STATEMENT OF CLARENCE H. "BUD" ALBRIGHT, JR.

UNDER SECRETARY

U.S. DEPARTMENT OF ENERGY

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

MARCH 5, 2008

Chairman Lampson and Ranking Member Inglis, and Chairman Gordon and Ranking Member Hall, and members of the Committee, I am pleased to be before you today presenting the President's fiscal year (FY) 2009 budget proposal for the Department of Energy's applied science research and development programs. The strength and prosperity of America's economy is built on the security of our nation and the reliability of energy sources. Since 2001, the Administration has committed $183 billion through the Department of Energy (DOE) to help drive America's economic growth, provide for our national security, and address the energy challenges that face our nation. The FY 2009 budget was developed to continue to meet these goals and does so in part through funding applied science and energy research and development.

With a request of $3.2 billion, a 24 percent annual increase of $623 million above the FY 2008 enacted $2.5 billion appropriation, the President's Advanced Energy Initiative (AEI) will continue to support clean energy technology breakthroughs that will help improve our energy security through diversification and help to reduce our dependence on foreign oil. The FY 2009 budget for AEI includes funding to promote the licensing of new nuclear power plants as well as research on an advanced nuclear fuel cycle. Also, the AEI's diverse energy portfolio includes investment in making solar power cost-competitive with conventional sources of electricity by 2015 and supports a robust vehicle technology program that includes developing lithium-ion batteries, plug-in hybrids, and drive-train electrification.

The Department is also requesting funds to improve our conventional sources of energy. We are partnering with industry to commercialize coal gasification and carbon sequestration processes and systems, and we are working to modernize the electricity delivery system, enhance the security and reliability of America's energy infrastructure, and to facilitate recovery from disruptions to energy supply.

It is important to remember that scientific breakthroughs and innovative solutions to our energy challenges cannot simply be mandated, produced and bought. They must be cultivated from a rich array of interdisciplinary knowledge. The scientists and engineers at the Department's applied science and energy laboratories and programs have this knowledge, and their work to discover tomorrow's efficient and clean and secure technologies, and the science that produce them, must be understood unique capability that is unparalleled. Funding these laboratories and the programs they work with at the President's request is vitally important if we are to overcome America's energy challenges.

The 2009 AEI Budget includes:

- $588 million for the Coal Research Initiative, R&D focused on coal gasification and carbon sequestration processes and systems, including $156 million for the restructured FutureGen program to demonstrate these technologies;
- $543 million for the GNEP and Nuclear Power 2010 initiatives to demonstrate advanced fuel cycle technologies, to expand the domestic use of nuclear power, and to provide for safe, environmentally responsible global nuclear energy systems that support nonproliferation objectives;
- $225 million for biomass science and technology R&D to help enable cellulosic ethanol to become practical and competitive;

• $156 million for solar science and technology R&D to accelerate development of cost-effective photovoltaic materials;
• $146 million for R&D on hydrogen fuel cells and affordable hydrogen-powered cars;
• $103 million for R&D of hybrid electric systems including $49 million for high-energy, high-power batteries for hybrid-electric and "plug-in" hybrid vehicles;
• $53 million for wind energy research to help improve the efficiency and lower the costs of wind technologies for use in low-speed wind environments;
• $30 million for geothermal research.

## APPLIED SCIENCE ENERGY PROGRAMS

### A. OFFICE OF NUCLEAR ENERGY (NE)

The Office of Nuclear Energy leads the government's efforts to develop, in cooperation with industry, new nuclear energy generation technologies to meet energy and climate goals; develop advanced, nuclear fuel cycle technologies that maximize energy from nuclear fuel and strengthen the nuclear nonproliferation regime; and maintain and enhance the national nuclear infrastructure. A key mission of DOE's nuclear energy research and development program is to lead in the planning, conducting, and deploying the next generation of nuclear technologies.

The President's commitment to nuclear power stems from its role as one of the most feasible near-term options for producing significant amounts of carbon-free, baseload electricity. The expansion of nuclear power will play a key role in our decisions to find viable solutions to address the challenges posed by greenhouse gas emissions, climate change, and energy security.

It is significant to note that this Administration has increased its funding request for nuclear energy in every year, and in total, the FY 2009 request represents a 330 percent increase in funding for nuclear energy since President Bush took office seven years ago. In FY 2009, a total of $1.4 billion is requested for nuclear energy activities, an increase of $385 million over the FY 2008 appropriation, including $487 million for the Mixed Oxide Fuel Fabrication Facility.

Today, 104 nuclear reactors produce nearly 20 percent of our total electricity—this 20 percent share represents over 70 percent of all non-carbon emitting electricity production. In the United States, seventeen utility companies are projected to build thirty-one new reactors, when completed, these new nuclear power plants will provide over 41 GWe of electricity, enough to power 30 million homes.

Worldwide, 31 countries operate 439 reactors totaling 372 GWe of electricity capacity. Thirty-four new nuclear power plants are under construction worldwide, and when completed will add an estimated 28 GWe of new electricity. This new construction is taking place or being considered in every major region in the world including Africa, Asia and the Indian subcontinent, Europe, the Middle East, South America, and North America.Nuclear power's ongoing expansion around the world that requires us to address the used fuel and proliferation challenges that confront the global use of nuclear energy. To ensure that the United States plays a significant role in global nuclear energy policy we must foster domestic actions that support a

significant role for nuclear power in our energy future, a robust nuclear research and development program, and a cutting-edge nuclear technology infrastructure and international actions that support reliable nuclear fuel services to countries that forego the development and deployment of enrichment and reprocessing technologies. To meet these challenges, the President initiated the Global Nuclear Energy Partnership (GNEP). The domestic component of GNEP promotes the accelerated development and deployment of advanced fuel cycle technologies, while the international component encourages cooperation among nations that share the common vision of the necessity of the expansion of nuclear energy for peaceful purposes worldwide in a safe and secure manner.

We have made progress in every one of our program areas, but much remains to be done. Our FY 2009 budget request moves us in the right direction, allowing the Department and the Office of Nuclear Energy to take the lead in spurring the nuclear renaissance in the United States. I would now like to take the time to highlight our program areas and their corresponding budget requests.

Nuclear Power 2010

A key component of our work and one of our most successful programs at the Department of Energy is the Nuclear Power 2010 program or NP 2010. This program was initiated by President Bush in 2002 and has produced significant results toward its goal of reducing the technical, regulatory, and institutional barriers to the deployment of new nuclear power plants. DOE and the President have increased our commitment to cross the finish line by nearly doubling its 2009 budget, calling on Congress to provide $241.6 million for NP 2010 to help ensure this important program can complete its work.

NP 2010 supports industry through cost-sharing near-term technology development and regulatory demonstration activities focused on enabling an industry decision to build a new nuclear plant by 2010.

Of the six Construction and Operation License (COL) applications that have been submitted to the Nuclear Regulatory Commission (NRC), five COL applications have been officially accepted for review by the NRC. And of these five, two applications—TVA's application for two Westinghouse AP1000 reactors at the Bellefonte site in Alabama, and Dominion Energy's application for a General Electric-Hitachi Economic Simplified Boiling Water Reactor at the North Anna site in Virginia—were developed through the NP 2010 cost-share program. In total, the NRC expects to receive twenty COL applications for thirty-one new reactors by seventeen different utility companies. Of these 20 COL applications, eight will reference either the Bellefonte or North Anna license applications. This simplification in the licensing process is expected to reduce the license application and review time these reference COLAs by up to 50 percent.

Three early site permits have been approved for Exelon's Clinton site in Illinois, Entergy's Grand Gulf site in Mississippi, and the North Anna site, all a part of the NP 2010 cost share program, and a fourth ESP permit is pending. In addition, two new reactor design certifications have been approved by the NRC, the ABWR and the AP1000, and DOE is

continuing with on-going first-of-a-kind design finalization activities for the standardized AP1000 and ESBWR designs, including: preparation of engineering analyses and calculations, design criteria documents, and total cost and schedule estimates necessary for an industry purchase of a new nuclear plant.

The NP 2010 program will continue to develop generic application preparation guidance for fifteen COL applications expected in 2008 to help resolve regulatory issues that could potentially delay or derail NRC approval.

Advanced Fuel Cycle Initiative and GNEP

President Bush announced the Global Nuclear Energy Partnership (GNEP) as part of his Advanced Energy Initiative in February 2006. The Advanced Fuel Cycle Initiative (AFCI) is the domestic technology development and deployment component of GNEP. The AFCI program aims to develop and demonstrate advanced fuel cycle technologies for recycling used reactor fuel to develop an integrated used fuel recycling plan, and support on-going research efforts with the goal of reducing the amount of material that needs disposal in a geologic repository and maximizing our use of energy resources.

In effort to further this important work, our budget request includes $301.5 million in Fiscal Year 2009 funding for AFCI. This request supports research and development activities that will advance the economic and sustained production of nuclear energy while reducing waste and satisfying requirements for a controlled nuclear materials management system that helps strengthen the nuclear nonproliferation regime. The request also supports on-going international activities to establish a framework for ensuring reliable international fuel services and the availability of grid-appropriate reactors, and the continued utilization of industry for schedule, cost, and technology developments for eventual recycling facility deployment.

Long-term goals of AFCI/GNEP include the partitioning of used fuel and recycling of long-lived radioactive isotopes for destruction through transmutation in liquid metal-cooled fast neutron spectrum reactors for actinide consumption and nuclear resource sustainability

AFCI/GNEP funding also provides support for a large number of universities involved in fuel cycle research and development, which both ensures that the U.S. has the intellectual capital needed to sustain our nuclear fuel cycle for the future and provides the important research needed for today's fuel cycle activities. Recycling used nuclear fuel rather than permanently disposing of it in a repository would result not only in utilizing more of the energy, but would also reduce the amount of high-level waste that needs disposal in a repository, thereby greatly enhancing the potential capacity of any geological repository. This increased efficiency in the fuel supply could ensure that even with the expansion of nuclear energy, the potential capacity of any geological repository would be greatly enhanced.

Generation IV

The Generation IV program is focused on very high temperature reactor technologies for use in a Next Generation Nuclear Power Plant (NGNP) to produce electricity, process heat, and hydrogen. Generation IV also is readying technologies that will further improve the economics and safety performance of existing Light-Water Reactor and advanced Generation IV reactor concepts.

The FY 2009 budget request includes $70 million for the Generation IV program. The Energy Policy Act of 2005 (EPACT) authorized the Department to create a two-phased NGNP Project at the Idaho National Laboratory (INL). The Department is presently engaged in Phase I of the EPACT-defined scope of work, which includes: developing a licensing strategy, selecting and validating the appropriate hydrogen production technology, conducting enabling research and development for the reactor system, determining whether it is appropriate to combine electricity generation and hydrogen production in a single prototype nuclear reactor and plant, and establishing key design parameters. Phase I will continue until 2011, at which time the Department will evaluate the need for continuing into the design and construction activities called for in Phase II.

Additionally, this request supports component and material aging and degradation research and development that will provide the basis for extending the operating license period for existing nuclear reactors beyond 60 years, and will also enable the design of advanced reactor concept plants with longer operating life spans.

Hydrogen Initiative

Nuclear energy has the potential to produce large quantities of hydrogen efficiently without producing greenhouse gases and could play a significant role in hydrogen production for transportation and industrial sectors. Considerable progress in hydrogen combustion engines and fuel cells is bringing hydrogen-powered transportation close to reality. The goal of the Nuclear Hydrogen Initiative (NHI) is to demonstrate hydrogen production technology at increasingly larger scales through the use of nuclear energy that would be technically and economically suited for commercial deployment in concert with a nuclear power plant.

$16.6 million dollars has been requested for the NHI to continue hydrogen production systems operation and testing, evaluation of process improvements, and assessment of long-term process stability, operability, and component durability. Furthermore, results from the integrated laboratory-scale experiments will be analyzed to identify cost drivers with an end goal of supporting a hydrogen technology selection by 2011.

Nuclear Facilities

The Department of Energy supports nuclear science and technology through one of the world's most comprehensive research infrastructures. The Office of Nuclear Energy has requested $222 million dollars to maintain and operate infrastructure at Idaho National Laboratory (INL), Los Alamos National Laboratory (LANL), Brookhaven National Laboratory

(BNL), and Oak Ridge National Laboratory (ORNL). $104.7 million is dedicated to Idaho National Laboratory's facilities management. INL conducts science and technology research across a wide range of disciplines, INL's core missions include: development of advanced, next generation fuel cycle and reactor technologies; promotion of nuclear technology education, and applying technical skills to enhance our Nation's security.

Additionally, $38.7 million is requested to maintain a wide range of nuclear and radiological facilities and their associated infrastructures in an operational, safe, secure, and environmentally compliant manner at LANL, BNL, and ORNL. This infrastructure supports national priorities, including the provision of radioisotope power systems for national security uses and space exploration.

Other Defense Activities

Included in the Office of Nuclear Energy Fiscal Year 2009 request, under Other Defensive activities, is $487 million for activities associated with the continued construction of the Mixed Oxide Fuel Fabrication Facility and $78.8 million for site-wide safeguards and security activities at the Idaho National Laboratory to protect the assets and infrastructure from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause unacceptable adverse impacts on national security, program continuity, or the health and safety of employees, the public, or the environment.

University Funding

Our FY 2009 budget request continues our commitment to fostering the expansion of nuclear engineering programs at our universities and research institutions. Specifically, the budget request for the Office of Nuclear Energy explicitly states that we "will continue to support R&D activities at universities and research institutions through competitive awards focused on advancing nuclear energy technologies," and we have committed to "designate 20 percent of funds appropriated to its R&D programs for work to be performed at university and research institutions." These funds will support basic research and mission-specific applied R&D activities, as well as human capitol development activities, such as fellowships and infrastructure and equipment upgrades for university-based research reactors and laboratories. At the level set forth in the President's Budget Request for FY 2009, 20 percent provides almost $77 million for this work. This commitment of 20 percent of appropriated funds will serve as a catalyst for success in achieving the objectives of the President's American Competitiveness Initiative and the America COMPETES Act.

It is critical to note that the growth of nuclear power is only possible if we continue to develop a responsible path for disposing of spent nuclear fuel. Therefore, $494.7 million is requested in FY 2009 for the continued development of the geologic waste repository at Yucca Mountain, Nevada, and to support the defense of the License Application that we will submit in 2008 to the Nuclear Regulatory Commission for authorization to construct the repository.

## B. OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (EE)

The Office of Energy Efficiency and Renewable Energy (EERE) conducts research, development, and deployment activities in partnership with industry to advance a diverse supply of energy efficiency and clean power technologies and practices. The FY 2009 budget request continues to support research on alternatives that can help decrease our nation's dependence on foreign oil and accelerate development of clean electricity supply options.

EERE's FY 2009 request of $1.255 billion, approximately $19 million higher than the FY 2008 request, provides a balanced and diverse portfolio of solutions to address the energy and environmental challenges facing us today. The request will enable EERE to research and develop renewable energy technologies to that can help increase the amount of clean energy produced in the U.S.; advance energy efficiency technologies and practices to sustainably decouple energy demand from economic growth; and promote deployment of these clean energy technologies.

EERE's overall budget request reflects the funding needed to meet our energy challenges head on. Advanced fuels and vehicles, renewable power, efficiency in buildings and industry, and technology deployment comprise EERE's portfolio and multipronged approach to energy solutions.

### BIOMASS PROGRAM

In FY 2009, the Department is requesting $225 million for the Biomass Program, an increase of $26.8 million from the FY 2008 appropriation. The Biomass Program's funding supports the Biofuels Initiative that was launched in 2006 as part of AEI and is designed to achieve cost competitive cellulosic ethanol by 2012. The funding also supports the President's "Twenty-in-Ten" initiative, announced in the 2007 State of the Union, to reduce gasoline consumption by 20 percent by 2017.

The Biomass Program's funding request for technology development and demonstration supports timely achievement of the goal of cost-competitiveness by 2012. The Biomass Program is focused on: Feedstock Infrastructure to reduce the cost of feedstock logistics; Platforms R&D for efficiently converting feedstocks into cost competitive commodity liquid biofuels; and Utilization of Platform Outputs to demonstrate and validate integrated technologies that achieve commercially acceptable performance and cost targets through public-private partnerships. The Program Biomass strategy is to accelerate development of the next generation of feedstocks and conversion technology options for validation and demonstration in integrated biorefineries at commercial and 10 percent of commercial scale. This strategy balances the program's research, development, and deployment (RD&D) portfolio by encouraging technology transfer while maintaining core R&D funding for next generation technologies. The Biomass Program will continue to emphasize cellulosic ethanol and expand the focus on other renewable biofuels, such as biobutanol and green diesel.

VEHICLE TECHNOLOGIES PROGRAM

The FY 2009 Vehicle Technologies (VT) Program's request is $221.1 million, an $8 million increase over the FY 2008 appropriation.

The Vehicle Technologies Program activities focus on advanced, high-efficiency vehicle technologies, including combustion engines and enabling fuels, hybrid vehicle systems (including plug-in hybrids), high-power and high-energy batteries, advanced lightweight materials, and power electronics. These technologies are critical to near-term oil savings when used in advanced combustion hybrid and plug-in hybrid electric vehicles (PHEVs). In FY 2009, emphasis will increase R&D for PHEVs, such as high energy storage batteries.

The VT Program continues to place increasing emphasis on accelerating RD&D on lithium-ion batteries, plug-in hybrids (including plug-in hybrid vehicle demonstrations), and drive-train electrification to diversify and make our nation's vehicles more efficient to reduce petroleum dependency. For more traditional vehicles, the program conducts research and development on improving advanced combustion engine systems and fuels and on reducing vehicle parasitic losses. The Vehicle Technologies budget is modified in the FY 2009 request by transferring three activities from the Hydrogen Technology Program: Education; Technology Validation; and Safety and Codes and Standards. These activity areas have congruent objectives with other efforts within the VT Program, and combining them within one program enables management efficiencies.

The VT Program will continue FY 2008 efforts to evaluate the impact of intermediate ethanol blended gasoline (i.e., greater than E10) in conventional (i.e., non-FFV) vehicles and to improve the efficiency of engines operating on ethanol blends. Late model and legacy vehicles will be tested for emissions, performance, and materials impacts. These efforts help support existing mandates and the President's 20 in 10 plan.

HYDROGEN TECHNOLOGY PROGRAM

The Hydrogen Technology Program's FY 2009 budget request is $146.2 million, $64.8 million less than the FY 2008 appropriation, due in part to the movement of the three activities mentioned above to the Vehicle Technologies Program. In 2009, the program will focus on remaining critical path barriers to the technology readiness goals for 2015. Substantial increases are included for hydrogen storage and fuel cell R&D. To provide for those increases, funding for hydrogen production from renewables has been eliminated, and systems analyses continues at a somewhat reduced funding levels.

The Hydrogen Program continues to research and develop critical hydrogen technologies that enable near-term commercialization pathways. Hydrogen Storage is one of the most technically challenging barriers to the widespread advancement of hydrogen and fuel cell technologies in the transportation sector. Our portfolio continues to identify new materials for on-board storage having the potential for greater than 50% improvement in capacity than those available prior to 2004. Much needs to be done to enable these materials to operate at practical temperatures and pressures.

In 2009, the Hydrogen Program will significantly increase investment in applied R&D of novel materials and breakthrough concepts with potential to meet on-board storage system performance targets. All storage R&D funding will be conducted through competitively selected Centers of Excellence and independent projects. The overarching goal is lightweight, low-cost, low-pressure, and efficient on-board vehicular storage systems to achieve a driving range of greater than 300 miles, without impacting vehicular cargo or passenger space to be competitive with today's vehicles.

To address the critical barriers of fuel cell cost and durability, the FY 2009 request significantly increases funding for Fuel Stack Components R&D. Our R&D efforts have made progress in this area and will continue to work toward our stated goals. One notable achievement has been the development of a membrane with 5,000 hours lifetime - a giant leap toward the 2010 goal of 5,000 hours durability in an automotive fuel cell system.

The Hydrogen Program's fuel cell R&D will continue to pursue a number of technological advancements. Proton-conducting membranes that are low-cost, durable, and operable at a low relative humidity will be developed. Non-precious metal and alloy catalysts will be identified and developed to further lower the cost of fuel cell systems. Gas flow through the flow fields will be modeled and measured while fuel cells are in operation to ensure optimal gas and water distribution over the catalyst and membrane surface. And fuel cells for distributed energy generation will continue to be developed with an emphasis on system integration, cost reduction and efficiency improvements. The Department will also continue its participation in the International Partnership for Hydrogen Economy (IPHE) – collaborating on R&D of materials for both fuel cells and storage, and working on such projects as the evaluation of fuel cell-related test protocols from different countries, as well as hydrogen pathway and infrastructure analyses.

SOLAR ENERGY PROGRAM

The FY 2009 budget request for the Solar Energy Program is $156.1 million, $12.3 million less than the FY 2008 appropriation. Through the President's Solar America Initiative (SAI), announced in the 2006 State of the Union, the Solar Program will accelerate market competitiveness of solar photovoltaic technologies by conducting R&D to support less expensive, more efficient, and highly reliable solar systems. Targeting improved performance and reliability with reduced cost, the Solar Program focuses its RD&D activities in two technology areas: photovoltaics (PV) and concentrating solar power (CSP).

The Solar Program's goal in the area of photovoltaics is to develop and deploy highly reliable PV systems that are cost-competitive with electricity from conventional resources. The Solar Program focuses on improving the performance of cells, modules, and systems; reducing the manufacturing cost of cells, modules, plant components, and systems; reducing the installation, interconnection, and certification costs for residential, commercial, and utility systems; and increasing system operating lifetime and reliability. To lower costs more rapidly and improve performance, the Solar Program is focusing on PV technology pathways that have the greatest potential to reach cost competitiveness by 2015. Industry-led partnerships, known as

"Technology Pathway Partnerships," will be continued in FY 2009 to help address the issues of cost, performance, and reliability associated with each pathway.

The Program's CSP focus is to develop concentrating solar technologies. A solicitation issued in FY 2007 resulted in 12 industry contract awards focused on establishing a U.S. manufacturing capability of low cost trough components and the technical feasibility of low cost thermal storage. In FY 2008, funds will be provided for Phase I of these contracts with the more promising contracts moving into Phase II in FY 2009. One of the most important advantages of CSP is its ability to thermally store power for later use. The development of advanced thermal energy storage technologies in FY 2009 will be expanded to include single heat transfer fluid systems that eliminate the need for multiple heat exchangers and thereby increase system efficiency and reduce cost. For distributed applications, research in FY 2009 will continue on improving the reliability of dish systems through the operation and testing of multiple units as well as improving the manufacturability of dish systems.

WIND ENERGY PROGRAM

The Wind Energy Program's FY 2009 request is $52.5 million, an increase of $3.0 million from the FY 2008 appropriation. The Wind Energy Program supports the AEI objective to maximize wind energy resource utilization in the United States by leading the nation's R&D efforts to improve wind energy generation technology and address barriers to the use of wind energy in coordination with stakeholders. The Wind Program's R&D efforts will focus on improving the performance of turbines, blades, and related components.

The Wind Program believes that wind energy is at a transitional point, particularly for large land-based wind systems. The program is concentrating on reducing technological barriers that undermine the growth potential of wind energy in the U.S. by focusing on improving cost, performance, and reliability of large scale land-based technology.

In addition, the Wind Program is facilitating wind energy's rapid market expansion by anticipating and addressing potential regulatory, transmission and manufacturing barriers; and investigating wind energy's application to other areas, including distributed and community owned wind projects.

In 2009 the Wind Program will also work on grid integration to help maximize wind energy resource utilization, thereby beginning to address a barrier to increasing the domestic wind energy supply while also enhancing system reliability.

WATER POWER PROGRAM

The Water Power Program's budget request of $3.0 million will support initial R&D activities, and follows an initial congressional appropriation of $9.9 million in FY 2008. The program needs to evaluate the results of its FY 2008 R&D projects and technology assessments (which will continue into FY 2009) before considering further applied research efforts. The mission of the Water Power Program is to research and develop innovative and effective technologies capable of harnessing hydrokinetic energy resources, including ocean wave and current energy.

The program will focus on conducting technology characterizations to identify manufacturers, performance limits and issues, known environmental impacts, and other relevant technical and market variables. In addition, the program will engage with key collaborative international activities.

GEOTHERMAL TECHNOLOGY PROGRAM

The FY 2009 request for the Geothermal Technology Program is $30 million, which is an increase of $10.2 million from the FY 2008 appropriation. The Geothermal Program focuses on the innovative technology of Enhanced Geothermal Systems (EGS) which are engineered reservoirs created to produce energy from geothermal resources. EGS is a new pathway for producing geothermal energy by drilling wells into hot rock, fracturing the rock between the wells, and circulating a fluid through the fractured rock to extract the heat. While EGS reservoirs have been designed, built, and tested in various countries, a number of technical hurdles remain to be overcome, the most important involving creation of EGS reservoirs with viable production rates and lifetimes. The Department's approach will to concentrate initially on reservoir-related technological issues. This strategy involves research as well as work with cost-sharing partners at existing geothermal fields to develop, test, and perfect the tools needed to fracture hot, impermeable rock and efficiently circulate fluids.

BUILDING TECHNOLOGIES PROGRAM

The Building Technologies (BT) Program's FY 2009 request is $123.8 million, an increase of $14.8 million from the FY 2008 appropriation. The BT Program develops technologies, techniques, and tools for making residential and commercial buildings more energy efficient and cost competitive. The Program's funding supports a portfolio of activities that includes solid state lighting (SSL), improved energy efficiency of other building components and equipment, and their effective integration using whole building system design techniques that will enable the design of net Zero Energy Buildings. The BT Program also includes the development of building codes and appliance standards and successful education and market introduction programs, including ENERGY STAR and EnergySmart Schools.

The Residential and Commercial Buildings integration components of the BT Program aim to transform the carbon footprint of the built environment through Zero Energy Buildings. The residential-focused Building America subprogram focuses on reducing total energy use in a new home by 60 to 70 percent. During FY 2009, research for production-ready new residential buildings that are 40 percent more efficient will continue for three climate zones, with completion in two. The BT Program's activities in the commercial sector are focused on alliances of leading market companies with national portfolios of buildings.

The Emerging Technologies subprogram seeks to develop cost-effective technologies for residential and commercial buildings that enable reductions in building energy use. Solid State Lighting will develop technologies that can help reduce commercial building lighting electricity consumption. Space Conditioning and Refrigeration R&D will continue work on HVAC design

concepts. Other highlights include highly insulating windows and building integrated solar heating and cooling systems.

The Equipment Standards and Analysis subprogram develops minimum energy efficiency standards that are technologically feasible and economically justified as required by law. Federal energy conservation standards that have gone into effect since 1988 are projected to save a cumulative total of 75 quadrillion Btus (quads) of energy by the year 2045 (in 2007, total annual U.S. consumption of primary energy was about 103 quads). Between FY 2005 and FY 2007, the Department identified and carried out significant enhancements to rulemaking activities. The Department has made a commitment to clear the backlog of delayed actions that accumulated during prior years, while simultaneously implementing two new requirements of the Energy Policy Act (EPACT) of 2005. The Energy Independence and Security Act significantly increased the number of efficiency standards and test procedures DOE must develop. The Department will continue to implement productivity enhancements that will allow multiple rulemaking activities to proceed simultaneously, while maintaining the rigorous technical and economic analysis required by statute. Energy conservation standards for 10 products were initiated in FY 2006 and 2007 that will continue in FY 2009. In FY 2008, efficiency standards rulemakings were initiated on 4 additional products. In FY 2008, DOE is proceeding simultaneously on rulemakings for 15 products and 10 test procedures. In FY 2009, 4 more standards and test procedures for 7 more products will be added.

The Technology Validation and Market Introduction subprogram funds activities that validate and promote clean, efficient, and domestic energy technologies. Expanding the ENERGY STAR program to include solid state lighting, water heaters, photovoltaics, fuel cells, micro-wind turbines, combined heat and power, and other advanced technologies, as well as targeting the civic infrastructure (e.g., schools, hospitals, libraries, municipal facilities), are central activities that the BT Program carries out to invest in Energy Smart solutions. DOE will continue to work with the Environmental Protection Agency on the development and implementation of Energy Star and other efforts to minimize duplication and maximize efficiency. In addition to these efforts, the BT Program focuses on outreach efforts to help move specific technologies – such as solid-state lighting and high-performance windows – toward commercial applications. These efforts include design and rating tools, durability and product lifetime data, testing procedures, demonstrations, retailer education, and training on proper installation.

## INDUSTRIAL TECHNOLOGIES PROGRAM

The Industrial Technologies (IT) Program seeks to reduce the energy intensity (energy demand per unit of industrial output) of the U.S. industrial sector through coordinated research and development, validation, and technical assistance activities. The program works to increase dissemination of energy efficiency technologies and operating practices. The FY 2009 Budget request for the IT Program is $62.1 million, which is $2.3 million less than the FY 2008 appropriation. Internal funding shifts reflect a continued strategy to emphasize more effective ways to increase energy efficiency among energy intensive industries. The shift toward more crosscutting and higher impact R&D activities will allow the IT Program to develop advanced, energy-efficient technologies to serve a broader set of industries.

The IT Program will continue to support the Secretary of Energy's "Easy Ways to Save Energy" campaign through the Save Energy Now (SEN) industrial energy savings assessments at the Nation's most energy-intensive industrial facilities. This has been a very successful activity, having reached its 24-month goal of conducting 450 assessments from 2006 through 2007.

Building on this success, the IT Program will expand partnerships with leading corporations across major manufacturing supply chain and deliver DOE plant assessments, tools, and technologies to enable dramatic energy efficient improvements.

C. OFFICE OF FOSSIL ENERGY (FE)

The Office of Fossil Energy (FE) conducts research, development and demonstration activities in partnership with industry to enhance US economic, environmental and energy security by using conventional hydrocarbon sources of fuel. To further this mission, the Office is developing technological capabilities that could dramatically reduce carbon emissions to achieve near-zero atmospheric emissions power production. FE's budget request of $1.127 billion for FY 2009 is an increase of $223 million over the FY 2008 appropriation, of which $754 million supports research and development and $373 million supports petroleum reserves.

The Department's energy portfolio recognizes the abundance of coal as a domestic energy resource and remains committed to research and development to promote its clean and efficient use. Since coal in the United States accounts for 25% of the world's coal resources, the FY 2009 request focuses on carbon capture and storage.

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

The Department's Fossil Energy Research and Development (FERD) program is directed at electric power generation from coal, our most abundant and lowest cost domestic fossil fuel. Coal today accounts for nearly one-quarter of all the energy -- and about half the electricity – consumed in the United States.

FERD supports many Presidential initiatives and priorities including the Coal Research Initiative, Hydrogen Fuel Initiative, and FutureGen. FERD also supports the Climate Change Technology Program, which is a priority for the Department.

FUTUREGEN

FutureGen promotes advanced, full-scale integration of integrated gasification combined cycle (IGCC) and carbon capture and storage technology to produce electric power from coal while capturing and sequestering carbon dioxide ($CO_2$), resulting in near-zero atmospheric emissions coal energy systems. The Department is restructuring FutureGen in a way that accelerates the commercial demonstration and deployment of carbon capture and storage technologies.

The new approach proposes multiple 300-600 Megawatt (MW) commercial-scale demonstration clean coal power plants – as opposed to a single, 275 MW R&D facility - each producing electricity and capturing and safely sequestering at least an estimated annual one

million metric tons of $CO_2$. In the FY 2009 budget proposal, FutureGen receives an $81.7 million funding increase over the FY 2008 appropriation

CLEAN COAL POWER INITIATIVE

The Clean Coal Power Initiative (CCPI) is a cooperative, cost-shared program between the government and industry to demonstrate advanced coal-based power generation technologies. CCPI is now focused on projects to help accelerate development and deployment of coal technologies that could economically capture carbon dioxide, including increasing the efficiency and reliability of carbon capture technologies. CCPI allows the nation's power generators, equipment manufacturers, and coal producers to help identify the most critical barriers to coal use and the most promising advanced technologies to use coal cleanly, affordably, and with higher efficiencies that reduce carbon intensity.

The CCPI budget request for FY 2009 is $85 million, a $15.6 million increase over the FY 2008 appropriation. In FY 2009 will complete the third round of project solicitations, proposal evaluations, and project selections of advanced technology systems that capture carbon dioxide for sequestration or beneficial reuse.

CARBON SEQUESTRATION

The FY 2009 budget request of $149 million for carbon sequestration, one of the key components of the Fuel and Power Systems program, is an increase of $30 million over the $119 million provided in the FY 2008 appropriation.

The increase should help develop economical ways to separate and permanently store (sequester) greenhouse gas emissions from the combustion of fossil fuels. The technologies will help existing and future fossil fuel power generating facilities by reducing the cost of electricity impacts and also providing protocols for carbon capture and storage demonstrations to capture, transport, store, and monitor the $CO_2$ injected in geologic formations.

The increase will support site selection and characterization, regulatory permits, community outreach, and completion of site operations plan for large-scale, geologic, carbon storage tests. It will also fund large-scale injections and remaining infrastructure development.

HYDROGEN

The budget request of $10 million in FY 2009 for hydrogen from coal -- a clean fuel for future advanced power technologies such as fuel cells and transportation systems – is down nearly $15 million from the FY 2008 appropriation. The decrease is due to the elimination of integrated coal-biomass processing for carbon emissions research (which is generally advanced through the gasification program), elimination of substitute natural gas and coal-to-liquids production research (which are mature industries and do not provide the high-return investment that FE focuses on), and a right-sizing of the effort level for early engineering and design studies on hydrogen production modules in near-zero atmospheric emissions coal plants.

GASIFICATION TECHNOLOGY

The Integrated Gasification Combined Cycle (IGCC) budget request for FY 2009 is $69 million, a $15.5 million increase over the FY 2008 appropriation. The IGCC program develops advanced gasification-based technologies aimed at reducing the cost of coal-based IGCC plants, improving thermal efficiency, and achieving near-zero atmospheric emissions of all pollutants. These technologies will be an integral part of the carbon capture and storage demonstration projects.

FUEL CELLS

Flexible fuel cell systems that can operate in central coal-based power systems and with applications for electric utility, industrial and commercial/residential markets, receive a funding request of $60 million in FY 2009 – a $4.5 million increase over the FY 2008 appropriation of $55.5 million. This activity enables the generation of highly efficient, cost-effective electricity from domestic coal with near-zero atmospheric emissions of carbon and air pollutants in central station applications. The technology also provides the technology base to permit grid-independent distributed generation applications.

OIL AND NATURAL GAS TECHNOLOGY

Oil and gas R&D activities are more appropriate for the private-sector industry to perform. Consistent with the budget requests for Fiscal years 2006, 2007 and 2008, the Petroleum - Oil Technology and Natural Gas Technologies research and development programs are being terminated in FY 2009.

The Ultra-Deepwater and Unconventional Gas and Other Petroleum Research Fund was created by the Energy Policy Act of 2005 (Public Law 109-58) as a mandatory program beginning in FY 2007. The program is funded from mandatory federal revenues from oil and gas leases. Consistent with the Fiscal Year 2007 and 2008 budget requests, the FY 2009 budget proposes to repeal the program through a legislative proposal.

D. OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY (OE)

The mission of the Office of Electricity Delivery and Energy Reliability (OE) is to lead national efforts to modernize the electricity delivery system, enhance the security and reliability of America's energy infrastructure, and facilitate recovery from disruptions to energy supply. These functions are vital to the Department's strategic goal of protecting our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally responsible energy.

The President's FY 2009 budget includes $134 million for OE in FY 2009, which is a decrease of $4.6 million from the FY 2008 appropriation. This includes $14.1 million for Operations and Analysis activities (an increase of $2.7 million from the FY 2008 appropriation), and $19.7 million for Program Direction (an increase of $2.1 million from the FY 2008 appropriation).

ELECTRICITY DELIVERY RESEARCH AND DEVELOPMENT

In FY 2009, the Department is requesting $100.2 million for Research and Development activities, a decrease of $9.3 million from the FY 2008 appropriation. Effort is focused in four critical areas: High Temperature Superconductivity; Visualization & Controls; Renewable & Distributed Systems Integration; and Energy Storage & Power Electronics.

Our High Temperature Superconductivity activities continue to support second generation wire development as well as research on dielectrics, cryogenics, and cable systems. This activity is being refocused to address a near-term critical need within the electric system to not only increase current carrying capacity, but also to relieve overburdened cables elsewhere in the local grid. The superconductivity industry in the United States is now at the critical stage of moving from small business development to becoming a part of our manufacturing base. The FY 2009 funding request for High Temperature Superconductivity is $28.2 million, an increase of $0.3 million from the FY 2008 appropriation.

Enhanced security for control systems used by the transmission grid is critical to the development of a more reliable and resilient modern grid. The Visualization and Controls Research & Development activity focuses on improving our ability to measure and address the vulnerabilities of controls systems, detect cyber intrusion, implement protective measures and response strategies, and sustain cyber security improvements over time.

This activity is also developing the next generation system control and data acquisition (SCADA) system that features GPS-synchronized grid monitoring, secure data communications, custom visualization and operator cueing, and advanced control algorithms. Advanced visualization and control systems will allow operators to detect disturbances and take corrective action before problems cascade into widespread outages. The need to improve electric power control systems security is well-recognized by both the private and public sectors. The FY 2009 funding request for Visualization & Controls is $25.3 million, an increase of $0.2 million from the FY 2008 appropriation.

The Energy Storage & Power Electronics activities support the development of new and improved energy storage devices and systems at utility scale, which will be incorporated in DOE's Basic Energy Science basic research results. The Department will also work to achieve substantial improvements in seeking lifetime, reliability, energy density, and cost of energy storage devices. Through this, highly leveraged prototype testing and utility demonstration projects will be expanded with state energy office participation focusing on areas of greatest utility need. The increase will also serve to focus on enhanced research in Power Electronics to improve material and device properties needed for transmission-level applications. The FY 2009 funding request for the Energy Storage and Power Electronics program is $13.4 million, an increase of $6.7 million from the FY 2008 appropriation.

Large scale, megawatt-level electricity storage systems, or multiple, smaller distributed storage systems, could significantly reduce transmission system congestion, manage peak loads, make renewable electricity sources more dispatchable, and increase the reliability of the overall

electric grid. The FY 2009 funding request for Energy Storage & Power Electronics is $13.4 million, an increase of $6.7 million from the FY 2008 appropriation.

The Renewable and Distributed Systems Integration activities will develop and demonstrate Smart Grid technologies for an integrated and intelligent electric transmission and distribution network in accordance with the Energy Independence and Security Act; will demonstrate distributed energy systems as a resource to decrease peak electric load demand, increase asset utilization, and defer electric system upgrades; and in coordination with EERE, will develop renewable energy grid integration technologies and methods to facilitate increased deployment of renewables and other clean energy sources. The FY 2009 funding request for Renewable & Distributed Systems Integration is $33.3 million, an increase of $7.8 million from the FY 2008 appropriation.

## CONCLUSION

I appreciate the opportunity to appear before you to present the Department of Energy's FY 2009 budget proposal for the applied energy programs' research and development efforts. I will be happy to take any questions that members of the subcommittee may have.