivered online. The World Energy Project web page has been redesigned to include: (1) a spatial search capability, (2) an increased availability of metadata and documentation, (3) an improved access to search and browse activities, and (4) a means to more effectively locate ERP products. This prototype will serve as the foundation for a Program-wide revision of all ERP-supported web sites. The ERP-supported webmasters are redesigning all energy-related web sites to better serve our customers, to more seamlessly deliver information, and to facilitate more efficient access to products.

The ERP, where appropriate, will continue to support efforts at preservation and archiving of information, maps, and data that might otherwise disintegrate or be destroyed. Just one example is the NERSL project that obtained the NPRA data set from NOAA, who was no longer able to archive the data set. This data set, which cost well over a billion 1980 dollars to acquire, is one of the most complete in the federal government in an area that is now actively undergoing exploration. This rescued data set has since been used by industry as a basis for exploration in NPRA and by Federal and State agencies to plan and implement lease sales in and near NPRA. The data set, now secure, resides online and can be accessed by the national and international communities.

7. Partner with other organizations, including donor organizations, to address domestic and international issues regarding geologically based energy resources

The ERP staff is teamed with an expert federal workforce, consisting of three regional energy teams and adjunct partners in numerous agencies, facilities, and academic institutions, that has extensive experience and expertise in energy research, resource assessment, and geological, geochemical, and geoenvironmental research, as well as data-management capabilities in problem identification and solving. Where appropriate, the ERP partners with colleagues within the USGS (interdisciplinary) and with other agencies and institutions to leverage funding, expertise, and facilities, thereby maximizing the

scope of research activities, and the quality and quantity of products generated, and the level of success in achieving complementary goals. Major partners include, but are not limited to, the following: DOD, NSF, DOE, EPA, BLM, EIA, and DOI, State Geological Surveys, state and local resource agencies, and major consortia of academic, governmental, and industry groups. In general, ERP provides the broad scientific framework that provides context and support for partners to conduct work on a more specific or local basis.

Some partnerships are collaborative, sharing only expertise, whereas others share costs in terms of facilities, data, or funding. The ERP establishes roles and responsibilities with partners through cooperative agreements, Memoranda of Understanding (MOUs), or Cooperative Research and Development Agreements (CRADAs). One example is the CRADA that the ERP forged with industry and academia to explore for and conduct research on CBM resources in the Gulf Coast. Both of these kinds of agreements contribute to the short-term goals of understanding the nature, occurrence, and distribution of the resource to fulfill the long-term goal of assessing the technically recoverable resource. Other agreements are funded by partners who need specific expertise from ERP.

Effective collaboration between ERP and others is evidenced by the many working agreements it has with customers and stakeholders from numerous sectors of society, including other entities within the Bureau, other federal and state agencies, foreign government and research organizations, NGOs, academia, and private industry. A detailed list highlighting these partnerships is given in Appendix C. Examples of successful agreements include: (1) gas hydrate research with DOE, MMS, BLM, industry consortia, and research organizations of other countries; (2) CBM work with BLM and industry consortia; and, (3) collaboration with the BLM and the U.S. Forest Service in responding to EPCA. The ERP also works closely with a number of State geological agencies in energy-bearing States, including efforts that are both long-term and short-term depending on the need and the type of research involved. We work particularly closely with State surveys in our coal studies, through our State Coop Program. In all of these relationships, the ERP plays a distinct, complementary role. One example highlighting this role is the EPCA work – ERP scientists provide estimates of undiscovered oil and gas resources underlying Federal lands, and the BLM identifies restrictions and impediments to developing those resources. Such cooperative working relationships benefit both parties, and ERP scientists gain access to data, knowledge, and expertise. Some arrangements result in other tangible benefits – for example, members of the ANWR consortium requested the ERP to reprocess reflection seismic data from ANWR, and in return, the ERP acquired a corresponding number of miles of company-owned seismic data at no charge. To acquire these data commercially would have cost more than \$1.5 million.

The ERP and energy teams receive substantial OFA because of their resident expertise in energy resource geosciences. This OFA helps sustain efforts in a number of research areas that are closely aligned with essential ERP mission work. The ERP is often sought out for technology transfer and institution-building projects related to energy resources; examples include the oil, gas and coal assessments and infrastructure building of Afghanistan, conducted with funding from USAID and USTDA. The ERP receives requests from numerous organizations to conduct resource assessments, train organizations on methodologies, and work cooperatively on petroleum geochemical studies. With some notable exceptions (for example, ongoing studies of Afghanistan), most reimbursable funding is directed toward enhancing operating expenses rather than salary. Partnerships are developed only in cases where the proposed activity is aligned with the ERP mission, enhances ERP's fundamental research capabilities, or promotes the ERP mission through an OFA opportunity. These constraints are imposed to inhibit

deviation from the ERP mission, and to ensure that OFA opportunities augment rather than divert ERP scientific efforts. By maintaining a core expertise in energy resource geosciences, the ERP is able to support these partnerships with other organizations and will continue to meet regional, national, and international priorities related to geologically based energy resources.

ERP reimbursable funding has changed over the years; below is a list of current OFA projects:

Bureau of Land Management – Surface Geologic Mapping, Alaska
Bureau of Land Management – Coalbed Methane Studies/Rural Energy, Alaska
Bureau of Land Management – Coalbed Methane Studies, New Mexico
Bureau of Land Management – Coalbed Methane Studies, Wyoming
Bureau of Land Management – Energy Policy and Conservation Act
Bureau of Land Management – Gas Hydrate Assessment on North Slope AK
Bureau of Land Management – Geothermal Studies in the Great Basin
Department of Defense – Training opportunities and resource assessments
Department of Energy – Coalbed Methane Studies/Rural Energy, Alaska
Department of Energy – Gas Hydrate Studies
Department of Energy – Geothermal Studies in Coso
State of Utah – Oil Shale Studies
U.S. Trade and Development Agency – Afghanistan Oil and Gas Resources
U.S.AID – Afghanistan Coal Resources
U.S. CRDF – Ukrainian Health Project (Mercury)

Program Budget and Performance Integration

1. Funding

The USGS Budget Justifications and Performance Information publication (“Greenbook”) lists the ERP allocations as follows: National Oil and Gas Assessment (including gas hydrate research) (55 percent of ERP funding), National Coal Assessment (11 percent), World Oil and Gas Assessment (8 percent), and Energy Information and Environment (26 percent). These four allocations support the Program 5-Year Goals mentioned earlier:

1. the National Oil and Gas Assessment supports the Program 5-Year Goals numbers 1, 3, and 4.
[The growing interest in uranium, oil shale, and geothermal resources, combined with the new funding to expand existing geothermal resource research efforts, will likely necessitate a separate listing of these activities in the Greenbooks of subsequent fiscal years so as to highlight and assist in tracking of these activities.];
2. the National Coal Assessment supports Program Goal 2;
3. the World Oil and Gas Assessment supports Program Goal 1;

4. the Energy Information and Environment research effort supports Program Goals 5 and 6; and,
5. all allocations are aligned to support Program Goal 7.

2. Linking Program-Funded Research with Performance Measures

The ERP research goals and activities are aligned with USGS and DOI priorities. Under DOI, the Bureaus have their own set of Activity Based Cost/Management (ABC/M) work activities defining bureau management needs. These Bureau work activities align with the DOI work activities in a hierarchical relationship that assigns one or more Bureau work activities to a single DOI work activity to facilitate the execution of DOI's mission in resource protection, resource use, recreation, and serving communities (U.S. Department of Interior, 2005). These activities ultimately support the President's Management Agenda (PMA) by improving strategic linkages among efforts to manage human capital, integrate budget and performance information, expand electronic government, promote competitive sourcing, and improve financial management.

The ERP has a number of measures in support of the OMB PART, the DOI Strategic Plan (U.S. Department of Interior, 2003), and Bureau strategic plans (U.S. Geological Survey, 1998; 1999). Progress on these measures (the "Performance Summary" under the "Performance Budget" section of the Greenbook) is verified quarterly and reported and updated annually. To clearly measure progress in providing information essential to its customers, ERP tracks four intermediate outcome measures associated with producing baseline information about oil and gas assessments for targeted basins, and the quality, content, and satisfaction with the data provided. Outputs associated with these intermediate outcome measures include the delivery of systematic investigations and analyses to customers, the maintenance and update of 3 long-term data collections, and the provision of formal workshops or training to customers.

2A. DOI Strategic Plan and Activity-Based Costing

The ERP is housed within the DOI Strategic Plan End Outcome Goal UEO.1 "Manage or influence resource use to enhance public benefit, promote responsible use, and ensure optimal value – Energy." The ERP's Intermediate Outcome is to "Improve information base, information management and technical assistance." Under this Outcome, the ERP has several performance measures (table 1). For comparison, the Program 5-Year Goals described in a previous section (Introduction) are listed in this table according to the corresponding performance measure(s) supported. These goals are aligned in such a manner that they currently support performance measures derived from the DOI Strategic Plan, and will continue to do so in the future.

Table 1. ERP performance measures under the DOI Strategic Plan.
Program Goal numbers refer to listing in Introduction section.

Item	Measure	Program Goals
Baseline Information	# of targeted basins with [oil and gas] resource assessments available to support management decisions	1, 2 (3,4)
Quality and Utility of information	X % of customers satisfied with timeliness of data	1, 2, 3, 4, 6, 7
Quality and Utility of Information	X % of data are accessible	1, 2, 3, 4, 5, 6
Quality and Utility of Information	X % of customers for which energy data meets their needs	1,2,3,4,5,6,7
Quality and Utility of Information	X% of energy studies validated through appropriate peer review or independent review	1, 2, 3, 4, 5

An ABC/M system developed by the National Business Center captures cost and performance information against work activities and goals and strategies of DOI's Strategic Plan (U.S. Department of Interior, 2003). The objective of the ABC/M system is to provide information on: (1) the unit cost of production of all DOI work activities, (2) the cost of executing goals and strategies in DOI's strategic plan, (3) performance against targets, (4) minimum efficient workload, (5) predicting costs for changing workloads, and (6) organizations and programs where cost efficiency needs to be improved (U.S. Department of Interior, 2005).

To specifically track ERP performance, projects are coded according to the Bureau Activity Based Costing (ABC) codes (table 2), so that these activities can be tied back to the DOI Strategic Plan. In FY 2005, ABC coding was conducted at the project level. The resulting distribution (figure 5) for the ERP, using FY 2005 Actual (direct and reimbursable) funding data obtained from the Federal Financial System, provides an overview of the ERP work activity portfolio for this fiscal year. Starting in FY2006, ABC coding will be taken to the task level (within each project) to provide a higher resolution analysis of ERP work activities. This increased degree of resolution is deemed necessary because most ERP projects are a combination of research, assessment, and technical assistance activities.

Table 2. Activity Based Codes for the Energy Resources Program.

DOI Mission Area: Resource Use	
Goal: Manage or Influence Resource Use – Energy	
Program: Geologic Resource Assessments: Energy Resources	
ABC Code/Work Activity	Output
F2 Collect data to inform decisions on Energy resource	# of gigabytes (annually)
M7 Conduct assessments to inform decisions on Energy resources	Analyses and Investigations delivered
M8 Conduct research to inform decisions on Energy resources	Analyses and Investigations delivered
U7 Manage and distribute data to inform decisions on Energy resources	# of cumulative gigabytes accessible
17 Plan/Evaluate programs to inform decisions on Energy resources	Plans and evaluations reports
Y5 Provide technical assistance to inform decisions on Energy resources	Technical assistance instance, issue, or event
43 Manage Energy Programs (Indirect)	No output

2B. Program Assessment Rating Tool (PART)

The ERP has PART Efficiency and other Output Measures (table 3), and the Program 5-Year Goals described earlier (Introduction section) are listed according to the corresponding measure(s) currently supported. These ERP goals are aligned such that future research efforts conducted through implementation of this 5-Year Plan will continue to support the PART Efficiency and other Output Measures. In addition, as indicated in the PART review conducted by OMB, the ERP will gather information regarding the customer citation of select ERP products within a 3-year time period following product delivery, and will expand the number of ERP products released in digital format to the public.

Table 3. PART Efficiency and other Output Measures for the Energy Resources Program.
Program goal numbers refer to listing in Introduction section.

Measure	Program Goals
# of systematic analyses and investigations delivered to customers	1, 2, 3, 5
# of formal workshops or training provided to customers	1, 2, 3, 4, 5
% of targeted analyses/ investigations/ assessments which are cited by identified partners within 3 years of delivery	1, 2, 3
average cost of a systematic analysis or investigation	1, 2, 6
# of annual gigabytes collected	1, 2
# of cumulative gigabytes managed	1, 2

A graphic chart showing the linkages between the Program goals, examples of ERP products, and ERP's Intermediate Outcomes (from the DOI Strategic Plan) and its Outputs (from the PART) is shown in figure 6.

Program Review

To gauge ERP's effectiveness and evolve its energy research portfolio, stakeholder and partner feedback is actively sought using many venues, including: (1) NRC reviews, (2) customer surveys, (3) interactions with customers at scientific and technical meetings, (4) web surveys and web statistics, (5) scientific and technical stakeholder meetings, and (6) participation in interagency steering committees. Energy Resources Program scientists develop state-of-the-art methodologies and techniques for synthesizing geoscientific studies into energy resource assessments, and are recognized leaders in this field. Results from ERP studies are delivered in many public forums, including ERP web sites, portable media (publications, CD's), and presentations at scientific and academic forums. The ERP seeks outside reviews of its science, methodologies, assessments, and studies to ensure the scientific robustness of the framework and resulting interpretations. For example, the ERP requested the American Association of Petroleum Geologists Committee on Resource Evaluation to evaluate its assessment methodology for the World Energy, National Oil and Gas, and ANWR assessments; this committee endorsed ERP methodologies. The ERP has recently revised its coal assessment methodology in order to evaluate those resources that are technically and economically recoverable on a basin scale (that is, the reserve base). The ERP convened a peer review for the methodology, because no equivalent organization exists to the AAPG Core committee. The coal reserve methodology peer review consisted of individuals from other federal government agencies, state agencies, academia, and industry. The ERP conducted an outside, independent audit of its coal laboratory facilities to ensure quality results.

Energy Resource Program staff and scientists belong to a number of interagency steering committees and host a number of working group meetings for specific research purposes, including the EPCA steering committee (USGS, BLM, USFS, DOE, EIA), the MMS-USGS interagency working group, the BLM-USGS interagency working group, the Methane Hydrates Steering Committee (DOE, USGS, MMS, NSF, NOAA, and NRL), the World Petroleum Assessment consortia (a consortia of industry, other government agencies, and nongovernmental organizations), standardization committees such as American Society for Testing and Materials and the United Nations Resource/Reserve Committee for both petroleum and coal and many more.

Baselines and targets for ERP projects are listed in the Geologic Discipline (GD) Annual Science Plans, annual project work plans and proposals in Basis+, and in annual Federal budget justifications. Each ERP-funded project is reviewed annually for short- and long-term relevance, focus, cost, and potential impact, and to ensure that project workplans are properly aligned with Program, USGS-GD, and DOI science plan priorities and goals. This review allows the ERP Program Council to carefully monitor and, when necessary, recalibrate research activities in order to ensure project progress and ascertain that the targets are appropriate, ambitious, and obtainable. The ERP Program Council, a rotating membership of senior energy experts from ERP, other programs, and outside organizations, reviews projects to: (1) ensure progress on project and program goals; (2) identify new ideas and partnerships; (3) bring new expertise and perspective to project decisions; (4) help ERP identify stakeholder needs; (5) adjust work as needed to meet long-term goals, customer needs, and emerging energy needs; and (6) evaluate effectiveness and relevance of project work. Priorities in any given year include U.S. and global oil, gas, and coal assessment activities, research in support of these assessments and other agencies' activities, and research efforts where ERP contains significant expertise and scientific investment, in, for example, such fields as gas hydrates, coal quality, and CBM. The ERP also has a project review every other year, in which Project Chiefs present an overview of their projects to Program and Regional management, other ERP-funded scientists, regional personnel and other interested scientists.

Expertise and Capabilities

The ERP is designed to support research activities pertaining to geologically based energy resources that generate products of use to customers and stakeholders. In concert with Energy Resource Teams in the Eastern, Central, and Western regions, the ERP works with regional USGS managers to employ an expert federal workforce with extensive experience in energy research, resource assessment, and related expertise, such as data management and information technology.

The fundamental areas of expertise currently housed within ERP research teams are mainly *geologists*, with expertise in sedimentology, sequence stratigraphy, and structural geology; *geophysicists*, with expertise in seismic analysis and interpretation; and *geochemists*, with expertise in organic and inorganic geochemistry. All are especially focused on particular research as applied to the understanding of fossil fuels and to an evaluation of the potential effects that the occurrence and utilization of these resources may have on the environment and human health. These core capabilities of the Energy Resources Program scientists are supported by a small contingent of personnel with special expertise in such fields as economics, statistics, and engineering which support all phases of the program. The ERP will continue to maintain this core expertise in cutting-edge energy resources research and to generate scientifically robust, societally relevant products, such as resource assessments.

The ERP's long-term workforce plan is to maintain core competencies by retaining and attracting appropriately skilled energy resource scientists, who have the academic and experiential background and the wherewithal to address and meet the national energy resource information demands of the future. These attributes are not expected to shift dramatically from those characterizing the current workforce. Rather, the comprehensive roster of capabilities currently existing within the ERP will enable its research portfolio to evolve and to respond appropriately to a wide variety of research and information needs for most geologically based energy resources, in such essential fields as sedimentology, stratigraphy, geophysics, geochemistry, petrology, and GIS. However, should a higher priority directive arise (for example, from a Congressional mandate), the ERP has the flexibility in core staffing to meet mission directives.

To supplement existing ERP expertise and capabilities, the ERP fosters the USGS scientist emeritus program, providing emeriti the opportunity to complete on-going work that is aligned with ERP priorities, but which may not have been otherwise attained, given the existing workload of full-time staff scientists. Several such successes of emeritus work include the accomplishments of Schweinfurth (2003), the development and patent of an ozonator by Sato, and work on heavy oils and bitumen (Meyer and Attanasi, 2003). The bulk of the current uranium and oil shale work currently done in ERP is also conducted by emeritus scientists (for example, Finch, 2003). These contributions enable the ERP to maintain flexibility and sustain activities in less prominent areas, such as oil shale and uranium, so that the Program is able to respond appropriately to changes in needs or priorities within the Administration, Congress, DOI, and the Bureau.

Facilities

The ERP Office and ERP-funded Teams continually review space and facilities requirements to optimize use, which is realized through consolidating space into contiguous blocks so that non-essential space can be returned to GSA. Optimization is also realized through the sharing of facilities with other groups (other programs, regional offices, and other teams). Examples include (1) the analytical lab in Building 20 on the Denver Federal Center, which is shared in part with the Mineral Resources and Crustal Teams; (2) the computer room in Building 25 on the Denver Federal Center where computer resources are shared with the Central Region Office, and the Hazards and ESD Teams; and (3) sharing of equipment and facilities between ERP and Coastal and Marine Geology Program.

ERP partners with others (federal agencies, states, academia, industry consortia), and by leveraging funding, expertise, and facilities, maximizes the impact of science accomplished, lessons learned, and products produced.

Laboratories are operated at regional USGS centers where costs are shared with other programs. Increased ERP efficiency and effectiveness can be measured using a number of IT, web, and laboratory improvements. ERP products are digital in nature, having moved away from the limitations and expense of hard-copy paper publications. The widespread use of GIS technology has facilitated an increase in overall efficiency and productivity, as GIS products enable users to build upon existing databases and maps and can be used for purposes beyond the original intent.

References Cited

- Ahlbrandt, T.S., Pierce, B.S., and Nuccio, V.F., 2003, USGS world petroleum assessment 2000; new estimates of undiscovered oil, natural gas, and natural gas liquids, including reserve growth, outside the United States: U.S. Geological Survey Fact Sheet FS-062-03, 2 p.
- Energy Information Administration, 2003a, Annual Energy Review 2003: Report #DOE/EIA-0384(2003), 428 p.
- Energy Information Administration, 2004a, International Energy Annual 2002: Available from <<http://www.eia.doe.gov/international/reports.html#IEAPDF>>.
- Energy Information Administration, 2004b, Annual Energy Outlook 2004 – With Projections to 2025: Report #DOE/EIA-0383(2004), 278 p.
- Energy Information Administration, 2005, Annual Energy Outlook 2005 – With Projections to 2025: Report #DOE/EIA-0383(2005), 248 p.
- Finch, W.I., 2003, Uranium – Fuel for Nuclear Energy 2002: U.S. Geological Survey Bulletin 2179-A, 18 p.
- International Energy Agency, 2001, World Energy Outlook: Assessing Today's Supplies to Fuel Tomorrow's Growth: OECD/IEA, Paris, France, 421 p.
- Klett, T.R., 2003, Graphic comparison of reserve-growth models for conventional oil and accumulation: U.S. Geological Survey Bulletin B2172-F, p. F1-F63.
- Klett, T.R., and Schmoker, J.W., 2003, Reserve growth of the world's giant oil fields: American Association of Petroleum Geologists Memoir 78, p.107-122.
- Meyer, R.F. and Attanasi, E.D., 2003, Heavy oil and natural bitumen – Strategic petroleum resources: U.S. Geological Survey Fact Sheet FS-070-03, 2 p.
- National Research Council, 1999, Meeting energy resource needs: The Energy Resources Program of the U.S. Geological Survey. National Academy Press, Washington, D.C., 68 p.
- Schweinfurth, S.P., 2003, Coal – A complex natural resource: U.S. Geological Survey Circular 1143, 39 p.
- U.S. Department of the Interior, 2003, U.S. Department of the Interior Strategic Plan Fiscal Year 2003-2008, 92 p.
- U.S. Department of the Interior, 2005, The Department of the Interior Activity Based Cost/Management (ABC/M) Initiative Information Paper: Available from <<http://www.doiu.nbc.gov/abc/html/white.html>>.
- U.S. Geological Survey, 1998, Geology for a changing world: A science strategy for the Geologic Division of the U.S. Geological Survey, 2000-2010: U.S. Geological Survey Circular 1172, 59 p.
- U.S. Geological Survey, 1999, U.S. Geological Survey Strategic Plan FY2000-2005, 25 p.
- Verma, M.K., Ahlbrandt, T.S., and Al-Gailini, M., 2004, Petroleum reserves and undiscovered resources in the total petroleum systems of Iraq; reserve growth and production implications: GeoArabia v.9, no.3, p.51-74.

Appendix A. Figures

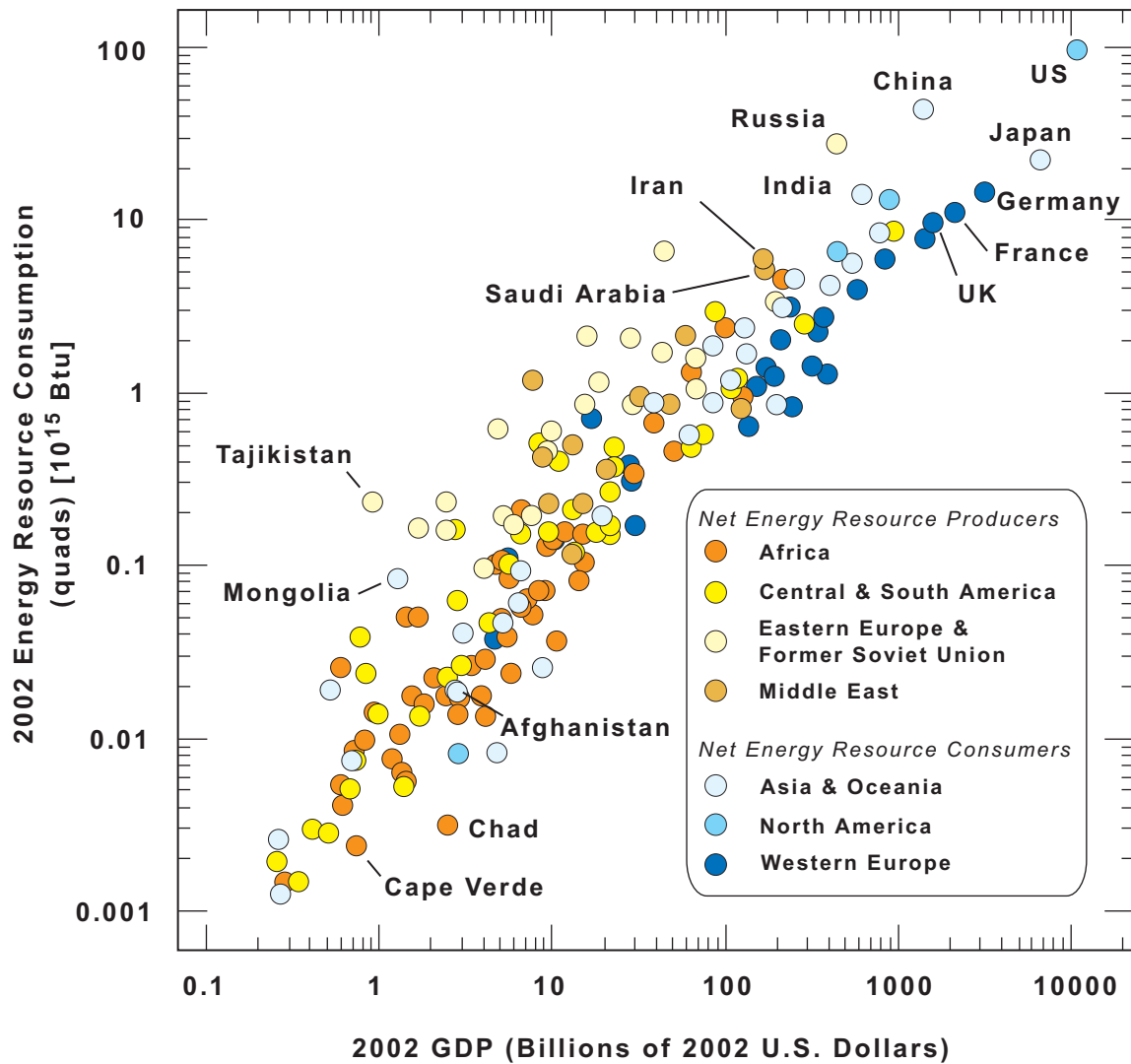
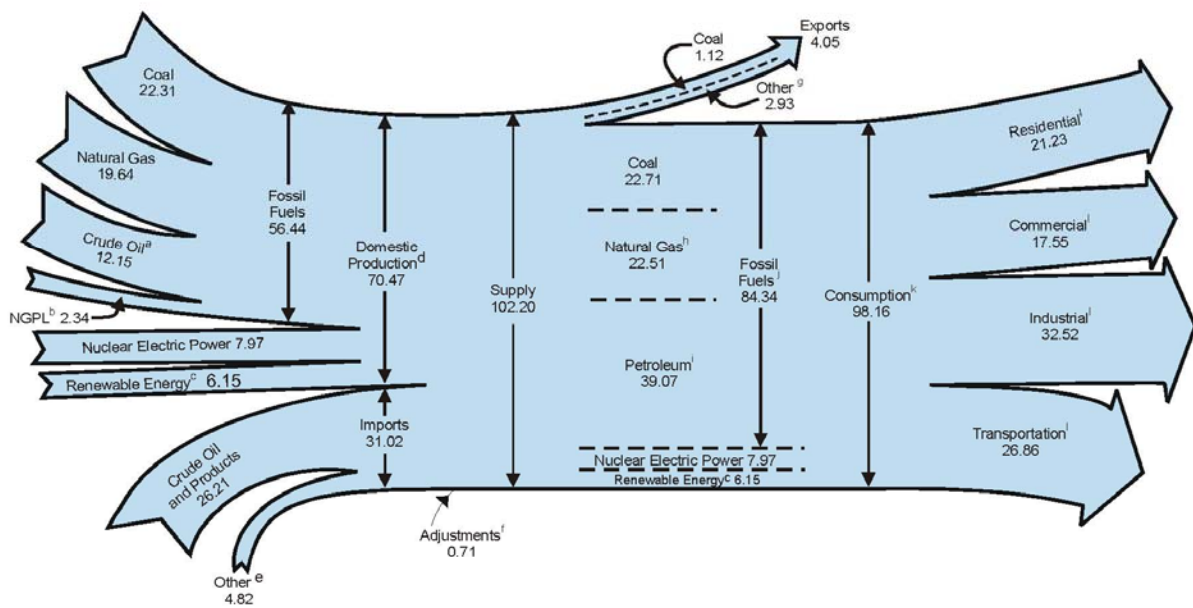


Figure 1. Relationship between energy resources consumption and GDP by country -and region- for the year 2002. Select countries are labeled for comparison. Graph compiled using Energy Information Administration data (2004a).



^a Includes lease condensate.
^b Natural gas plant liquids.
^c Conventional hydroelectric power, wood, waste, ethanol blended into motor gasoline, geothermal, solar, and wind.
^d Includes -0.09 quadrillion Btu hydroelectric pumped storage.
^e Natural gas, coal, coal coke, and electricity.
^f Stock changes, losses, gains, miscellaneous blending components, and unaccounted-for supply.
^g Crude oil, petroleum products, natural gas, electricity, and coal coke.
^h Includes supplemental gaseous fuels.
ⁱ Petroleum products, including natural gas plant liquids.
^j Includes 0.05 quadrillion Btu of coal coke net imports.
^k Includes, in quadrillion Btu, -0.09 hydroelectric pumped storage; -0.24 ethanol blended into motor gasoline, which is accounted for in both fossil fuels and renewable energy but counted only once in total consumption; and 0.02 electricity net imports.
^l Primary consumption, electricity retail sales, and electrical system energy losses, which are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See note at end of Section 2.
 Notes: • Data are preliminary. • Totals may not equal sum of components due to independent rounding.
 Sources: Tables 1.1, 1.2, 1.3, 1.4, and 2.1a.

Figure 2. U.S. energy flow for the year 2003, in units of quadrillion Btu. Image from the Energy Information Administration (2003a.)

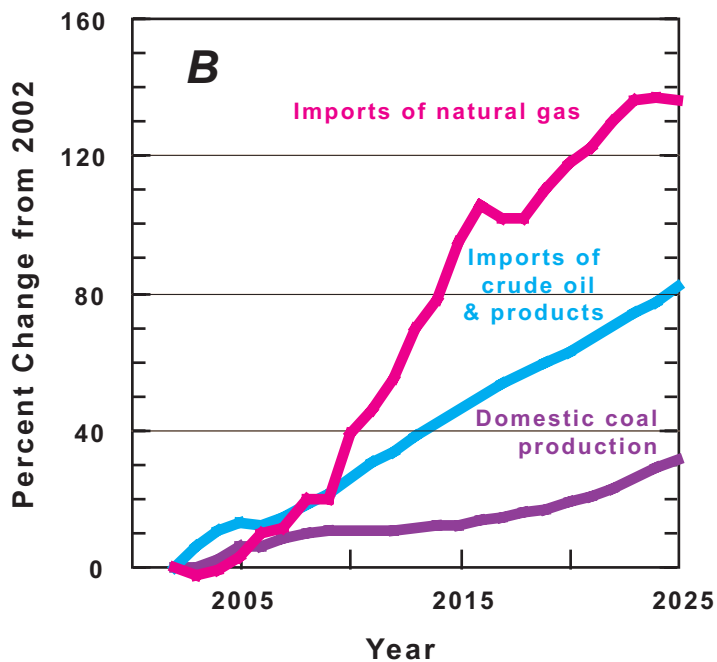
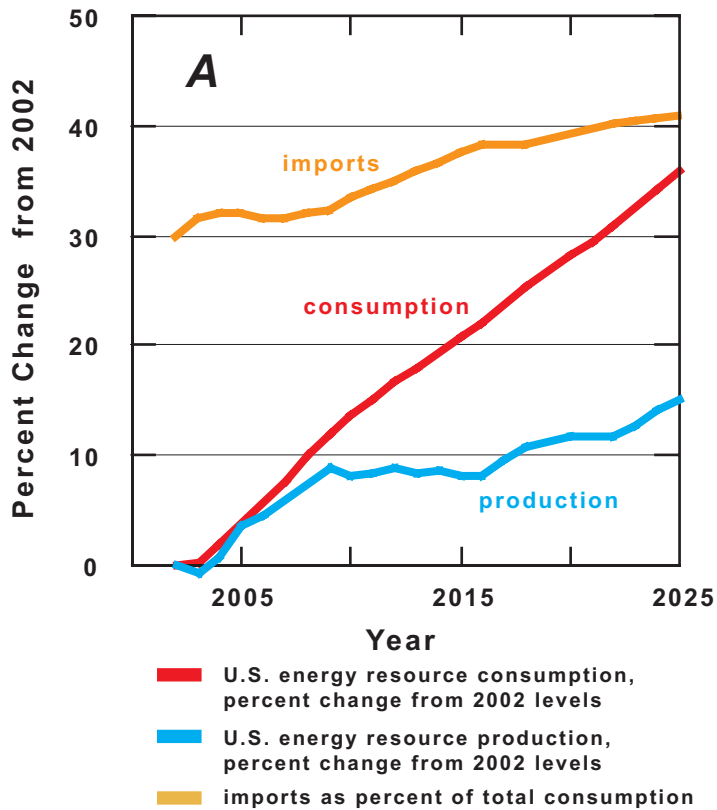


Figure 3. A Forecast percent changes to U.S. total energy resource consumption and production (relative to 2002 levels, using reference case economic growth scenario), and projected change in U.S. energy resource imports as a proportion of total consumption; **B** Forecast percent changes to U.S. energy resource consumption by commodity (relative to 2002 levels, using reference case economic growth scenario). Note difference in y-axis scales. Graphs compiled using Energy Information Administration data (2005).

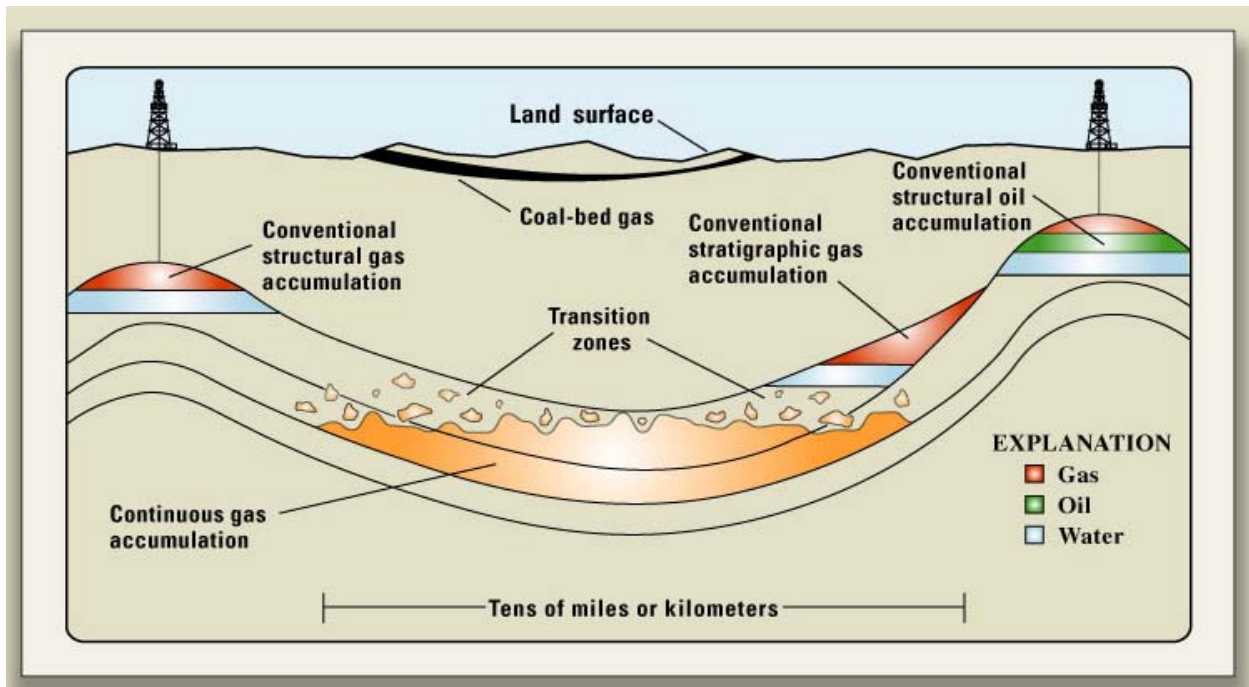
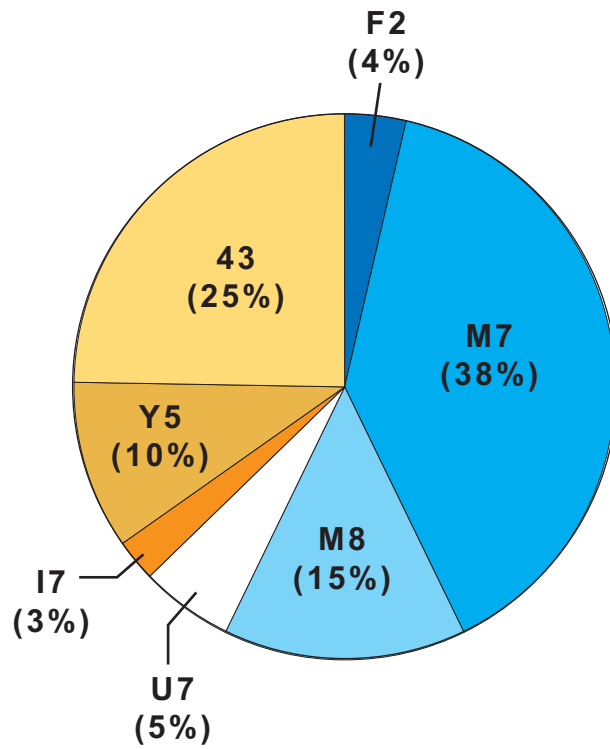


Figure 4. Depiction of continuous versus conventional gas accumulations.



FY 2005 Total Actual-Energy: \$24,664,062.

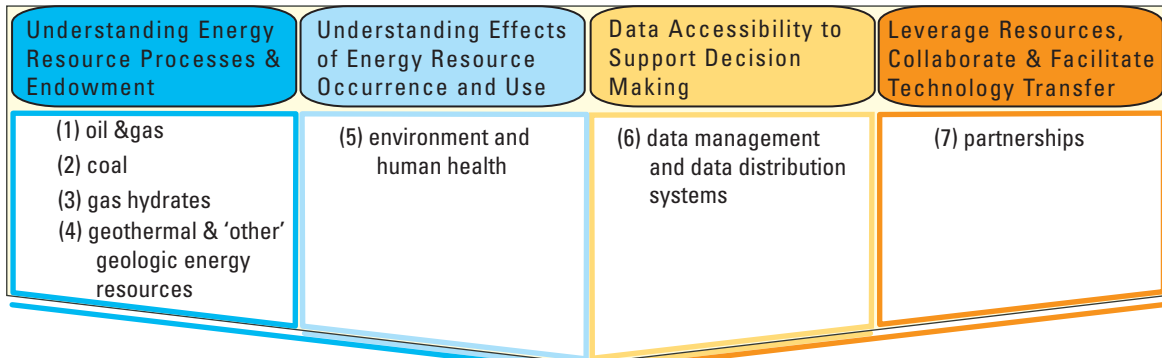
KEY - ABC Code/Work Activity:

- F2** Collect Data-Energy
- M7** Conduct Assessments - Energy
- M8** Conduct Research - Energy
- U7** Manage and Distribute Data - Energy
- I7** Plan/Evaluate Programs
- Y5** Provide Technical Assistance - Energy
- 43** Manage Energy Programs (Indirect)

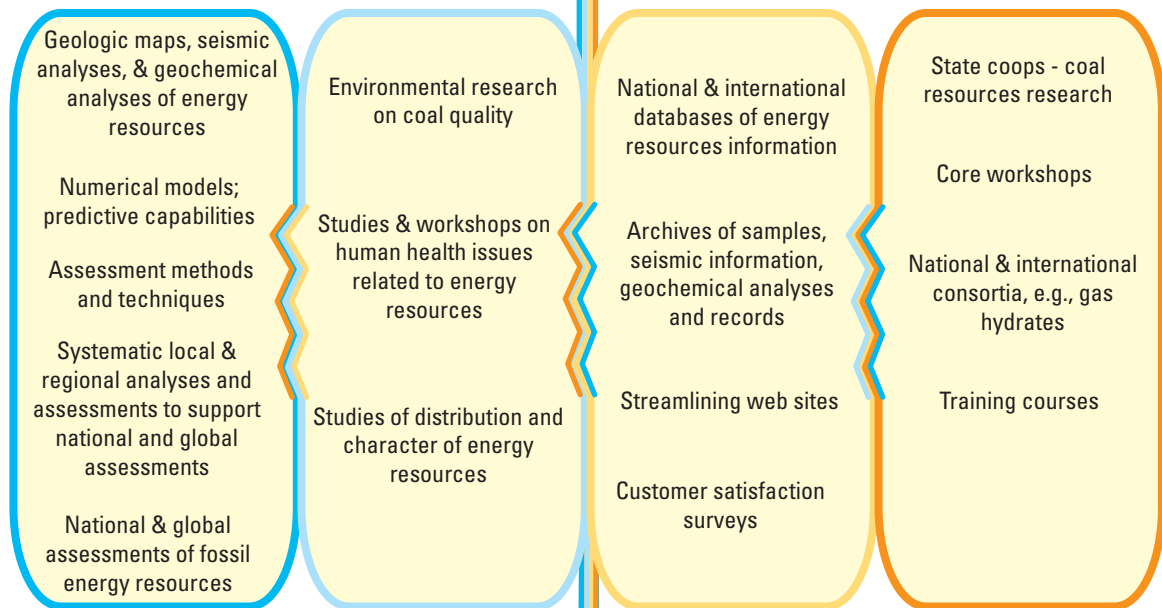
Figure 5. Distribution of FY 2005 Actual funding (Direct+Reimbursable) among ABC-coded work activities within the Energy Resources Program. Graph compiled using Federal Financial System data.

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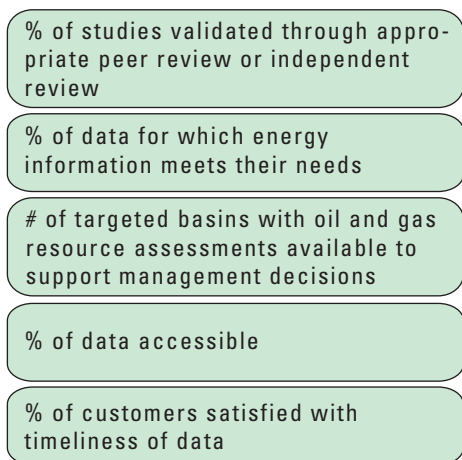
GOALS:



EXAMPLES of PRODUCTS / EVENTS:



INTERMEDIATE OUTCOMES:



OUTPUTS:

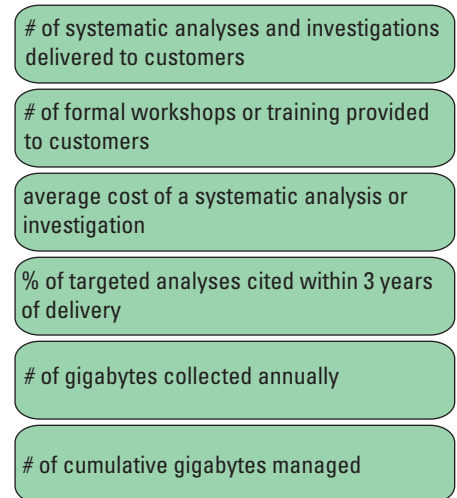


Figure 6. Flowchart depicting linkages among ERP research goals, example products and events, and performance measures – that is, intermediate outcomes and outputs.

Appendix B. Recent Authorizations from the Energy Policy Act of 2005

Section	Title	Excerpted Language
226	ASSESSMENT OF GEOTHERMAL ENERGY POTENTIAL	Not later than 3 years after the date of enactment of this Act and thereafter as the availability of data and developments in technology warrants, the Secretary of the Interior, acting through the Director of the United States Geological Survey and in cooperation with the States, shall— (1) update the Assessment of Geothermal Resources made during 1978; and (2) submit to Congress the updated assessment.
351	PRESERVATION OF GEOLOGICAL AND GEOPHYSICAL DATA	(a) SHORT TITLE.—This section may be cited as the “National Geological and Geophysical Data Preservation Program Act of 2005”. (b) PROGRAM.—The Secretary shall carry out a National Geological and Geophysical Data Preservation Program in accordance with this section— (1) to archive geologic, geophysical, and engineering data, maps, well logs, and samples; (2) to provide a national catalog of such archival material; and (3) to provide technical and financial assistance related to the archival material (j) DEFINITIONS.—In this section: (1) ADVISORY COMMITTEE.—The term “Advisory Committee” means the advisory committee established under section 5 of the National Geologic Mapping Act of 1992 (43 U.S.C. 31d). (2) PROGRAM.—The term “Program” means the National Geological and Geophysical Data Preservation Program carried out under this section. (3) SECRETARY.—The term “Secretary” means the Secretary of the Interior, acting through the Director of the United States Geological Survey. (4) SURVEY.—The term “Survey” means the United States Geological Survey. (k) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out this section \$30,000,000 for each of fiscal years 2006 through 2010.
353	GAS HYDRATE PRODUCTION INCENTIVE	(a) PURPOSE.—The purpose of this section is to promote natural gas production from the natural gas hydrate resources on the outer Continental Shelf and Federal lands in Alaska by providing royalty incentives. (e) REVIEW.—Not later than 365 days after the date of enactment of this Act, the Secretary, in consultation with the Secretary of Energy, shall carry out a review of, and submit to Congress a report on, further opportunities to enhance production of natural gas from gas hydrate resources on the outer Continental Shelf and on Federal lands in Alaska through the provision of other production incentives or through technical or financial assistance.

Section	Title	Excerpted Language
357	COMPREHENSIVE INVENTORY OF OCS OIL AND NATURAL GAS RESOURCES	(a) IN GENERAL.—The Secretary shall conduct an inventory and analysis of oil and natural gas resources beneath all of the waters of the United States Outer Continental Shelf (“OCS”). (b) REPORTS.—The Secretary shall submit a report to Congress on the inventory of estimates and the analysis of restrictions or impediments, together with any recommendations, within 6 months of the date of enactment of the section. The report shall be publicly available and updated at least every 5 years.
364	ESTIMATES OF OIL AND GAS RESOURCES UNDERLYING ONSHORE FEDERAL LAND	(b) METHODOLOGY.—The Secretary of the Interior shall use the same assessment methodology across all geological provinces, areas, and regions in preparing and issuing national geological assessments to ensure accurate comparisons of geological resources.
369	OIL SHALE, TAR SANDS, AND OTHER STRATEGIC UNCONVENTIONAL FUELS	(m) NATIONAL OIL SHALE AND TAR SANDS ASSESSMENT.— (1) ASSESSMENT.— (A) IN GENERAL.—The Secretary shall carry out a national assessment of oil shale and tar sands resources for the purposes of evaluating and mapping oil shale and tar sands deposits, in the geographic areas described in subparagraph (B). In conducting such an assessment, the Secretary shall make use of the extensive geological assessment work for oil shale and tar sands already conducted by the United States Geological Survey. (B) GEOGRAPHIC AREAS.—The geographic areas referred to in subparagraph (A), listed in the order in which the Secretary shall assign priority, are— (i) the Green River Region of the States of Colorado, Utah, and Wyoming; (ii) the Devonian oil shales and other hydrocarbon bearing rocks having the nomenclature of “shale” located east of the Mississippi River; and (iii) any remaining area in the central and western United States (including the State of Alaska) that contains oil shale and tar sands, as determined by the Secretary. (2) USE OF STATE SURVEYS AND UNIVERSITIES.—In carrying out the assessment under paragraph (1), the Secretary may request assistance from any State-administered geological survey or university.

Section	Title	Excerpted Language
374	LIVINGSTON PARISH MINERAL RIGHTS TRANSFER	<p>Section 102 of Public Law 102–562 (106 Stat. 4234) is amended by striking subsection (b) and inserting the following:</p> <p>“(b) RESERVATION OF OIL AND GAS RIGHTS AND CONVEYANCE OF REMAINING MINERAL RIGHTS.—Subject to the limitations set forth in subsection (c), the United States hereby excepts and reserves from the provisions of subsection (a), all rights to oil and gas underlying such lands, along with the right to explore for, and produce the oil and gas under applicable law and such regulations as the Secretary of the Interior may prescribe. Not later than 180 days after the date of enactment of the Energy Policy Act of 2005, the Secretary of the Interior shall convey the remaining mineral rights to the parties who as of the date of enactment of the Energy Policy Act of 2005 would be recognized as holders of a right, title, or interest to any portion of such minerals under the laws of the State of Louisiana, but for the interest of the United States in such minerals.</p> <p>“(c) OIL AND GAS RESOURCE ASSESSMENT AND REPORT.—The United States Geological Survey shall conduct a resource assessment and publish a report of the findings of such resource assessment (‘USGS Assessment and Report’) within 1 year of the date of enactment of the Energy Policy Act of 2005. The USGS Assessment and Report shall provide an assessment of all oil and gas resources underlying the certain lands in Livingston Parish, Louisiana, as described in section 103 (the ‘Livingston Parish lands’). Upon a finding by the Secretary of the Interior based upon the USGS Assessment and Report that it is unlikely that economically recoverable oil and gas resources are present, the Secretary shall convey all rights to oil and gas underlying such lands to the recipients, or their successors, heirs, or assigns, of the conveyances under subsection (b). Such further conveyances shall be made within 180 days after a finding by the Secretary that it is unlikely that economically recoverable oil and gas resources are present.”.</p>
437	INVENTORY REQUIREMENT	<p>(a) REVIEW OF ASSESSMENTS.—</p> <p>(1) IN GENERAL.—The Secretary of the Interior, in consultation with the Secretary of Agriculture and the Secretary, shall review coal assessments and other available data to identify—</p> <p>(A) Federal lands with coal resources that are available for development;</p> <p>(B) the extent and nature of any restrictions on the development of coal resources on Federal lands identified under paragraph (1); and</p> <p>(C) with respect to areas of such lands for which sufficient data exists, resources of compliant coal and supercompliant coal.</p> <p>(2) DEFINITIONS.—For purposes of this subsection—</p> <p>(A) the term “compliant coal” means coal that contains not less than 1.0 and not more than 1.2 pounds of sulfur dioxide per million Btu; and</p> <p>(B) the term “supercompliant coal” means coal that contains less than 1.0 pounds of sulfur dioxide per million Btu.</p> <p>(b) COMPLETION AND UPDATING OF THE INVENTORY.—The Secretary—</p> <p>(1) shall complete the inventory under subsection (a) by not later than 2 years after the date of enactment of this Act; and</p> <p>(2) shall update the inventory as the availability of data and developments in technology warrant.</p> <p>(c) REPORT.—The Secretary shall submit to the Committee on Resources of the House of Representatives and to the Committee on Energy and Natural Resources of the Senate and make publicly available—</p> <p>(1) a report containing the inventory under this section, by not later than 2 years after the effective date of this section; and</p> <p>(2) each update of such inventory.</p>

Section	Title	Excerpted Language
965	<i>OIL AND GAS RESEARCH PROGRAMS</i>	(c) NATURAL GAS AND OIL DEPOSITS REPORT.—Not later than 2 years after the date of enactment of this Act and every 2 years thereafter, the Secretary of the Interior, in consultation with other appropriate Federal agencies, shall submit to Congress a report on the latest estimates of natural gas and oil reserves, reserves growth, and undiscovered resources in Federal and State waters off the coast of Louisiana, Texas, Alabama, and Mississippi.
968	<i>METHANE HYDRATE RESEARCH AND DEVELOPMENT PROGRAM</i>	“(1) COMMENCEMENT OF PROGRAM.—Not later than 90 days after the date of enactment of the Energy Research, Development, Demonstration, and Commercial Application Act of 2005, the Secretary, in consultation with the Secretary of Commerce, the Secretary of Defense, the Secretary of the Interior, and the Director, shall commence a program of methane hydrate research and development in accordance with this section.
999A&B	<i>TITLE IX—RESEARCH AND DEVELOPMENT Subtitle J—Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources</i>	<p><i>SEC. 999A. PROGRAM AUTHORITY.</i></p> <p>(a) IN GENERAL.—The Secretary shall carry out a program under this subtitle of research, development, demonstration, and commercial application of technologies for ultra-deepwater and unconventional natural gas and other petroleum resource exploration and production, including addressing the technology challenges for small producers, safe operations, and environmental mitigation (including reduction of greenhouse gas emissions and sequestration of carbon).</p> <p>(e) CONSULTATION WITH SECRETARY OF THE INTERIOR.—In carrying out this subtitle, the Secretary shall consult regularly with the Secretary of the Interior.</p> <p><i>SEC. 999B. ULTRA-DEEPWATER AND UNCONVENTIONAL ONSHORE NATURAL GAS AND OTHER PETROLEUM RESEARCH AND DEVELOPMENT PROGRAM.</i></p> <p>(7) FOCUS AREAS</p> <p>(B) UNCONVENTIONAL RESOURCES.—including advanced coalbed methane, deep drilling, natural gas production from tight sands, natural gas production from gas shales, stranded gas, innovative exploration and production techniques, enhanced recovery techniques, and environmental mitigation of unconventional natural gas and other petroleum resources exploration and production.</p>
1811	<i>COAL BED METHANE STUDY</i>	<p>(a) STUDY.—</p> <p>(1) IN GENERAL.—The Secretary of the Interior, in consultation with the Administrator of the Environmental Protection Agency, shall enter into an arrangement under which the National Academy of Sciences shall conduct a study on the effect of coal bed natural gas production on surface and ground water resources, including ground water aquifers, in the States of Montana, Wyoming, Colorado, New Mexico, North Dakota, and Utah.</p> <p>(2) MATTERS TO BE ADDRESSED.—The study shall address the effectiveness of—</p> <p>(A) the management of coal bed methane produced water;</p> <p>(B) the use of best management practices; and</p> <p>(C) various production techniques for coal bed methane natural gas in minimizing impacts on water resources.</p>

Appendix C. Specific Customers, Partners, and Cooperators

USGS Programs, Disciplines, Regions, and Science Centers

Mineral Resources Program
Coastal and Marine Geology Program
Earthquake Hazards Program
Contaminant Biology Program
Status and Trends Program
Water Quality Program
National Research Program (Water)
Geographic Discipline
Geospatial Information Office
Eastern, Central, and Western Regions
Alaska Science Center
Florida Integrated Science Center
Communications Office
Budget Office

Other Federal Government Agencies

Department of Interior
Bureau of Indian Affairs
Bureau of Land Management
Fish and Wildlife Service
Minerals Management Service
Office of Surface Mining
National Park Service
Central Intelligence Agency
Department of Defense
Department of Energy
 Argonne National Laboratory
 Brookhaven National Laboratory
 Energy Information Administration
 Idaho National Engineering and Environmental Laboratory
 Lawrence Berkeley National Laboratory
 Lawrence Livermore National Laboratory
 Los Alamos National Laboratory
 National Energy Technology Laboratory
 Oak Ridge National Laboratory
 Office of Fossil Energy
 Office of Nuclear Energy Science and Technology
 Rocky Mountain Oilfield Testing Center (RMOTC)
Department of Health and Human Services
 Center for Disease Control and Prevention - Agency for Toxic Substances and Disease Control
 National Institutes of Health
Department of State
Environmental Protection Agency

National Risk Management Research Lab/Robert S. Kerr
Environmental Research Center
Internal Revenue Service
Securities and Exchange Commission
U.S. Agency for International Development
U.S. Army
Armed Forces Institute of Pathology
Corps of Engineers
U.S. Forest Service
U.S. Trade and Development Agency

Other Governmental Organizations

The Administration
Carnegie Institution of Washington – Geophysical Laboratory
Congress – committees, subcommittees, staffers
Congressional Research Service
Smithsonian Institution
National Academy of Sciences
Board on Earth Sciences and Resources
Board on Energy and Environmental Systems
National Aeronautics and Space Administration
Johnson Space Flight Center
National Imaging and Mapping Agency
National Oceanic and Atmospheric Administration
National Research Council
National Science Foundation
Nuclear Regulatory Commission

State

(including geological survey, health department, water management, environmental protection, and/or parks and wildlife agencies)

Alabama
Alaska
Arkansas
California
Colorado
Connecticut
Delaware
Dist. of Columbia
Florida
Georgia
Illinois
Indiana
Kansas
Kentucky
Louisiana
Maine
Maryland

Massachusetts
Michigan
Mississippi
Montana
New Hampshire
New Jersey
New York
North Carolina
Ohio
Pennsylvania
Rhode Island
South Carolina
Tennessee
Texas

City of Houston Brownfields Redevelopment Program

Vermont

Virginia

West Virginia

Wisconsin

Wyoming

Wyoming State Office Reservoir Management Group (WSO-RMG)

Industry Groups and Consortia

Advanced Resources International

AGIP Oil Company

Anadarko Petroleum

Arco Alaska, Inc.

Baker Tools

British Petroleum Exploration Alaska (BPXA)

British Petroleum, Ltd.

Caithness Corporation

Calpine Geothermal Corporation

CDX Gas

Chevron Overseas Petroleum, Ltd.

Chevron

ConocoPhillips Alaska

Del Rio Resources

Devon Energy Corporation

Encana Oil and Gas, Inc.

Enervest Management Partners

ExxonMobil

Geomechanics International

Hach Company

Harvest Gas Management

Humble Geochemical Services

Integrated Ocean Drilling Program

Japan Petroleum Exploration Company

Joint Industry Project (JIP)

Kennecott Exploration Company

Landmark Seismic Interpretation Company

Mallik Drilling Consortium
Maurer Technology
PetroCanada
Saudi Aramco
Schlumberger HydroGeologica Services
Sciences International, Inc.
Talisman Energy
Teckocominco
WesternGECO Geophysical Company

Professional Societies/Other Consortia

American Association of Petroleum Geologists
 Committee on Resource Evaluation
American Geophysical Union
American Petroleum Institute
American Society for Testing and Materials
Eastern Mine Drainage Federal Consortium (15 Federal Agencies)
International Ocean Drilling Program
Gas Technology Institute
Geological Society of America
Ground Water Protection Council
Monterey Bay Aquarium Research Institute
National Geodetic Survey
National Petroleum Council
Organization of Petroleum Exporting Countries
Petroleum Technology Transfer Council (PTTC) -- Michigan Basin Center
Petroleum Technology Transfer Council (PTTC) -- Appalachian Region
Railroad Commission of Texas
Rocky Mountain Association of Geologists
Woods Hole Oceanographic Institution

Environmental Community

New Mexico Wilderness Alliance
Oklahoma Clean Lakes and Watersheds Association
The Wilderness Society

Other Groups

Native Alaskans, including Doyon Corporation, ASRC, North Slope Borough
National Petroleum Council (a FACA to DOE)
National Coal Council
Navajo Nation
Northern Cheyenne Tribe
Osage Nation
Zuni Tribe (New Mexico)

Foreign or International Groups

Autonomous Prefecture Anti-Epidemic Station of Southwest Guizhou Province, China
Bulgarian Ministry of Health
Carbon Sequestration Leadership Forum
Chinese Academy of Sciences
 Institute of Geographical Sciences and Natural Resources Research
 Institute of Geography and Agricultural Ecology
 State Key Laboratory of Environmental Geochemistry
Commonwealth Scientific & Industrial Research Organisation, Australia
 Division of Petroleum Resources
Directorate General of Hydrocarbons, Government of India
Fault Dynamics Group at Royal Holloway
French Petroleum Institute
GeoForschungsZentrum Potsdam (GFZ)
Geological Survey of Canada
Geological Survey of Norway
Geological Survey of Sweden
Geoscience Australia
German Geological Survey (BGR)
International Energy Agency
Japan Oil, Gas, and Metals National Corporation
Ministry of Petroleum and Natural Gas, Government of India
North Atlantic Treaty Organization (NATO)
Norwegian Petroleum Directorate
Netherlands Institute for Sea Research
Romanian Ministry of Health
Saskatchewan Geological Survey
Serbian Ministry of Health
South Africa - Sasol
Ukraine Institute of Occupational Health
Ukrainian Ministry of Health
United Nations
World Health Organization (WHO)
World Petroleum Congress

Media

Numerous print, radio, and television contacts

Colleges and Universities – Domestic

Carnegie Mellon University
Colorado School of Mines
George Mason University
Georgia Institute of Technology
Harvard University
Indiana University
Louisiana State University
Massachusetts Institute of Technology
Michigan Technological University

New Mexico Technological University
Oklahoma State University
Pennsylvania State University
Stanford University
Texas A&M University
The George Washington University
The Johns Hopkins University
University of Alabama
University of Alaska - Fairbanks
University of Arizona
University of Arizona, Tucson
University of California, Berkeley
University of Kentucky
University of Louisiana
University of Louisiana – Lafayette
University of Michigan
University of Mississippi
University of Nevada, Reno
University of Oklahoma
University of Rochester
University of Tennessee
University of Texas at El Paso
University of Toledo
University of Tulsa
 Integrated Petroleum Environmental Consortium
University of Utah
 Energy and Geoscience Institute
Virginia Tech University
West Virginia University
Western Kentucky University

Colleges and Universities – Foreign

Curtin University of Technology,
 Centre for Petroleum and Environmental Organic Geochemistry (Australia)
Donetsk National Technical University
Polish University of Mining and Metallurgy
The Hebrew University of Jerusalem
University of British Columbia, Canada
University of Calgary
University of Canterbury, New Zealand
University of Central Venezuela
University of Cologne, Germany
University of Naples
University of New South Wales, Australia
University of Victoria, Australia
University of Zambia

Appendix D. Energy Resources Program 5-Year Plan Writing Team

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