ENERGY AND WATER, AND RELATED AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2006

TUESDAY, MARCH 15, 2005

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 2:21 p.m., in room SD–124, Dirksen Senate Office Building, Hon. Pete V. Domenici (chairman) presiding.

Present: Senators Domenici, Craig, Allard and Dorgan.

DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

STATEMENT OF DAVID GARMAN, ASSISTANT SECRETARY

OPENING STATEMENT OF SENATOR PETE V. DOMENICI

Senator DOMENICI. The hearing will please come to order.

We have checked, and the minority has suggested that we proceed, even though they're not in attendance, because they won't be able to be here for awhile, and we have to get a few things on the record. So if there are questions, we will give them plenty of opportunity to present them, and if you would answer them in due course we would appreciate it.

So, today we are going to hear from the Office of Science, the Office of Nuclear Energy, and the Office of Energy Efficiency and Renewable Energy.

Since the Senate Appropriations Committee reorganized 2 weeks ago, this is the first opportunity for this subcommittee to hold hearings on several DOE activities that had previously been under the jurisdiction of the Interior Subcommittee. Overall, this subcommittee will add to its jurisdiction roughly $1.6 billion in new programs, and various functions from the Interior Subcommittee.

Today we have three witnesses; Dr. Ray Orbach, Director of the Office of Science; David Garman, Assistant Secretary for the Office of Energy Efficiency and Renewable Energy; Mr. William Magwood, Director of the Office of Nuclear Energy.

Mr. Garman, the President has nominated you to serve as the Under Secretary. During the last Congress, you served in this same position and did a fine job. I hope that we're going to be able to work out things where we can proceed with your confirmation quickly.

Mr. GARMAN. Thank you, Mr. Chairman.

Senator DOMENICI. The President made deficit reductions a top priority in his budget; as a result, things are very tight. The budget for the Department of Energy proposes a $23.4 billion, which overall is a 2 percent reduction from the current year. The Office of Science budget provides for $3.46 billion, and it's down about 3.8 percent.

Despite these tight budgets, Dr. Orbach and his team have put together a program that supports cutting-edge research and funds for world-class research facilities, at least as we see it. We'll be talking about that briefly today. Completes the construction of a Spallation Neutron Source at Oak Ridge, a marvelous new facility which I think will make that national laboratory a very significant laboratory for years to come.

The DOE will also complete construction of four of the five nanotechnology centers, another very exciting activity. We read a lot about it, not very often do they mention the DOE is out front, on the cutting edge of that.

In Biology and Environmental Research programs, funding for the Genomes to Life program, the human genome and the low dose radiation study are all continued at current levels.

One area which we believe the budget comes up short is in the area of fusion energy research. The budget shifts funding from the United States research to the international thermonuclear experimental reactor, despite the fact that there is no agreement on the site of that facility as we speak here today. If we're to remain at the cutting edge of fusion research, it would seem to me, unless we can be convinced to the contrary, that we can't undermine our scientific excellence by under-funding our own capability. Now, maybe we can be convinced that we're not under-funding to that extent, but it would appear so, just looking at the numbers and activities.

OFFICE OF NUCLEAR ENERGY

The Office of Nuclear Energy—which concerns all of us—last year Congress increased the funding for the Office of Nuclear Energy and R&D by $100 million. In the fiscal year 2006, this account is up an additional 12 percent. This budget provides $56 million to support the Nuclear Power (NP) 2010 program, and that provides matching funds for early-site permitting, and shares the cost associated with the first of the kind engineering of a new plant. To date, three utilities have now applied for early-site permits—rather exciting news—three more in the exploration phase. Two consortia have applied for DOE funding, to support construction and operating licenses for new plants before the Nuclear Regulatory Commission.

While I am pleased with the utility interest, and will be having further meetings with others who will be financing nuclear power plants in the future—so we'll get a full picture of the enthusiasm, or lack of it, whichever the case may be—since Congress last passed the budget in November, DOE designated two groups go forward. Four months later, the Office of Nuclear Energy has yet to send out a single dollar in that regard. So, I'm concerned with the administration's commitment to supporting long-term research in

the next generation of reactors. We would expect some comment on that today.

The budget fails to mention what has become of the $25 million earmarked in the 2005 Energy Conference Report for the deployment of the next generation of nuclear plants at Idaho National Laboratory. I intend to work with the Secretary and certainly with Senator Craig to develop a path to ensure that the Idaho National Lab will develop the next generation nuclear plant. We designated that laboratory to do that, and we're really wondering what happened—I assume something has happened—but we want to make sure that the resources are there to continue with it.

We all know that we're going to continue to support new reactors that are more efficient, produce less waste, and support the President's Hydrogen Initiative. On the Office of Energy Efficiency and Renewables, this budget provides $1.2 billion for that function, and that's a 4 percent reduction. We'd like to know what you think that's going to do, I would assume that you're moving things around, and assume that the major activities won't be harmed significantly.

The budget for the Hydrogen Initiative for the present is a big winner, and well it should be. While it's way out in the future—or out in the future—it clearly is one of the bright spots, it's where we might go with a new kind of transportation, an engine that will move our transportation. In addition, that budget provides a $359.9—almost $600 million—for hydrogen research, that's a $34 million increase, and a $100 million from 2004, so that's pretty good.

Biomass, it won't get as much money as before, we'll have somebody talk about that. There's a reduction of 37 percent. Solar energy research is down about 2 percent, funding for research is up on wind energy, significantly.

Finally, the administration has proposed ending the hydropower R&D effort, and requested only nominal funding to close out this office. I'm sure some Senators will be interested in that, we'll see what they have to say. Perhaps Senator Craig will be one, I don't know.

As I noted earlier, there's a significant number of functions and activities now under this jurisdiction of our subcommittee. We'll be learning of these new accounts, hopefully finding some savings through efficiencies that can be applied toward additional scientific research, which is what we want to try to stress.

Now, Senator Reid is not here, but I note that—I assume he's not going to be here, Senator Reid, is that correct? Okay, so we'll put Senator Reid's statement in the record, whenever he wants to put it in, and with that, Senator Craig, if you have some comments, and Senator Dorgan, if you do, then we'll proceed to our witnesses. Senator Craig.

STATEMENT OF SENATOR LARRY CRAIG

Senator CRAIG. Mr. Chairman, I'll be very brief. You've outlined the essence of the President's budget, and in many ways it points to energy's future, it's a budget that's gone wanting for more resource. I say that, gentlemen, because I know you spend a good deal of time out traveling and speaking—as do many of us—and in

every audience, the question is always asked, "What are you going to do about our national energy policy? What are you going to do about the future of energy for our country?" Because most Americans believe it has been a failure of Congress and administrations to produce a national energy policy. We're doing that. The chairman is working overtime at this moment to assure that by the close of this year, we're going to have a national energy policy in place, and this administration and this President have worked very hard to promote that.

But, I must tell you, this budget is not reflective of as much of that as we would like to see, without question. Because the kind of money that the Federal Government spends as the R&D and future type of research that builds that long-term energy base, so we'll work closely with you as we deal with this budget, it is a tight budget year, and all of us can afford, and will do, some belt tightening. But I hope that in the budget we can establish the priorities that really are futuristic in their vision as it relates to need, and certainly as it relates to what's going on in this country. I just can't imagine that the Congress and this administration will sit idly by, and allow our energy future to continue to erode. Certainly that's not where we're all intending to go, and where we're all intending to be at the close of business on this issue, and I hope that we can work with you to make sure that the budgets also reflect that. Thank you, Mr. Chairman.

Senator DOMENICI. Thank you very much. Senator Dorgan.

STATEMENT OF SENATOR BYRON L. DORGAN

Senator DORGAN. Mr. Chairman, thank you very much. I'm unable to stay for the entire hearing, but I did want to be able to comment, say just a word at the start. I share many of the comments made by my colleague from Idaho, and you, Mr. Chairman.

We are just one terrorist event away from a catastrophe with respect to energy. Sixty percent of our oil comes from off our shores, and our economy is vulnerable as a result. I really think that we need to move towards a hydrogen fuel cell economy. I know that the chairman also has an interest in that and other members of the Energy Committee on which we serve. I think to do that you need to be bold and aggressive, and need almost a Manhattan or an Apollo-type project to get there. I really hope that we will be able to have some discussion about that once again this year. I think in the near term, we need to expand the role that renewables play with respect to our energy supply. Mr. Garman, I know that you've been to some events that I've held, and others have held on renewables, and you understand that.

I might make just one other comment: probably one of the cheapest ways to acquire a barrel of oil is to save a barrel of oil through increased efficiency. The saving of energy is critically important. I'm involved—along with some of my colleagues here in Congress—in something called the Alliance to Save Energy. It has done a lot of important work, including the development of the Energy Star Awards with the Department of Energy.

And so, I think those three areas are critically important: a bold hydrogen fuel cell initiative which moves us towards a different kind of energy construct; the use of more renewables, including re-

newable portfolio standards; and then focusing on efficiency. And I have great hope as we—in another committee—put together an energy bill. I have great hope that we will be able to construct an energy bill this year that really moves aggressively down the road in all three of those areas, and I hope also that we're able to find ways—as my colleague Senator Craig just said—to fund, aggressively, these areas in the appropriations process. Mr. Chairman, thank you for your patience.

STATEMENT OF DAVID GARMAN

Senator DOMENICI. Let's proceed. As I understand it, it is common that you will proceed first, Dr. Orbach, then Mr. Magwood. So, if you please be as brief as you can, your statement will be made a part of the record, so will yours, and Mr. Magwood, so will yours at this point. Please proceed.

Mr. GARMAN. I will briefly summarize, Mr. Chairman.

As you mentioned, the President's budget includes $1.2 billion for the Office of Energy Efficiency and Renewable Energy, and I'll briefly outline our priorities for the use of those funds.

REDUCE DEPENDENCE ON FOREIGN OIL

First, our top priority is to reduce America's dependence on foreign petroleum. And since the majority of the oil that we use is used to fuel transportation, we're seeking increases in both our vehicle technologies program, and our hydrogen and fuel cell program, proposing to spend nearly $349 million in these areas. Our work, conducted in partnership with auto makers and energy providers, among others, includes research and development on gasoline-electric hybrid propulsion, new generations of spark and compression ignition internal combustion engines, vehicle systems, lightweight materials, and of course, hydrogen fuel cells, and elements of the hydrogen re-fueling structure to support them.

WEATHERIZATION PROGRAM

Our next priority—and this is a new area under this subcommittee—is to reduce the burden of energy prices on the disadvantaged. To this end, we're proposing $230 million for the low income Weatherization Program, an increase over last year's appropriated levels.

RENEWABLE ENERGY

Another priority of our office is to increase the viability and deployment of renewable energy technologies. To this end, we're seeking approximately $260 million. This funding includes our work on solar, wind, biomass, geothermal, hydropower and the facilities and activities needed to support these programs.

BUILDINGS AND APPLIANCES

Our next priority is to increase the energy efficiency of buildings and appliances. To this end, we're seeking more than $75 million for our Building Technologies Program, ENERGY STAR®, Rebuild America, and building code training and assistance activities.

BIOMASS

Our fifth priority is the creation of the domestic bio-industry. In pursuit of this priority, we are seeking over $72 million for our Biomass Technologies Program. Our work in this area includes lowering the cost of sugars derived from discarded or under-utilized cellulosic materials, from which ethanol and other chemicals and products can be made.

DISTRIBUTED POWER GENERATION

Our sixth priority is to increase the efficiency and performance of distributed power generation, which can enhance the reliability of the entire electricity grid. We propose to spend $57 million on our distributed energy program, which includes work on reciprocating engines, microturbines, thermally activated technologies, and the packaging and integration of these technologies into compact, affordable systems.

INDUSTRIAL TECHNOLOGIES

Our seventh priority is to increase the energy efficiency of industry, and to that end we're seeking $56.5 million for our industrial technologies program. Technologies we're working on in that area are as varied as continuous melt electric arch furnaces, coke-less iron making, and high pressure super boilers. We're also making efforts to communicate best energy efficiency practices among a wide spectrum of industrial partners.

FEDERAL ENERGY MANAGEMENT

Our eighth priority is to assist the largest single user of energy in the United States' economy—the U.S. Federal Government—to lead by example in using energy more efficiently, and procuring more energy from renewable resources. In pursuit of this goal, we operate the Federal Energy Management Program, with over $19 million of funding for those activities.

PREPARED STATEMENT

Mr. Chairman, this is an extremely diverse portfolio of different activities that's sometimes challenging to manage, and that's why our ninth priority has been to change and continuously improve the way that we do business. While we have made a great deal of progress, there's still much we can do to improve our performance. We appreciate the efforts of the subcommittee in working with us to ensure that we continue that improvement through stronger planning and program management efforts. With that, Mr. Chairman, I'd be pleased to take any questions you have, either today or in the future. Thank you.

[The statement follows:]

PREPARED STATEMENT OF DAVID GARMAN

Mr. Chairman and members of the subcommittee, I appreciate the opportunity to testify on the President's Fiscal Year 2006 Budget Request for the Office of Energy Efficiency and Renewable Energy (EERE). My focus today will be on the energy conservation, renewable energy, and hydrogen activities under the purview of this subcommittee.

The President's Fiscal Year 2006 Budget includes $1.2 billion for EERE. In his February 2 State of the Union Address, the President underscored the need to restrain spending in order to sustain our economic prosperity. As part of this restraint, it is important that total discretionary and non-security spending be held to levels proposed in the Fiscal Year 2006 Budget. The budget savings and reforms in the budget are important components of achieving the President's goal of cutting the budget deficit in half by 2009 and we urge the Congress to support these reforms. The Fiscal Year 2006 Budget includes more than 150 reductions, reforms, and terminations in non-defense discretionary programs, of which one affects EERE's programs. The Department wants to work with the Congress to achieve these savings.

The programs funded by this appropriation continue support for certain Presidential initiatives; build on research, development, and deployment successes already achieved; and focus on implementing results-oriented business practices to help achieve strategic energy goals and fulfill the Department's mission.

EERE has made good on its strategic goal of "changing the way it does business." Last fall, the National Academy of Public Administration (NAPA) completed an 18-month review of EERE's reorganized structure and noted in its final report, Reorganizing for Results, that "the basic construct of the reorganization—eliminating the sector organizations and restructuring around the major programs, and consolidating the business administration functions—was sound," and that "EERE has made great strides to reinvent how it does business." Our innovative business and management model is enabling EERE to fund the right mix of research and development (R&D) and to get more technical work done effectively with the R&D dollars appropriated. EERE is also guided by the research and development investment criteria (RDIC) called for in the President's Management Agenda, as well as the Office of Management and Budget's (OMB) Program Assessment Rating Tool (PART) to guide its decisions and focus its R&D on long-term, high-payoff activities that require Federal involvement to be successful.

A primary long-term goal for our Nation must be to significantly reduce our dependence on foreign oil, and to develop the technologies that enable Americans to make greater use of our abundant, clean, domestic renewable energy resources. EERE's fiscal year 2006 request continues support for the President's Hydrogen Fuel Initiative to ensure that hydrogen production, storage, and infrastructure technologies will be available and affordable when hydrogen-powered fuel cell vehicles are ready for commercialization. EERE also continues support for its FreedomCAR program (where CAR stands for Cooperative Automotive Research), working with industry to improve the efficiency and lower the cost of advanced combustion engines and hybrid vehicle technologies. In addition, EERE will pursue critical technical improvements to biorefineries and the processes that use biomass, the only renewable resource that can directly produce liquid transportation fuels such as ethanol.

But long-term results are only part of the story for EERE's programs. The Fiscal Year 2006 Budget Request is designed to provide results to the American people today by advancing technologies that are making their way into energy-related products and services that are an integral part of America's energy economy. Since 2001, research sponsored by EERE has won 37 R&D 100 awards, ten in 2004 alone. One technology winner this year is the world's first portable, flexible photovoltaic (PV) power module made from thin-film copper indium gallium selenide (CIGS). The U.S. Army is already using these lightweight PV systems that can be folded as small as a 9×12 envelope, stowed in a small backpack, and easily carried over long distances to supply efficient and reliable power.

Targeting all sectors of energy use, EERE's fiscal year 2006 activities are designed to make a difference in the everyday lives of Americans today, and an even greater difference in years to come.

ENERGY CONSERVATION AND RENEWABLE ENERGY PROGRAMS FISCAL YEAR 2006 REQUEST

EERE programs funded by the Energy and Water Development appropriation include Hydrogen and Fuel Cell Technologies, Vehicle Technologies, Solar Energy Technologies, Wind and Hydropower Technologies, Geothermal Technologies, Biomass and Biorefinery Systems, Weatherization and Intergovernmental, Distributed Energy Resources, Building Technologies, Industrial Technologies, Federal Energy Management, and Program Management and Direction.

HYDROGEN AND FUEL CELL TECHNOLOGIES

The Fiscal Year 2006 Budget Request for Hydrogen and Fuel Cell Technologies totals $182.7 million: $99.1 million for hydrogen activities, a $5.1 million increase over the fiscal year 2005 comparable appropriation, and $83.6 million for fuel cell activities, an $8.7 million increase. Hydrogen and fuel cell technologies are the foundation of the President's Hydrogen Fuel Initiative and help support the Department's FreedomCAR program. Under the FreedomCAR and Fuel Partnership, government and industry are working together on research activities to overcome key technical barriers to commercialization of advanced efficient vehicles, and to facilitate a fuel cell hybrid vehicle and hydrogen infrastructure commercialization decision by industry in the year 2015. Because hydrogen fuel cell vehicles emit no criteria pollutants or carbon dioxide, their development and commercial success would essentially remove light-duty transportation as an environmental issue. The hydrogen will be produced from diverse domestic resources, making our Nation self-reliant for our personal transportation energy needs.

Much of the proposed increase in Hydrogen Technology is to accelerate and expand research and development of advanced technologies for producing hydrogen using renewable feedstocks such as biomass and renewable energy sources such as wind and solar. The program is also developing technologies for distributed hydrogen production from reforming of natural gas and from electrolysis. Other priorities include development of on-board vehicular hydrogen storage systems to achieve a driving range of greater than 300 miles and development of hydrogen delivery technologies. The ultimate goal is to reduce the cost of producing, storing, and delivering hydrogen to a cost competitive with that of gasoline.

Validation of fuel cell vehicle and hydrogen infrastructure technologies under "real-world" operating conditions is essential to track progress and to help guide research priorities. This year's request contains $24 million for fuel cell technology validation which is a 35 percent increase over the fiscal year 2005 comparable appropriation. We are also requesting $14.9 million in funding for the validation of hydrogen infrastructure technology, a 58 percent increase over the fiscal year 2005 comparable appropriation. Automotive and energy partners are matching public dollars on a "50–50" cost-shared basis, and the Department is beginning to receive essential statistical data on the status of fuel cell vehicle and infrastructure technologies relative to targets in the areas of efficiency, durability, storage system range, and fuel cost. By measuring progress under real-world driving conditions, the Department can accurately monitor success in overcoming remaining fuel cell and infrastructure technology barriers and assess progress towards the 2015 commercialization decision by industry. These activities also provide technical information and analysis to support the development of codes and standards for the commercial use of hydrogen, and feedback on vehicle and infrastructure safety. Fiscal year 2006 activities include opening eight hydrogen fueling stations, assessing performance and cost of hydrogen production and delivery technologies, and validating 1,000 hours of fuel cell vehicle durability "on the road." By 2009, the program is expected to validate fuel cell vehicle durability of 2,000 hours, a 250-mile vehicle range, and hydrogen production cost of less than $3.00/gge (gasoline gallon equivalent).

As highlighted by Secretary Bodman in earlier Congressional testimony, I am pleased to report that our fuel cell activities achieved an important technology cost goal this past year when they reduced the high-volume cost of automotive fuel cells from $275 per kilowatt in 2002 to $200 per kilowatt in 2004. This accomplishment is a major step toward the program's goal of reducing the cost of transportation fuel cell power systems to $45 per kilowatt by 2010.[1] Research successes like this will enable a positive commercialization decision in 2015 that could lead to the market introduction of hydrogen fuel cell vehicles by 2020.

The President's Hydrogen Fuel Initiative was received by Congress with enthusiasm, and we appreciate this subcommittee's support. However, while the EERE fiscal year 2005 comparable appropriation for hydrogen technology was $94 million, 40 percent of those funds were earmarked for specific projects that are not wholly consistent with our research plan or the recommendations of the National Research Council. As a consequence, we must delay some very important work in areas such as hydrogen production and storage, and our ability to meet our established research targets in the specified timeframes may be in jeopardy. The Department looks forward to working with the subcommittee to help ensure that projects supported by the committee are consistent with our established goals in an effort to keep our progress on track.

[1] Cost of 50 kW vehicle fuel cell power systems estimated for production rate of 500,000 units per year.

VEHICLE TECHNOLOGIES

The FreedomCAR & Vehicle Technologies Program focuses on the development of more energy efficient and environmentally friendly technologies for cars and trucks that will use significantly less oil, and still preserve America's freedom of mobility. Many of these technologies also serve as the foundation of tomorrow's hydrogen fuel cell vehicles.

The Fiscal Year 2006 Budget Request for Vehicle Technologies is $165.9 million, a $0.5 million increase over the fiscal year 2005 comparable appropriation. Activities in this program contribute to two Departmental initiatives: the FreedomCAR initiative and the 21st Century Truck initiative.

FreedomCAR activities in fiscal year 2006 focus on innovative, high-efficiency vehicle technologies including advanced combustion engines, advanced fuel formulations, hybrid vehicle systems, high-powered batteries, lightweight materials, and power electronics. These critical technologies can lead to near-term oil savings when used with advanced combustion hybrid electric vehicles and support the future development of hydrogen fuel cell hybrid vehicles.

FreedomCAR goals include increasing passenger and light-duty vehicle combustion engine efficiency from 30 percent to 45 percent by 2010 (while meeting 2010 EPA emissions standards), and reducing the cost of high-power batteries for hybrid vehicles from $3,000 (1998 baseline) to $500 for a 25kW battery by 2010. Combustion engine efficiency is making good progress, and in fiscal year 2006 we expect to reach 41 percent efficiency, a major step towards the 2010 goal of 45 percent. Battery technologies have also made significant progress toward these goals: the program reached its $1,000 cost target for fiscal year 2004, and the fiscal year 2006 budget is expected to bring that down to $750.

The 21st Century Truck initiative has similar objectives but is focused on commercial vehicles. The 2006 request will fund cooperative research efforts between the commercial heavy-duty vehicle (trucks and buses) industry and major Federal agencies to develop technologies that will make our Nation's commercial vehicles more efficient, cleaner, and safer. The effort centers on R&D to improve engine systems, heavy-duty hybrids, truck safety, and to reduce parasitic losses (e.g., aerodynamic drag as the vehicle moves down the road at 60 mph, and the power drain from belt driven accessories like power steering and air conditioning) and engine idling.

In fiscal year 2004, the heavy-duty vehicle activity demonstrated a reduction of parasitic losses from 39 percent baseline to 27 percent in a laboratory setting, and activities included in the fiscal year 2006 budget are expected to bring those losses down to 24 percent. The program also demonstrated an increase in heavy-duty diesel engine efficiency from the baseline of 40 percent to 45 percent in fiscal year 2004 (while meeting EPA 2007 emission standards) and we expect the fiscal year 2006 budget to raise that to 50 percent (while meeting EPA 2010 emission standards)—important steps toward meeting our long-term goal of 55 percent energy efficiency in 2013.

SOLAR ENERGY TECHNOLOGIES

The Solar Energy Technologies Program focuses research on advanced solar devices that can bring reliable and affordable solar energy technologies into the marketplace, helping our Nation meet electricity needs and reducing the stress on our critical electricity infrastructure. The Department's efforts are directed in the interrelated areas of photovoltaics, concentrating solar power (CSP), and solar heating and lighting. The Fiscal Year 2006 Budget Request for solar technology is $84.0 million, which is roughly equivalent to the fiscal year 2005 comparable appropriation of $85.1 million.

The Department's photovoltaic research and development is focused on next-generation technologies such as thin-film photovoltaic cells and leap-frog technologies such as polymers and nanostructures. The fiscal year 2006 request of $75.0 million for photovoltaic energy systems includes $31.4 million for critical laboratory research, $28.6 million for advanced materials and devices, and $15.0 million for technology development efforts to improve reliability of the entire system. The Department has included $4.5 million in the fiscal year 2006 request to support the new Collaborative Crystalline Silicon Photovoltaic Initiative designed to strengthen through research and development the technological competitiveness of U.S. products in a rapidly growing world market.

The $6.0 million request for concentrating solar power research includes funds to accelerate the development of next-generation parabolic trough concentrators and receivers. Development of advanced thermal energy storage technologies will continue and field validation will be conducted on new collector technology being de-

ployed in trough projects in Arizona and Nevada. For distributed applications, research in fiscal year 2006 will focus on improving the reliability of dish systems through the operation and testing of multiple units at Sandia National Laboratory. Technical support will also be provided to the Western Governors' Association to assist their CSP deployment activities.

WIND AND HYDROPOWER TECHNOLOGIES

Wind Energy research and development promotes greater use of the Nation's fastest growing energy resource. Since 2000, installed wind turbine capacity in the United States has more than doubled, driven in large part by the tremendous reductions in cost that have resulted from wind energy research. Our research contributed to reducing the cost of electricity generation by a factor of 20 since 1982, to 4 cents or less per kilowatt-hour in areas with excellent wind resources.

The Fiscal Year 2006 Budget Request for Wind Energy is $44.2 million, $3.4 million more than the fiscal year 2005 comparable appropriation. Most of the fiscal year 2006 request is to fund R&D on multiple large wind system technology pathways in lower wind speed areas to achieve the goal of 3 cents per kilowatt-hour for onshore systems and 5 cents per kilowatt-hour for off-shore systems by 2012. Working in collaborative partnerships with industry, the Department plans to complete field testing of the first full-scale Low Wind Speed Technology prototype turbine in fiscal year 2006, and begin fabrication of a second prototype turbine (both 2.5 MW scale) which will enable electricity to be generated closer to where people live.

Hydropower is the most widely used form of renewable energy in the world today, accounting for over 7 percent of total electricity generation in the United States and over 75 percent of domestic renewable electricity generation. The Department has supported the development of new turbine technology that reduces fish mortality associated with hydropower plant operation. With the completion of testing on new turbine technologies, and consistent with previous Congressional direction, the Department plans to close out the Hydropower Program and transfer remaining program activities and information to the private sector.

The fiscal year 2006 hydropower request of $0.5 million will be used to complete the monitoring of plant operation and maintenance, and document previous program activities. Outstanding contracts will be closed out in fiscal year 2006.

GEOTHERMAL TECHNOLOGY

The Geothermal Technologies Program works in partnership with industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. Currently a $1.3 billion a year industry, geothermal energy production generates electricity or provides heat for applications such as aquaculture, crop drying, and district heating, or for use in heat pumps to heat and cool buildings without the emission of greenhouse gases. The Fiscal Year 2006 Budget Request for Geothermal Technologies is $23.3 million, a $2.0 million decrease from the fiscal year 2005 comparable appropriation. The fiscal year 2005 appropriation included $3.6 million in funds for congressionally-directed activities now completed.

In fiscal year 2006, the program will conduct extensive field tests of exploration technologies such as remote sensing techniques to increase the U.S. geothermal resource base, and expand and accelerate the geothermal resource assessments conducted in collaboration with the U.S. Geological Survey. The program will continue its Enhanced Geothermal Systems (EGS) technology research to increase the productivity and lifetime of engineered reservoirs. The Department estimates that EGS technology could quadruple the amount of economically and technically viable geothermal resources in the West and open up new geothermal possibilities throughout the United States.

BIOMASS AND BIOREFINERY SYSTEMS R&D

EERE's Biomass Program focuses on advanced technologies to transform the Nation's domestic biomass resources into high value fuels, chemicals, materials, and power. Working with the U.S. Department of Agriculture (USDA), the program leads a multi-agency initiative that coordinates and accelerates all Federal bioenergy R&D in accordance with the Biomass Research and Development Act of 2000.

In fiscal year 2006, the Department is requesting $72.2 million for Biomass Program activities, $15.9 million less than the fiscal year 2005 comparable appropriation. Last year's appropriation, however, included $35.3 million in funds for congressionally-directed activities for which the Department is not requesting additional funds.

The Department requests $43.4 million to support platforms R&D. The $15 million request for Thermochemical Platform R&D will focus on developing technologies for the production, cleanup, and conditioning of biomass syngas and pyrolysis oils suitable for conversion to fuels and chemicals. This will be done in collaboration with industrial partners selected under a joint DOE/USDA solicitation issued in fiscal year 2004. The $28.4 million requested for Bioconversion Platform R&D is to work with industry to improve the performance and reduce the costs of enzymes and biomass pretreatment, resulting in a low cost sugar stream in support of the nearerterm biorefinery.

The request also includes $21.8 million for cost-shared R&D with U.S. industry to advance technologies that will convert this low cost sugar stream into affordable products (chemicals and materials), furthering the development of efficient biorefineries. Work with industry, universities, and the National Laboratories will focus on improving the efficiency of individual process steps such as catalysis and separations, with a focus on producing key building-block chemicals that have the potential to result in a multitude of high-value, renewable chemicals and materials.

WEATHERIZATION AND INTERGOVERNMENTAL PROGRAMS

In fiscal year 2006, we are requesting $310.1 million for Weatherization and Intergovernmental Activities, a $15.7 million reduction from the fiscal year 2005 comparable appropriation. This includes $230 million for the Weatherization Assistance Program, which will support weatherization of approximately 92,300 low-income homes, saving the low-income homeowner an average of $274 annually on their energy bills at today's prices, according to estimates by the Oak Ridge National Laboratory.

The Department's Intergovernmental activities promote rapid deployment of clean energy technologies and energy efficient products. The Fiscal Year 2006 Budget requests $41.0 million for State Energy Program grants. These grants, and the funds they leverage, allow State governments to target their own high priority energy needs and expand clean energy choices for their citizens and businesses.

In fiscal year 2006, we request $4.0 million for the Tribal Energy Program which will enable the Department to continue to build partnerships with Tribal governments to assess Native American energy efficiency needs and renewable energy opportunities for residential, commercial, and industrial uses. These activities are helping to complete the foundational work that will encourage private sector investment in energy projects on Native American lands.

The Department includes an increase of $1.7 million in its fiscal year 2006 request to expand and support Home Performance with ENERGY STAR®, an innovative residential program designed to improve the energy efficiency of existing homes by up to 30 percent using certified local contractors to perform whole-house retrofits. State and local pilot projects will be supported at the national level by the dissemination of best practices, contractor training, program design assistance, and marketing support.

DISTRIBUTED ENERGY RESOURCES

By producing electricity where it is used, distributed energy technologies can strengthen our Nation's aging electricity power infrastructure, relieve congestion on transmission and distribution systems, and increase supplies during periods of peak demand. The Distributed Energy Program seeks to develop and deploy a diverse array of integrated distributed generation and thermal energy technologies that are competitively priced, reliable, and highly efficient. The Fiscal Year 2006 Budget Request for this program is $56.6 million, a $3.8 million reduction from the fiscal year 2005 comparable appropriation. This funding level reflects the reallocation of funds given the advances made in previous years and changes within the overall energy research and development portfolio. As in previous years, this year's request emphasizes integrated designs for end-use systems.

Key performance target goals for fiscal year 2006 include the development of a combined heat and power (CHP) system which operates at over 70 percent efficiency and a prototype microturbine which can achieve 35 percent efficiency for small-scale power generation. To help potential users take better advantage of distributed energy opportunities, the program will complete a State regulatory database including information on regulations such as environmental permitting, utility tariffs, and interconnection standards, and continue funding the eight Regional Combined Heat and Power Application Centers across the United States.

BUILDING TECHNOLOGIES

With an annual price tag of over $250 billion, energy use by residential and commercial buildings accounts for nearly 40 percent of the Nation's total energy consumption, including two-thirds of the electricity sold in the United States. The $58 million included in this year's request for the Building Technologies Program is a decrease of $7.5 million from the fiscal year 2005 comparable appropriation, primarily due to reductions in space conditioning and building envelope R&D that is nearing commercialization. Fiscal year 2006 activities include solid state lighting, improved energy efficiency of other building components and equipment, and their effective integration using whole-building-system-design techniques, and the development of codes and standards for buildings, appliances, and equipment.

The $18.3 million request for Residential Buildings Integration aims to develop design packages that enable residential buildings to use 40 to 50 percent less energy than current practice, and integrate renewable energy systems into highly efficient building designs and operations in working toward the ultimate goal in 2020 of net Zero Energy Buildings: houses that produce as much energy as they use on an annual basis.

As part of the Department's focus on longer-term, high-risk activities with great potential for public benefit, in fiscal year 2006 we are requesting $11 million for solid state lighting research. Solid state lighting holds the potential to more than double the efficiency of general lighting systems, revolutionizing the energy efficiency, appearance, visual comfort, and quality of lighting products.

The fiscal year 2006 request also reflects the Department's continued commitment to advancing buildings codes and appliance standards. Because key analyses and peer reviews for several priority appliance rulemakings will be completed in fiscal year 2005, funding requirements for fiscal year 2006 will be reduced in this area.

FEDERAL ENERGY MANAGEMENT PROGRAM

The Federal Energy Management Program (FEMP) and the Departmental Energy Management Program (DEMP) assist Federal agencies and the Department in increasing their use of energy efficiency and renewable energy technologies through alternative financing contract support, technical assistance, and funding for retrofit projects. By using existing energy efficiency and renewable energy technologies and techniques, the Federal Government can set an example and lead the Nation toward becoming a cleaner, more efficient energy consumer.

FEMP's fiscal year 2006 request is $19.2 million, a $0.7 million reduction from the fiscal year 2005 comparable appropriation. We are requesting $6.8 million for FEMP technical support that promotes agency use of alternative financing tools, which allow Federal agencies to access private sector financing to fund energy improvements through Energy Savings Performance Contracts (ESPC) and Utility Energy Service Contracts (UESC) at no net cost to taxpayers. In addition, we are requesting $7.7 million for Technical Guidance and Assistance activities to help Federal energy managers identify, design, and implement new construction and facility improvement projects that incorporate energy efficiency and renewable energy.

INDUSTRIAL TECHNOLOGIES

The Industrial Technologies Program seeks to reduce the energy intensity of the U.S. industrial sector through a coordinated program of R&D, validation, and dissemination of energy-efficiency technologies and operating practices. The Department is working to achieve the program's goals by partnering with domestic industry, its equipment manufacturers, and its many stakeholders.

The Fiscal Year 2006 Budget Request is $56.5 million, an $18.3 reduction from the fiscal year 2005 comparable appropriation. We strongly believe that this level of funding is sufficient because the Industrial Technologies Program is becoming more focused and more strategic in its investments in next-generation industrial technologies. The Program's strategic approach is based on developing a focused, multi-year plan that is designed to identify a limited number of high-priority, energy-saving research and development opportunities, characterize the technical barriers associated with each of those opportunities, and implement a multi-year development pathway to achieve success in each identified focus area. Many of these R&D efforts will be in exploratory phases in fiscal year 2006 as the program identifies the most promising technology areas and adopts a balanced portfolio of high-risk, high-return R&D.

PROGRAM MANAGEMENT AND DIRECTION

The Program Management (Energy Conservation) and Program Direction (Energy Supply) budgets provide resources for executive and technical direction and oversight required for the implementation of EERE programs. The Budget Request covers Federal staff as well as the equipment, supplies, materials, information systems, technology equipment, and travel required to support management and oversight of programs. Also funded by this request are properties; public information activities; support service contractors; and crosscutting performance evaluation, analysis and planning.

The Fiscal Year 2006 Budget requests for Program Management and Program Direction total $108.1 million, representing a $4.0 million (3.6 percent) decrease from the fiscal year 2005 comparable appropriations. The decrease primarily reflects completion of the National Academy of Science review, the absence of support for prior congressionally-directed activities, and the movement of support service funding for the Climate Change Technology Program out of this request. With these activities excluded, our request actually represents an increase of $4.9 million to support our efforts to improve project management and to more accurately report our true cost of doing business. We also request $2.9 million within Renewable Program Support for crosscutting analysis and planning, which was formerly funded within individual renewable program budgets.

CONCLUSION

Mr. Chairman, we believe the administration's Fiscal Year 2006 Budget for energy efficiency and renewable energy research, development, demonstration, and deployment programs will contribute to improved energy security by promoting a diverse supply of reliable, affordable, and environmentally sound energy, and by promoting the efficient use of energy.

This completes my prepared statement, and I am happy to answer any questions the subcommittee may have.

Senator DOMENICI. Thank you very much. Dr. Orbach, will you please abbreviate your statement, and we'll ask you some questions shortly.

OFFICE OF SCIENCE

STATEMENT OF RAYMOND L. ORBACH, DIRECTOR

Dr. ORBACH. Mr. Chairman, Senator Allard, thank you for giving me this opportunity to testify on the President's fiscal year 2006 budget request for the Office of Science.

Mr. Chairman, you have laid out the major new initiatives that the 2006 budget contains. The budget is premised upon the maintenance of U.S. scientific leadership, of increased present and future research opportunities. In order to achieve this goal, difficult decisions had to be made within this budget climate, prioritizing core research funding, and facility construction and operation. The result augers well for U.S. science and scientists.

This budget enables a breathtaking array of scientific initiatives and opportunities. There are costs working within the current budget climate, but they are balanced against the opportunities essential for continued U.S. scientific primacy.

The Office of Science is committed to providing basic research support for the missions of the Department of Energy, leading to energy security for our country. Our programs contribute substantially to our Nation's economic development, to enhancing scientific literacy, and to our society's intellectual growth and excitement through scientific discovery. I believe this budget will accomplish these goals.

Mr. Chairman, I'd like to thank you again for this opportunity to discuss the work of the Office of Science, and I would be pleased to answer your questions.

[The statement follows:]

PREPARED STATEMENT OF RAYMOND L. ORBACH

Mr. Chairman and members of the subcommittee, thank you for the opportunity to testify today about the Office of Science's fiscal year 2006 budget request. I am deeply appreciative of your support for basic research, Mr. Chairman, and the support we have received from the other members of this subcommittee. I am confident that our fiscal year 2006 request represents a sound investment in our Nation's future. Through this budget we will position the Office of Science to be ready for the opportunities of the next decade.

This budget, Mr. Chairman, will enable thousands of researchers located across our Nation to work on some of the most pressing scientific challenges of our age. These researchers will demonstrate the scientific and technological feasibility of creating and controlling a sustained burning plasma to generate energy through participation in ITER (Latin for the way, ITER is an international fusion collaboration); use advanced computation and modeling tools to resolve complex scientific problems; restore U.S. leadership in neutron science with the start of operations at the Spallation Neutron Source (SNS); expand the frontier of nanotechnology through operation of Nanoscale Science Research Centers (NSRC's); pursue an understanding of how the universe began; contribute to our understanding of climate change including the potential of carbon sequestration; develop the knowledge that may enable us to harness microbes and microbial communities to improve energy production and environmental remediation; and contribute basic research that underpins the President's Hydrogen Fuel Initiative.

The Office of Science requests $3,462,718,000 for the fiscal year 2006 science appropriation, a decrease of $136,828,000 from the fiscal year 2005 appropriation, for investments in basic research that are critical to the success of Department of Energy (DOE) missions in national security and energy security; advancement of the frontiers of knowledge in the physical sciences and areas of biological, environmental, and computational sciences; and provision of world-class research facilities for the Nation's science enterprise (see Figure 1).

The Office of Science, within a period of budget stringency, has chosen its priorities so that the United States will continue its world primacy in science. We have made the hard decisions that will enable our scientists to work on the finest machines whose scale and magnitude will give them opportunities not found elsewhere. As a consequence, we have made difficult choices. But these have been taken with one end in mind: the Office of Science will support a world-class program in science and energy security research with this budget.

This budget request supports the following programs: Basic Energy Sciences, Advanced Scientific Computing Research, Biological and Environmental Research, High Energy Physics, Nuclear Physics, Fusion Energy Sciences, Science Laboratories Infrastructure, Science Program Direction, Workforce Development for Teachers and Scientists, and Safeguards and Security.

The Office of Science supports research across the scientific spectrum from high energy physics to biology and environmental research; from fusion energy sciences to nuclear physics, from basic energy sciences to advanced scientific computation research. We provide 42 percent of the Federal funding for the physical sciences in the United States, and are the stewards of support for fields such as high energy physics, plasma physics, catalysis, and nuclear physics. We build and operate the large scientific facilities used by over 19,000 faculty, students, and postdocs each year. They include synchrotron light sources, neutron sources, high energy and nuclear physics accelerators, fusion energy experiments, dedicated scientific computing resources, specialized environmental research capabilities, the Production Genome Facility, and will soon include the SNS, five NSRCs, and an X-ray free electron laser light source. Roughly half of our budget goes to the construction and operation of these facilities; the other half is split, roughly equally, between research at the DOE laboratories and research at universities. This supports the research of approximately 23,500 students, postdocs, and faculty throughout our Nation.

FIGURE 1.—OFFICE OF SCIENCE FISCAL YEAR 2006 PRESIDENT'S REQUEST

[In thousands of dollars]

	Fiscal Year 2004 Comparable Approp.	Fiscal Year 2005 Comparable Approp.	Fiscal Year 2006 President's Request
Basic Energy Sciences	991,262	1,104,632	1,146,017
Advanced Scientific Computing Research	196,795	232,468	207,055
Biological and Environmental Research	624,048	581,912	455,688
(Congressionally-directed projects)	(136,798)	(79,608)	.....
(Core Biological and Environmental Research)	(487,250)	(502,304)	(455,688)
High Energy Physics	716,170	736,444	713,933
Nuclear Physics	379,792	404,778	370,741
Fusion Energy Sciences	255,859	273,903	290,550
Science Laboratories Infrastructure	55,266	41,998	40,105
Science Program Direction	150,277	153,706	162,725
Workforce Development for Teachers and Scientists	6,432	7,599	7,192
Safeguards and Security	56,730	67,168	68,712
Small Business Innovation Research/Technology Transfer	114,915	.....	.....
Subtotal, Science	3,547,546	3,604,608	3,462,718
Use of prior year balances	−11,173	−5,062	.....
Total Science	3,536,373	3,599,546	3,462,718
(Total, excluding Congressionally-directed projects)	(3,399,575)	(3,519,938)	(3,462,718)

FISCAL YEAR 2006 SCIENCE PRIORITIES

In his testimony before the House Science Committee, the President's Science Adviser, Dr. Jack Marburger indicated, "Making choices is difficult even when budgets are generous. But tight budgets have the virtue of focusing on priorities and strengthening program management. This year's R&D budget proposal maintains levels of funding that allow America to maintain its leadership position in science and move ahead in selected priority areas."

The priorities the Office of Science has set within the overall Federal R&D effort and in support of DOE's mission are clear: Through the fiscal year 2006 budget, we will fully support Presidential initiatives in fusion and hydrogen; we will continue strong support for other administration priorities such as nanotechnology and information technology; we will complete—on time and within budget—unique scientific facilities that will maintain and enhance research in areas we believe offer the greatest potential for broad advances in future energy technologies. These scientific facilities were prioritized in our 20-year facilities outlook, announced in November 2003.

We will continue moving ahead with our contributions to the President's Hydrogen Fuel Initiative. We are supporting U.S. participation in the ITER project to pursue the potential of energy from fusion.

One of the biggest science stories of the year 2006 will be the start-up of the Spallation Neutron Source at our Oak Ridge National Lab, which will provide the most intense—by an order of magnitude—neutron beam in the world for cutting-edge research.

The fiscal year 2006 budget will also bring four of our five nanoscale science research centers on line, providing tools found nowhere else in the world for exploration at the atomic level, offering huge potential for the discovery of entirely new ways to build materials.

We are fully funding construction of the Linac Coherent Light Source at the Stanford Linear Accelerator Center, a machine that will produce X-rays 10 billion times brighter than any existing X-ray source on Earth. When it comes on line in 2009, it essentially will allow stop-action photography of atomic motion. Just ask the pharmaceutical industry what they could do with a machine that shows them how the chemical bond forms during a chemical reaction.

The Office of Science also will fully fund the National Energy Research Scientific Computing Center, a key center for capacity supercomputing used by roughly 2,000 researchers every year, and a separate open-access leadership class computing facility at Oak Ridge, focused on providing the capability to carry out a limited number of massive simulations not possible on any other civilian supercomputer in the United States.

The Department will also expand research underpinning biotechnology solutions to the world's energy challenges and research supporting the President's climate change science program.

Our research programs in high energy physics continue to receive strong support. We have increased funding for future accelerators such as the Large Hadron Collider, scheduled to begin operation in 2007, and the proposed International Linear Collider, which is now in an early R&D phase. Our nuclear physics program will continue to offer world-class facilities for use by thousands of researchers from around the world.

SCIENCE ACCOMPLISHMENTS

The Office of Science has proven its ability to deliver results over the past 50 years. That legacy includes 70 Office of Science sponsored Nobel Laureates since 1954. Our science has spawned entire new industries, including nuclear medicine technologies that save thousands of lives each year, and the nuclear power industry that now contributes 20 percent of the power to our Nation's electricity grid. It has also changed the way we see the universe and ourselves; for example—by identifying the ubiquitous and mysterious "dark energy" that is accelerating the expansion of the universe and by sequencing the human genome. The Office of Science has taken the lead on new research challenges, such as bringing the power of terascale computing to scientific discovery and industrial competitiveness. The Nation's investment in SC's basic research programs continues to pay dividends to the American taxpayer. Some of the past year's highlights include:

—*Promoting Science Literacy and Fostering the Next Generation of DOE Scientists*.—In fiscal year 2004, DOE launched a seven-part program named STARS: Scientists Teaching and Reaching Students. This program is designed to enhance the training of America's mathematics and science teachers; boost student achievement in science and math, especially in the critical middle school years; and draw attention to the women and men who have done DOE science so very well—and thereby encourage young people and prospective teachers to pursue careers in math and science. STARS is a critical step in leveraging the resources of DOE—and of all our national laboratories—to help create a new generation of scientists who will achieve the scientific breakthroughs and technological advances so essential to our future security and prosperity.

—*Nobel Prize in Physics*.—The 2004 Nobel Prize in physics was awarded to David J. Gross (Kavli Institute, UC Santa Barbara), H. David Politzer (Caltech), and Frank Wilczek (MIT) for their discovery of "asymptotic freedom" in the strong force. What they discovered was a surprising fact: as fundamental particles get closer to each other, the strong force between them grows weaker, and the further apart they are, the stronger it is, like stretching a rubber band. This discovery is a key component of the very successful Standard Model of particle physics, which describes three of the four fundamental forces of nature: electromagnetic, weak, and strong. Physicists dream of extending the theory to include the fourth fundamental force, gravity. The Office of Science has supported the research of Wilczek since the 1980's at Princeton and the Massachusetts Institute of Technology (MIT) and has supported Politzer at Caltech from the 1970's.

—*Nobel Prize in Physics*.—The 2003 Nobel Prize for Physics was shared by Argonne National Laboratory (ANL) researcher Alexei A. Abrikosov for his pioneering contributions to the theory of superconductors. The Office of Science has long supported Abrikosov's work on the mechanisms of high temperature superconductivity. Amongst the myriad applications of superconducting materials are the magnets used for magnetic resonance imaging, or MRI, and potential applications in high efficiency electricity transmission and high-speed trains.

—*New Physics Emerges From Quark-Gluon Plasma*.—In 2004, the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory (BNL) delivered gold beams at twice the accelerator design limits and greatly exceeded the expectations of the 1,000+ international physicists working on the four experiments at RHIC. The goal of RHIC is to recreate the predicted quark-gluon plasma, an extremely dense state of matter thought to have last existed microseconds after the Big Bang. RHIC data have revealed evidence of a quark-gluon state of matter at high density and temperature, exhibiting the properties of a highly correlated liquid—something new and unexpected—as well as indications of a dense, weakly interacting gluonic matter that has been called a "Color Glass Condensate"—again something new.

—*Wide Acceptance of Open-Source, High-End Cluster Software by Industry and Users*.—The Oak Ridge National Laboratory (ORNL) Open Source Cluster Ap-

plication Resources (OSCAR) computing software for high-end computing continues to expand its capability and to increase its user base. The software has been downloaded by more than 130,000 groups around the world and is promoted by vendors such as Dell and Intel. The adoption of this system has expanded the number of software packages available to the cluster community, and continues to reduce cluster total cost of ownership. It has simplified the job of software authors, system administrators, and ultimately the application user by providing a timely and much simpler method of supplying and applying software updates. The Scientific Discovery through Advanced Computing (SciDAC) Scalable Systems Software Integrated Software Infrastructure Center leverages OSCAR technology to simplify deployment for the end-user as well as application developers.

—*Advances in Fusion Energy Sciences Contribute to ITER*.—Efficient burning of the fusion's plasma fuel, a mixture of hydrogen isotopes, requires stably confining the plasma at temperatures of 50–100 million degrees, comparable to those found on the Sun, with magnetic fields designed to hold the plasma in place. Recent application of diagnostics that can measure the magnetic fields deep inside this highly energetic plasma with great precision and advanced computer codes that can model the detailed behavior of the plasma has given scientists unprecedented control over the behavior of the plasma. Experiments on the DIII–D tokamak have led the way in prototyping future experiments on ITER. Scientists are now able to use feedback control systems to confidently operate the plasma at pressures which optimize the fusion power output within a given magnetic field. In addition, experiments and the use of massively parallel computing to benchmark models that validate a whole new theoretical understanding of how plasmas can be insulated from loss of particles and energy give confidence that ITER can achieve the needed gain of 10 (50 Megawatts of heating, 500 Megawatts of fusion power production) required to enter the burning plasma regime.

—*Using DOE Technology and Know-how to Bring Sight to the Blind*.—DOE's artificial retina project is a model for success in an era when the boundaries of scientific disciplines, public and private sector roles in science, and Federal agency responsibilities are increasingly blurred. Success has come through the strength of partnerships between scientists in the public and private sectors, spanning scientific disciplines from materials to medicine to engineering to surgery, and with funds from both DOE and the National Institutes of Health (NIH). In June 2004, the project reached a major milestone as a sixth blind patient was successfully implanted with an artificial retina device. One patient has had the device since February 2002. All six patients can now read large letters (2-foot large letters 1 foot away) as well as tell the difference between a paper cup, a plate, and a plastic knife. The patients can also see colors although learning and understanding this process is still a challenge for both patients and scientists. Patients will soon begin using their retinal implants outside the laboratory and will even be able to use them alone at home. These initial patient studies are a key part of a Food and Drug Administration Investigational Device Exemption trial.

—*Record Operations Advance Physics at the Frontier*.—Both the Fermi National Accelerator Laboratory (Fermilab) and the Stanford Linear Accelerator Center (SLAC) set significant new records in data delivery ("luminosity") in 2004, with the accelerators at each of these centers more than doubling their outstanding performance levels from 2003. On Friday, July 16, the Tevatron proton-antiproton collider at Fermilab set a new luminosity record of 1×10^{32} cm^{-2} sec^{-1}. The use of the Recycler and Accumulator together to maximize the number of antiprotons available for collisions helped to set the new record. Since January 2004, the peak luminosity of the Tevatron has increased 100 percent. The fiscal year 2004 PEP–II/Babar run at SLAC ended as scheduled on July 31, setting new performance records. Since the SLAC facility for B meson research began operations in 1999, its accumulated total number of electron-positron collisions (integrated luminosity) has steadily increased to a level about five times higher than the design performance.

PROGRAM OBJECTIVES AND PERFORMANCE

Underpinning all of SC's programs is a fundamental quest for knowledge. Our program history provides a compelling story of how this knowledge has already shaped the world around us, and the future appears even more promising.

DOE's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and the environment) and seven subordinate general goals. The Office of

Science supports the Science Goals. Detailing Office of Science contributions to DOE's Science goals are 27 annual performance goals. Progress toward the annual goals is tracked quarterly through the Department's Joule system and reported to the public annually through the Department's Performance and Accountability Report (PAR).

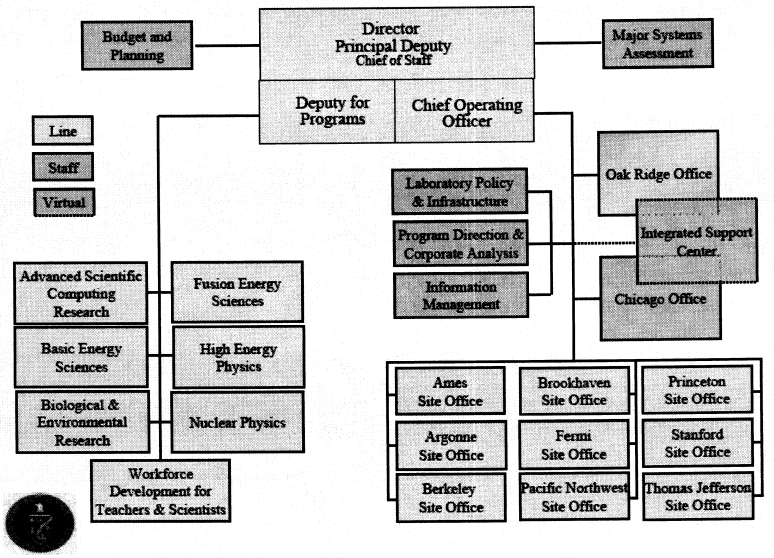
The one Office of Science annual performance goal that was not met in fiscal year 2004 was: "Focus usage of the primary supercomputer at the NERSC on capability computing. 50 percent of the computing time used will be accounted for by computations that require at least one-eighth of the total resource." The allocation process for NERSC resources is based on the potential scientific impact of the work, rather than on how well the work scales to large numbers of processors. When we proposed this measure we did not understand the extent to which users who run large jobs also run small jobs. It is critical for users to be able to run their software at both scales on the same computer because it significantly simplifies their software management. Therefore we are reducing the percentage of time dedicated to large jobs at NERSC to 40 percent. In addition, we have tasked the NERSC Users Group to develop science-based measures to better assess NERSC performance.

As a basic research program, the meaning and impact of our performance goals may not always be clear to those outside the research community. The Office of Science has created a website (www.sc.doe.gov/measures) to better communicate what we are measuring and why it is important. We are committed to improving our performance information and will soon be expanding the information included on the website and simplifying the interface so that the program objectives and results will be accessible to a wide audience.

ORGANIZATION

The OneSC Project was initiated to streamline the Office of Science structure and improve operations across the Office of Science complex in keeping with the principles of the President's Management Agenda. The first phase of this multiphase effort is now complete and we have realigned the Office of Science organization structure to establish a clear set of integrated roles and responsibilities for all Headquarters (HQ) and Field elements (Figure 2). Policy direction, scientific program development and management functions were defined as HQ responsibilities. Program execution, implementation, and support functions were defined as Field responsibilities. The major structural change implemented is the removal of a layer of management from the Office of Science Field structure, in effect removing the layer that existed between the Office of Science Director and the Site Office Managers located at Office of Science laboratories. In addition, the Chicago Office will now serve as the personnel office for Office of Science employees in HQ. The second phase of the OneSC initiative will entail a reengineering of our business processes and is in the preliminary stages of development.

FIGURE 2



SCIENCE PROGRAMS

BASIC ENERGY SCIENCES

Fiscal Year 2005 Comparable Appropriation—$1,104.6 Million; Fiscal Year 2006 Request—$1,146.0 Million

The Basic Energy Sciences (BES) program advances nanoscale science through atomic- and molecular-level studies in materials sciences and engineering, chemistry, geosciences, and energy biosciences. BES also provides the Nation's researchers with world-class research facilities, including reactor- and accelerator-based neutron sources, light sources soon to include the X-ray free electron laser, nanoscale science research centers, and micro-characterization centers. These facilities provide outstanding capabilities for imaging and characterizing materials of all kinds from metals, alloys, and ceramics to fragile biological samples. The next steps in the characterization and the ultimate control of materials properties and chemical reactivity are to improve spatial resolution of imaging techniques; to enable a wide variety of samples, sample sizes, and sample environments to be used in imaging experiments; and to make measurements on very short time scales, comparable to the time of a chemical reaction or the formation of a chemical bond. With these tools, we will be able to understand how the composition of materials affects their properties, to watch proteins fold, to see chemical reactions, and to understand and observe the nature of the chemical bond. Theory, modeling, and computer simulations will also play a major role in achieving these outcomes and will be a companion to experimental work. Also supported is basic research aimed at advancing hydrogen production, storage, and use for the coming hydrogen economy.

Fiscal year 2006 will mark the completion of construction and the initial operation of the Spallation Neutron Source (SNS). The SNS will be significantly more powerful (by about a factor of 10) than the best spallation neutron source now in existence—ISIS at the Rutherford Laboratory in England. We estimate the facility will be used by 1,000–2,000 scientists and engineers annually from academia, national and Federal labs, and industry for basic and applied research and for technology development. The high neutron flux (i.e., high neutron intensity) from the SNS will enable broad classes of experiments that cannot be done with today's low flux sources. For example, high flux enables studies of small samples, complex molecules and structures, time-dependent phenomena, and very weak interactions. The fiscal year 2006 budget authority request completes funding for the SNS Project. This will

involve procurement and installation of equipment for instrument systems, completion of an accelerator readiness review, commissioning of ring and target systems, and meeting all requirements to begin operations; and all SNS facilities will be turned over to operations. The estimated Total Project Cost remains constant at $1,411,700,000.

Operations will begin in fiscal year 2006 at four of the five NSRCs: the Center for Nanophase Materials at ORNL, the Molecular Foundry at Lawrence Berkeley National Laboratory (LBNL), the Center for Integrated Nanotechnologies at Sandia National Laboratories/Los Alamos National Laboratory (SNL/LANL), and the Center for Nanoscale Materials at ANL. The exception is the Center for Functional Nanomaterials at BNL, which is scheduled to begin operations in fiscal year 2008. The NSRC's are user facilities for the synthesis, processing, fabrication, and analysis of materials at the nanoscale. They are designed to promote rapid advances in the various areas of nanoscale science and technology and are part of the DOE contribution to the National Nanotechnology Initiative. The NSRC's are sited adjacent to or near existing BES synchrotron or neutron scattering facilities to enable rapid characterization of newly fabricated materials. Fiscal year 2006 funds are requested for construction of NSRC's located at LBNL, at SNL/LANL, and at BNL. Funds are also requested to complete the Major Item of Equipment (MIE) for the NSRC at ANL.

The Linac Coherent Light Source (LCLS) will continue Project Engineering Design (PED) and fiscal year 2006 budget authority is requested to initiate physical construction of the LCLS conventional facilities. Funding will be provided separately for preconceptual design of instruments for the facility. BES funding will also be provided to partially support, in conjunction with the High Energy Physics program, operation of the SLAC linac. This will mark the beginning of the transition to LCLS operations at SLAC. The LCLS project will provide the world's first demonstration of an X-ray free-electron-laser (FEL) in the 1.5–15Å (angstrom) range, 10 billion times greater in peak power and peak brightness than any existing coherent X-ray light source, and that has pulse lengths measured in femtoseconds, the timescale of electronic and atomic motions. The advance in brightness is similar to that of a synchrotron over a 1960's laboratory X-ray tube. Synchrotrons have revolutionized science across disciplines ranging from atomic physics to structural biology. Advances from the LCLS are expected to be even more dramatic. The LCLS project leverages capital investments in the existing SLAC linac as well as technologies developed for linear colliders and for the production of intense electron beams with radio-frequency photocathode guns. The availability of the SLAC linac for the LCLS project creates a unique opportunity for demonstration and use of X-ray FEL radiation. The estimated Total Project Cost is $379,000,000.

The fiscal year 2006 budget supports a Major Item of Equipment (MIE) for the Transmission Electron Aberration-corrected Microscope (TEAM). The Total Project Cost is in the range of $25,000,000 to $30,000,000. The TEAM project will construct and operate a new aberration-corrected electron microscope for materials and nanoscience research. The projected improvement in spatial resolution, contrast, sensitivity, and flexibility of design of electron optical instruments will provide unprecedented opportunities to observe directly the atomic-scale order, electronic structure, and dynamics of individual nanoscale structures.

Research to realize the potential of a hydrogen economy will be increased from $29,183,000 to $32,500,000. This research program is based on the BES workshop report Basic Research Needs for the Hydrogen Economy. The 2003 report highlights the enormous gap between our present capabilities for hydrogen production, storage, and use and those required for a competitive hydrogen economy. To be economically competitive with the present fossil fuel economy, the cost of fuel cells must be lowered by a factor of five and the cost of producing hydrogen must be lowered by a factor of four. Moreover, the performance and reliability of hydrogen technology for transportation and other uses must be improved dramatically. Simple incremental advances in the present state-of-the-art cannot bridge this gap. Narrowing the gap significantly is the goal of a comprehensive, long-range program of innovative high-risk/high-payoff basic research that is intimately coupled to and coordinated with the DOE's applied programs.

In order to accomplish these very high-priority, forefront activities, some difficult choices had to be made. In particular, the BES support for the Radiochemical Engineering and Development Center at ORNL will be terminated. The operations budgets of the remaining facilities will be at about the same level as in fiscal year 2005, decreasing available beam time and service for users. Core funding for university and national laboratory researchers decreases 7.8 percent compared to the fiscal year 2005 appropriation. While no research activities will be terminated, there will be reductions throughout.

ADVANCED SCIENTIFIC COMPUTING RESEARCH

Fiscal Year 2005 Comparable Appropriation—$232.5 Million; Fiscal Year 2006 Request—$207.1 Million

The Advanced Scientific Computing Research (ASCR) program significantly advances scientific simulation and computation, applying new approaches, algorithms, and software and hardware combinations to address the critical science challenges of the future. ASCR also provides access to world-class scientific computation and networking facilities to the Nation's scientific community to support advancements in practically every field of science. ASCR will continue to advance the transformation of scientific simulation and computation into the third pillar of scientific discovery, enabling scientists to look inside an atom or across a galaxy; and inside a chemical reaction that takes a millionth of a billionth of a second or across a climate change process that lasts for a thousand years. In addition, ASCR will shrink the distance between scientists and the resources—experiments, data, and other scientists—they need, and accelerate scientific discovery by making interactions that used to take months happen on a much shorter timescale.

The Mathematical, Information, and Computational Sciences (MICS) effort is responsible for carrying out the primary mission of the ASCR program. In addition, MICS research underpins the success of SciDAC. MICS supports both basic research and the development of the results from this basic research into software usable by scientists in other disciplines. MICS also supports partnerships with scientific discipline users to test the usefulness of the research—facilitating the transfer of research and helping to define promising areas for future research. This integrated approach is critical for MICS to succeed in providing the extraordinary computational and communications tools that DOE's civilian programs need to carry out their missions.

Major elements of the ASCR portfolio related to the SciDAC will be re-competed in fiscal year 2006, with attention paid to support for the long term maintenance and support of software tools such as mathematical libraries, adaptive mesh refinement software, and scientific data management tools developed in the first 5 years of the effort. In addition, in fiscal year 2006 ASCR is changing the way in which it manages its Genomics: GTL partnership with the Biological and Environmental Research program. The management of these efforts will be integrated into the portfolio of successful SciDAC partnerships. The fiscal year 2006 budget request includes $7,500,000 for continued support of the Genomics: GTL research program. The fiscal year 2006 budget request also includes $2,600,000 for the Nanoscale Science, Engineering and Technology initiative led by BES, and $1,350,000 for support of the Fusion Simulation Project, led by the Fusion Energy Sciences program. ASCR's contributions to these partnerships will consist of advancing the mathematics and developing new mathematical algorithms to simulate biological systems and physical systems at the nanoscale. The fiscal year 2006 budget request also provides $8,000,000 to initiate a small number of competitively selected SciDAC institutes at universities which can become centers of excellence in high end computational science in areas that are critical to DOE missions.

The fiscal year 2006 budget also includes $8,500,000 to continue the "Atomic to Macroscopic Mathematics" (AMM) research support in applied mathematics needed to break through the current barriers in our understanding of complex physics processes that occur on a wide range of interacting length- and timescales. Achieving this basic mathematical understanding will provide enabling technology to virtually every challenging computational problem faced by SC.

The National Leadership Computing Facility acquired under the Next Generation Architecture (NGA) Leadership Class Computing Competition in fiscal year 2004 will be operated to provide high performance production capability to selected Office of Science researchers. The NGA effort will play a critical role in enabling Leadership Class Machines that could lead to solutions for scientific problems beyond what would be attainable through a continued simple extrapolation of current computational capabilities. NGA will continue its focus on research in operating systems and systems software and will initiate a new competition for Research and Evaluation Prototype Computer testbeds. ASCR research efforts in Collaboratory Tools and Pilots and Networking will be restructured into an integrated Distributed Network Environment activity focused on basic research in computer networks and the middleware needed to make these networks tools for science. This change will enable the reduced NGA effort to operate computers acquired in fiscal year 2004 and fiscal year 2005 at the ORNL Center for Computational Sciences (CCS) as tools for science and especially to satisfy the demand for resources that has resulted from the successful SciDAC efforts.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Fiscal Year 2005 Comparable Appropriation—$581.9 Million; Fiscal Year 2006 Request—$455.7 Million

The Biological and Environmental Research (BER) program advances energy-related biological and environmental research in genomics and our understanding of complete biological systems, such as microbes that produce hydrogen; develops models to predict climate over decades to centuries; develops science-based methods for cleaning up environmental contaminants; provides regulators with a stronger scientific basis for developing future radiation protection standards; and develops new diagnostic and therapeutic tools, technology for disease diagnosis and treatment, non-invasive medical imaging, and biomedical engineering such as an artificial retina that is restoring sight to the blind.

The fiscal year 2006 budget includes funds for the continued expansion of the Genomics: GTL program—a program at the forefront of the biological revolution. This program employs a systems approach to biology at the interface of the biological, physical, and computational sciences to address DOE's energy, environment, and national security mission needs. This research will continue to more fully characterize the inventory of multi-protein molecular machines found in selected DOE-relevant microbes and higher organisms. It will determine the diverse biochemical capabilities of microbes and microbial communities, especially as they relate to potential biological solutions to DOE needs, found in populations of microbes isolated from DOE-relevant sites. Support for Microbial Genomics research as a separate research activity is terminated to consolidate all microbial research within Genomics: GTL. Support of structural biology, human genome, and health effects research is also reduced to support GTL research. GTL research will provide the scientific community with knowledge, resources, and tools that benefit large numbers of research projects with positive impacts on more scientists and students than are negatively impacted by the initial reduction.

In 2003, the administration launched the Climate Change Research Initiative (CCRI) to focus research on areas where substantial progress in understanding and predicting climate change, including its causes and consequences, is possible over the next 5 years. In fiscal year 2006, BER will contribute to the CCRI from four programs: Terrestrial Carbon Processes, Climate Change Prediction, Atmospheric Radiation Measurement (ARM), and Integrated Assessment. Activities will be focused on (1) helping to resolve the magnitude and location of the North American carbon sink; (2) deploying and operating of a mobile ARM Cloud and Radiation Testbed facility to provide data on the effects of clouds and aerosols on the atmospheric radiation budget in regions and locations of opportunity where data are lacking or sparse; (3) using advanced climate models to simulate potential effects of natural and human-induced climate forcing on global and regional climate and the potential effects on climate of alternative options for mitigating increases in human forcing of climate; and (4) developing and evaluating assessment tools needed to study costs and benefits of potential strategies for reducing net carbon dioxide emissions.

The completion of the International Human Genome Project and the transition of BER's Human Genome research program from a human DNA sequencing program to a DNA sequencing user resource for the scientific community which focuses on the sequencing of scientifically important microbes, plants, and animals will bring BER's Human Genome Ethical, Legal, and Societal Issues (ELSI) program to an end. In fiscal year 2006, ELSI research will include activities applicable to Office of Science issues in biotechnology and nanotechnology such as environmental or human health concerns associated with Genomics: GTL or nanotechnology research. Research with these funds will be coordinated across the Office of Science.

BER will focus fiscal year 2006 research activities on higher priorities, including GTL and Climate Change Research, in support of DOE goals and objectives. Funding reductions are initiated in the Environmental Remediation Research subprogram and the Medical Applications and Measurement Science Research subprogram. Accordingly, some current research activities will be phased out in fiscal year 2005. Based on findings of the BER Committee of Visitors for the Environmental Remediation Research subprogram, research activities are integrated into a single program to increase the efficiency of the activities and to better address the BER long term goals in environmental remediation research.

HIGH ENERGY PHYSICS

Fiscal Year 2005 Comparable Appropriation—$736.4 Million; Fiscal Year 2006 Request—$713.9 Million

The High Energy Physics (HEP) program provides over 90 percent of the Federal support for the Nation's high energy physics research. This research advances our understanding of dark energy and dark matter, the lack of symmetry in the current universe, the basic constituents of matter, and the possible existence of other dimensions, collectively revealing key secrets of the universe. HEP expands the energy frontier with particle accelerators to study fundamental interactions at the highest possible energies, which may reveal new particles, new forces, or undiscovered dimensions of space and time; explain the origin of mass; and illuminate the pathway to the underlying simplicity of the universe. At the same time, the HEP program sheds new light on other mysteries of the cosmos, uncovering what holds galaxies together and what is pushing the universe apart; understanding why there is any matter in the universe at all; and exposing how the tiniest constituents of the universe may have the largest role in shaping its birth, growth, and ultimate fate.

The HEP program in fiscal year 2006 will continue to lead the world with forefront user facilities producing data that help answer key scientific questions, but these facilities will complete their scientific missions by the end of the decade. Thus, we have structured the fiscal year 2006 HEP program not only to maximize the scientific returns on our investment in these facilities, but also to invest in R&D now for the most promising new facilities that will come online in the next decade. This has required a prioritization of our current R&D efforts to select those which will provide the most compelling science within the available resources. In making these decisions we have seriously considered the recommendations of the High Energy Physics Advisory Panel (HEPAP) and planning studies produced by the U.S. HEP community. This prioritization process will continue as the R&D programs evolve.

Because of its broad relevance in addressing many of the long-term goals of HEP, and its unique potential for new discoveries, the highest priority is given to the planned operations, upgrades and infrastructure for the Tevatron program at Fermilab. This includes the completion of the upgrade to the Tevatron accelerator complex in 2007 to provide increased luminosity and additional computational resources to support analysis of the anticipated larger volume of data. Over the last few years, the laboratory has developed and implemented a detailed, resource-loaded plan for Tevatron operations and improvements, which has resulted in more reliable luminosity projections. The Office of Science has reviewed the plan and is actively engaged in tracking its progress.

The fiscal year 2006 request supports initial operations of the Neutrinos at the Main Injector (NuMI) project at Fermilab, which has just completed construction and will study the puzzling but fundamental physics of neutrino masses and mixings. The NuMI beam operates in parallel with the Tevatron, also at Fermilab, currently the highest energy accelerator in the world.

In order to fully exploit the unique opportunity to expand our understanding of the asymmetry of matter and antimatter in the universe, a high priority is given to the operations, upgrades and infrastructure for the B-factory at SLAC. Support for B-factory will include an allowance for increased power costs and fully funded upgrades for the accelerator and detector which are currently scheduled for completion in 2006. This includes the completion of the upgrade to the accelerator complex and BaBar detector to provide more data; additional computational resources to support analysis of the larger volume of data; and, increased infrastructure spending to improve reliability. Funding for SLAC operations includes support from the BES program for the LCLS project, marking the beginning of the transition of Linac operations from HEP to BES as B-factory operations are terminated by fiscal year 2008 at the latest.

As the Large Hadron Collider (LHC) accelerator in Europe nears its turn-on date of 2007, U.S. activities related to fabrication of detector components will be completed and new activities related to commissioning and pre-operations of these detectors, along with software and computing activities needed to analyze the data, will ramp-up significantly. Support of a leadership role for U.S. research groups in the LHC physics program will continue to be a high priority for the HEP program.

In order to explore the nature of dark energy, pre-conceptual R&D for potential interagency sponsored experiments with NASA will continue in fiscal year 2006. These experiments will provide important new information about the nature of dark energy and dark matter that will in turn lead to a better understanding of the birth, evolution and ultimate fate of the universe. At this time, no funding for a space-based DOE/NASA Joint Dark Energy Mission past the pre-conceptual stage has been identified.

The engineering design of the BTeV ("B Physics at the Tevatron") experiment, which was scheduled to begin in fiscal year 2005 as a new Major Item of Equipment, is cancelled. This is consistent with the guidance of HEPAP which rated BTeV as of lesser scientific potential than other projects, although still important scientifically and of the Particle Physics Project Prioritization Panel (P5) which supported BTeV but only if it could be completed by 2010, which is not feasible given schedule and funding constraints.

The Linear Collider has been judged to be of the highest scientific importance by HEPAP as well as by scientific advisory bodies of the Asian and European HEP communities. In order to address the opportunity for significant new future research options, R&D in support of an international electron-positron linear collider is increased relative to fiscal year 2005 to support the continued international participation and leadership in linear collider R&D and planning by U.S. scientists.

Recent discoveries and studies have pointed to neutrinos as being an extremely important area of research for deepening our understanding of the nature of matter and the structure of the universe, and HEP is working with the Nuclear Physics program and the National Science Foundation to plan a coordinated program in neutrino physics. To provide a nearer-term future program, and to preserve future research options, R&D for other new accelerator and detector technologies, particularly in the emerging area of neutrino physics, will increase.

NUCLEAR PHYSICS

Fiscal Year 2005 Comparable Appropriation—$404.8 Million; Fiscal Year 2006 Request—$370.7 Million

The Nuclear Physics (NP) program is the major sponsor of fundamental nuclear physics research in the Nation, providing about 90 percent of Federal support. NP builds and operates world-leading scientific facilities and state-of-the-art instrumentation to study the evolution and structure of nuclear matter, from the smallest building blocks, quarks and gluons, to the stable elements in the Universe created by stars and to understand how the quarks and gluons combine to form the nucleons (proton and neutron), what are the properties and behavior of nuclear matter under extreme conditions of temperature and pressure, and what are the properties and reaction rates for atomic nuclei up to their limits of stability. Results and insight from these studies are relevant to understanding how the universe evolved in its earliest moments, how the chemical elements were formed, and how the properties of one of nature's basic constituents, the neutrino, influences astrophysics phenomena such as supernovae. Scientific discoveries at the frontiers of nuclear physics further the Nation's energy related research capacity, in turn contributing to the Nation's security, economic growth and opportunities, and improved quality of life.

In fiscal year 2006 the NP program will operate world-leading user facilities and make investments that will produce data and develop the research capabilities to achieve the scientific goals discussed above. The budget request reflects a balance in on-going facility operations and research support, and investments in capabilities. The fiscal year 2006 budget request provides the resources to operate the program's user facilities at 65 percent of optimum utilization with investments allocated so as to optimize their scientific programs. Fiscal year 2006 investments in capital equipment address opportunities identified in the 2002 Long Range Plan of the Nuclear Sciences Advisory Committee (NSAC) and in subsequent recommendations.

In fiscal year 2006 the Relativistic Heavy Ion Collider's (RHIC) beams of relativistic heavy ions will be used by approximately 1,000 scientists to continue the exploration of the nature of hot, dense matter and to recreate conditions under which nuclear matter dissolves into the predicted quark-gluon plasma. RHIC started operations in fiscal year 2000 and its first 3 runs have produced over 70 refereed journal papers, creating great interest in the scientific community with the observation of a new state of nuclear matter. In fiscal year 2006 funds are provided for accelerator improvements that will increase accelerator reliability and reduce costs, for detector upgrades needed to characterize the new state of matter observed and for Research and Development to increase the luminosity of the collider. These investments are important for optimizing the scientific research and productivity of the facility. These investments are made at the expense of operating time. Fiscal year 2006 funding will support 1,400 hours of operations, a 31 percent utilization of the collider. Effective operation will be achieved by combining fiscal year 2006-fiscal year 2007 running into a single back-to-back run bridging the 2 fiscal years.

Operations of the Thomas Jefferson National Accelerator Facility (TJNAF) in fiscal year 2006 will continue to advance our knowledge of the internal structure of protons and neutrons, the basic constituents of all nuclear matter. By providing pre-

cision experimental information concerning the quarks and gluons that form the protons and neutrons, the approximately 1,000 experimental researchers, together with researchers in nuclear theory, seek to provide a quantitative description of nuclear matter in terms of the fundamental theory of the strong interaction, Quantum ChromoDynamics. In fiscal year 2006 funds are provided to continue R&D activities for a potential 12 GeV Upgrade of the Continuous Electron Beam Accelerator Facility (CEBAF). These investments will poise the facility for a cost-effective upgrade that would allow insight on the mechanism of "quark confinement"—one of the compelling unanswered puzzles of physics.

In the fiscal year 2006 request funds are provided for the operation of the Argonne Tandem Linac Accelerator System (ATLAS) at ANL and the Holifield Radioactive Ion Beam Facility (HRIBF) at ORNL, for studies of nuclear reactions, structure and fundamental interactions. Included in this funding are capital equipment and accelerator improvement project funds provided to each facility for the enhancement of the accelerator systems and experimental equipment. These low energy facilities will carry out about 80 experiments in fiscal year 2006 involving about 300 U.S. and foreign researchers.

In fiscal year 2006, funds are provided to continue the fabrication of a next generation gamma-ray detector array (GRETINA) and of the Fundamental Neutron Physics Beamline (FNPB) at the Spallation Neutron Source (SNS) that will provide the United States with world-leader capabilities in nuclear structure and fundamental neutron studies, respectively. Support continues for completion of the important neutrino experiments at the Sudbury Neutrino Observatory (SNO) and KamLAND.

The research programs at the major user facilities are integrated partnerships between DOE scientific laboratories and the university community, and the planned experimental research activities are considered essential for scientific productivity of the facilities. Funding for university and national laboratory researchers and graduate students decreases 6.8 percent compared to the fiscal year 2005 appropriation.

While we have a relatively good understanding of the origin of the chemical elements in the cosmos lighter than iron, the production of the elements from iron to uranium remains a puzzle. The proposed Rare Isotope Accelerator (RIA) would enable study of exotic nuclei at the very limits of stability, advancing our knowledge of how the elements formed. In fiscal year 2006, R&D activities for the proposed RIA are maintained at the fiscal year 2005 Congressional budget request level.

FUSION ENERGY SCIENCES

Fiscal Year 2005 Comparable Appropriation—$273.9 Million; Fiscal Year 2006 Request—$290.6 Million

The Fusion Energy Sciences (FES) program advances the theoretical and experimental understanding of plasma and fusion science, including a close collaboration with international partners in identifying and exploring plasma and fusion physics issues through specialized facilities. This includes: (1) exploring basic issues in plasma science; (2) developing the scientific basis and computational tools to predict the behavior of magnetically confined plasmas; (3) using the advances in tokamak research to enable the initiation of the burning plasma physics phase of the FES program; (4) exploring innovative confinement options that offer the potential of more attractive fusion energy sources in the long term; (5) focusing on the scientific issues of nonneutral plasma physics and High Energy Density Physics (HEDP); and (6) developing the cutting edge technologies that enable fusion facilities to achieve their scientific goals. FES also leads U.S. participation in ITER, an experiment to study and demonstrate the sustained burning of fusion fuel. This international collaboration will provide an unparalleled scientific research opportunity with a goal of demonstrating the scientific and technical feasibility of fusion power.

The fiscal year 2006 request is $290,550,000, an increase of $16,647,000, 6.1 percent over the fiscal year 2005 appropriation. The fiscal year 2006 budget continues the redirection of the fusion program to prepare for and participate in the ITER project. The ITER International Agreement is currently being negotiated and is expected to be completed by the end of fiscal year 2005. Fiscal year 2006 FES funding of $49,500,000 is for the startup of the U.S. Contributions to ITER MIE. The total U.S. Contributions to the ITER MIE, $1,122,000,000, supports the fabrication of the equipment, provision of personnel, limited cash for the U.S. share of common project expenses at the ITER site, and ITER procurements. This MIE is augmented by the technical output from a significant portion of the U.S. Fusion Energy Sciences community research program. Virtually the entire FES program provides related con-

tributions to such ITER relevant research and prepares the United States for effective participation in ITER when it starts operations.

Within the overall priorities of the fiscal year 2006 FES budget, $15,900,000 is requested for the National Compact Stellarator Experiment (NCSX), a joint ORNL/Princeton Plasma Physics Laboratory (PPPL) advanced stellarator experiment being built at PPPL. This fusion confinement concept has the potential to be operated without plasma disruptions, leading to power plant designs that are simpler and more reliable than those based on the current lead concept, the tokamak. Fiscal year 2006 operation of the three major fusion research facilities will be reduced from a total of 48 weeks to 17 weeks.

Fiscal year 2006 funding for the Inertial Fusion Energy/High Energy Density Physics program is $8,086,000, a reduction of $7,255,000 from the fiscal year 2005 level. This will be accomplished by reducing the level of research on heavy ion beams. In addition, the Materials Research program will be eliminated in favor of utilizing the general BES materials effort for scientific advances in areas of fusion interest.

SCIENCE LABORATORIES INFRASTRUCTURE

Fiscal Year 2005 Comparable Appropriation—$42.0 Million; Fiscal Year 2006 Request—$40.1 Million

The mission of the Science Laboratories Infrastructure (SLI) program is to enable the conduct of DOE research missions at the Office of Science laboratories by funding line item construction projects to maintain the general purpose infrastructure and the clean up for reuse or removal of excess facilities. The program also supports Office of Science landlord responsibilities for the 24,000 acre Oak Ridge Reservation and provides Payments in Lieu of Taxes (PILT) to local communities around ANL-East, BNL, and ORNL.

In fiscal year 2006, General Plant Projects (GPP) funding is requested to refurbish and rehabilitate the general purpose infrastructure necessary to perform cutting edge research throughout the Office of Science laboratory complex. Fiscal year 2006 funding of $3,000,000 is requested to support continued design of the Pacific Northwest National Laboratory (PNNL) Capabilities Replacement Laboratory project. Funding of $11,046,000 is requested to accelerate decontamination and decommissioning (D&D) of the Bevatron Complex at the LBNL.

No funding is requested under the Health and Safety Improvements subprogram to continue health and safety improvements at the Office of Science laboratories identified in the Occupational Safety & Health Administration (OSHA) and Nuclear Regulatory Commission (NRC) reviews. If the administration determines that health and safety issues remain, resources will be requested in future years as necessary.

SCIENCE PROGRAM DIRECTION

Fiscal Year 2005 Comparable Appropriation—$153.7 Million; Fiscal Year 2006 Request—$162.7 Million

Science Program Direction (SCPD) enables a skilled, highly motivated Federal workforce to manage the Office of Science's basic and applied research portfolio, programs, projects, and facilities in support of new and improved energy, environmental, and health technologies. SCPD consists of two subprograms: Program Direction and Field Operations.

The Program Direction subprogram is the single funding source for the Office of Science Federal staff in headquarters responsible for managing, directing, administering, and supporting the broad spectrum of Office of Science disciplines. This subprogram includes planning and analysis activities, providing the capabilities needed to plan, evaluate, and communicate the scientific excellence, relevance, and performance of the Office of Science basic research programs. Additionally, Program Direction includes funding for the Office of Scientific and Technical Information (OSTI) which collects, preserves, and disseminates research and development (R&D) information of the Department of Energy (DOE) for use by DOE, the scientific community, academia, U.S. industry, and the public to expand the knowledge base of science and technology. The Field Operations subprogram is the funding source for the Federal workforce in the Field responsible for management and administrative functions performed within the Chicago and Oak Ridge Operations Offices, and site offices supporting the Office of Science laboratories and facilities.

WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

Fiscal Year 2005 Comparable Appropriation—$7.6 Million; Fiscal Year 2006 Request—$7.2 Million

The mission of the Workforce Development for Teachers and Scientists (WDTS) program is to provide a continuum of educational opportunities to the Nation's students and teachers of science, technology, engineering, and mathematics (STEM).

The Scientists Teaching and Reaching Students (STARS) education initiative was launched in fiscal year 2004 to promote science literacy and help develop the next generation of scientists and engineers. In support of this effort, additional fiscal year 2006 funding is requested for both the Laboratory Science Teacher Professional Development (LSTPD) activity and the Middle School Science Bowl. The LSTPD activity is a 3-year commitment experience for K–14 teachers and faculty. The LSTPD will run at five or more DOE national laboratories with about 105 participating STEM teachers, in response to the national need for science teachers who have strong content knowledge in the classes they teach.

The Faculty Sabbatical activity, which is being initiated in fiscal year 2005 for 12 faculty members from Minority Serving Institutions (MSI), will have five positions available in fiscal year 2006. The Faculty Sabbatical is aimed at providing sabbatical opportunities to faculty members from MSIs to facilitate the entry of their faculty into the research funding mainstream. This activity is an extension of the successful Faculty and Student Teams (FaST) program where teams consisting of a faculty member and two or three undergraduate students from colleges and universities with limited prior research capabilities work with mentor scientists at a national laboratory on a research project that is formally documented in a paper or presentation.

In the fiscal year 2006 request, the Pre-Service Teachers (PST) activity will be run at one national laboratory, as opposed to twelve national laboratories in fiscal year 2005, and students will be recruited from participating National Science Foundation (NSF) programs.

SAFEGUARDS AND SECURITY

Fiscal Year 2005 Comparable Appropriation—$67.2 Million; Fiscal Year 2006 Request—$68.7 Million

The Safeguards and Security (S&S) program ensures appropriate levels of protection against unauthorized access, theft, diversion, loss of custody, or destruction of DOE assets and hostile acts that may cause adverse impacts on fundamental science, national security or the health and safety of DOE and contractor employees, the public or the environment. The SC's Integrated Safeguards and Security Management strategy encompasses a tailored approach to safeguards and security. As such, each site has a specific protection program that is analyzed and defined in its individual Security Plan. This approach allows each site to design varying degrees of protection commensurate with the risks and consequences described in their site-specific threat scenarios.

The fiscal year 2006 request meets minimum, essential security requirements. Protection of employees and visitors is of primary concern, as well as protection of special nuclear material and research facilities, equipment and data. Priority attention is given to protective forces, physical security systems, and cyber security.

CONCLUSION

The Office of Science occupies a unique and critical role within the U.S. scientific enterprise. We fund research projects in key areas of science that our Nation depends upon. We construct and operate major scientific user facilities that scientists from virtually every discipline are using on a daily basis, and we manage civilian national laboratories that are home to some of the best scientific minds in the world.

Mr. Chairman, we have made some difficult decisions this year within the President's budget request for the Office of Science—consistent with our research priorities—which will allow us to build on the solid foundation created over the last 4 years, propel us into new areas of great scientific promise, and maintain America's world-class stature in science.

I want to thank you, Mr. Chairman, for providing this opportunity to discuss the Office of Science research programs and our contributions to the Nation's scientific enterprise. On behalf of DOE, I am pleased to present this fiscal year 2006 budget request for the Office of Science.

This concludes my testimony. I would be pleased to answer any questions you might have.

Senator DOMENICI. Thank you very much. Director of the Office of Nuclear Energy, Science and Technology, it's good to have you with us again, would you please give us your testimony?

OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY

STATEMENT OF WILLIAM D. MAGWOOD, IV, DIRECTOR

Mr. MAGWOOD. It's a pleasure. It's a pleasure, Mr. Chairman, I was trying to count the number of times I've appeared before you. I think this is the seventh. Mr. Garman, I believe, holds the record in the Department for the number of hearings overall, but I think I may beat him in terms of Appropriations Hearings.

It's a great pleasure to be here to talk about our fiscal year 2006 budget request. The Office of Nuclear Energy's request for 2006 totals $511 million, and it's a budget we believe will enable us to proceed to accomplish our mission of developing and deploying advanced energy technologies in the United States.

NUCLEAR ENERGY RESEARCH PROGRAM

In fiscal year 1998—as I'm sure you recall, Mr. Chairman—the Nation's Nuclear Energy Research Program came to a virtual standstill. In that year, our energy R&D budget in the Office of Nuclear Energy hit zero, and it was a year where the students who were taking nuclear engineering fell to a number that was below 500 for the first time. It was also a year that the international community began to turn away from the United States as a leader in nuclear technology.

Since that time, with the great help of this subcommittee and your colleagues in the House, we've been able to turn that situation around considerably. We've invested a lot of effort into turning the program around, and I think the results speak for themselves.

An important indicator is to look at the University community. Since 1998, when there were 480 students taking nuclear engineering in the United States, we're now seeing the number recovering to almost 1,600.

Senator DOMENICI. From which?

Mr. MAGWOOD. It went from 480 in 1998, to almost 1,600 now. So, we feel quite good about that. And that's due to the strong programs in the schools, such as Ohio State, Purdue, Texas A&M and many others across the country, but also new programs at small schools, such as South Carolina State University, and Wilberforce University. We're very pleased with our progress to date, and we think there's more to be done.

One thing, Mr. Chairman, that we'd like to alert you to is that we are, in fact, expanding our efforts to the high school level. Starting in 2 weeks, juniors and seniors from seven Pittsburgh high schools will begin a new nuclear science and technology curriculum that was developed by DOE and high school science teachers. These students will tour research reactors, participate in experiments, and receive lectures from national laboratory scientists. Once this pilot is complete, we plan to make this course available to high schools across the country, and we're very excited by that.

Senator DOMENICI. Would you please hold for a minute? I think the Senator from Colorado has to leave, but he wanted to ask a question.

PREPARED STATEMENT OF SENATOR WAYNE ALLARD

Senator ALLARD. I do, thank you, Mr. Chairman. I just want to submit my statement for the record, if I may. I just want to congratulate you on your commitment to new science and technology in the energy field. I know you're a strong proponent of nuclear energy, and I stand shoulder to shoulder with that. I'm a strong proponent of renewables, and working hard on many a legislation there, and I just thank you for your effort, and thank the panel for their testimony.

[The statement follows:]

PREPARED STATEMENT OF SENATOR WAYNE ALLARD

Mr. Chairman, thank you for holding this hearing today. As you know, I am co-chairman of the Senate Renewable Energy & Energy Efficiency Caucus and represent the State which the National Renewable Energy Laboratory calls home. And, as a scientist myself, I have always been a strong supporter of research funding in all areas. For these reasons, I have a special interest in today's hearing.

Today more attention is being focused on clean energy and energy efficient technologies. This is a time when the development of alternative energy sources and increased energy efficiency technology are becoming more important than ever.

We must also continue to provide incentives for the implementation of renewable technologies, and for the infrastructure necessary to support these renewable sources. These technologies are a necessary step in balancing our domestic energy portfolio, increasing our Nation's energy security and advancing our country's technological excellence.

The National Renewable Energy Laboratory in Colorado can, and does, make an incredible contribution to the development of these resources. Technologies being developed at NREL—whether providing alternative fuels and power, or making our homes and vehicles more energy efficient—are vital to our Nation's energy progress.

This is a step in the right direction. Renewable energy is a very important way that we can begin to reduce the demand for oil and, thereby, help to make our country more secure. There are great opportunities for solar, wind, geothermal, biomass, fuel cells and hydro to make significant contributions. Research and the input of both government and industry entities is very important to allowing these opportunities to live up to their potential.

I look forward to working with the committee to ensure that R&D in all fields of energy technology are funded in a manner that is responsible, but sufficient to ensure that the development and implementation of new technologies continues.

Senator DOMENICI. Thank you very much. Mr. Magwood.

Mr. MAGWOOD. Thank you.

We have also reasserted U.S. leadership in the international community. One of the examples I note is that, as a representative of the United States, I've been elected by my colleagues internationally to serve as the chair of two international bodies. The Organization for Economic Cooperation and Development (OACD) Steering Committee for Nuclear Energy, and The Generation IV International Forum. And I wanted to recognize Helen Leiser who is with me here today, back there somewhere, who is an official with the United Kingdom's Department of Trade and Industry who has spent the last 2 years detailed to the Department of Energy, to serve as a Generation IV International Forum policy director. She's leaving us at the end of this month with a record of success, and we appreciate her accomplishments.

NEXT GENERATION NUCLEAR ENERGY TECHNOLOGIES

Last month Secretary Bodman joined ambassadors and senior officials from France, the United Kingdom, Japan and Canada to sign the world's first multi-lateral agreement for the development of next generation nuclear energy technologies. As this Gen IV agreement, and other actions, demonstrate, the United States is once again setting the pace for international cooperation and partnership.

NUCLEAR POWER 2010 INITIATIVE

At the same time, we're working with U.S. utilities toward exploring the construction of new U.S. nuclear power plants for the first time in many decades. The discussions we've been having with these utilities are the most detailed and serious I've ever seen, and I believe they will eventually lead to the first new nuclear power plants we've seen since the 1970's.

Mr. Chairman, I have no doubt that our work on the Nuclear Power 2010 program contributed to these positive developments. For this effort, we've helped the industry organize itself to take the vital steps towards building the next plants. The subcommittee's support has been essential to this progress, and the administration's request of $56 million for fiscal year 2006 will enable this effort to proceed on schedule.

IDAHO NATIONAL LABORATORY

Finally, Mr. Chairman, I'd like to note that in February we also successfully launched the new Idaho National Laboratory. The development of this new laboratory is an essential step in furthering our nuclear energy research agenda. We now—like each of the programs represented here today—have a core laboratory that can serve as the command center for our program's key research efforts. We are committed to the success of this laboratory, and working with Beth Sellers—the manager of the Idaho Operations Office, who's joined me here today—we are working towards making sure the Department is a good partner to work with the lab to make sure its goal of becoming the world's premier nuclear energy resource center in 10 years can be achieved.

PREPARED STATEMENT

I conclude my remarks, Mr. Chairman, by recognizing and thanking you for your long leadership in this endeavor, and as I say, I think we've been an effective team in reviving the Federal Government's nuclear energy technology efforts. While much remains to be done, we should remember that we've accomplished quite a bit over the last several years. Thank you very much.

[The statement follows:]

PREPARED STATEMENT OF WILLIAM D. MAGWOOD, IV

Mr. Chairman, Senator Reid, and members of the subcommittee, it is a pleasure to be here to discuss the Fiscal Year 2006 Budget submission for DOE's Office of Nuclear Energy, Science and Technology.

In his February 2 State of the Union Address, the President underscored the need to restrain spending in order to sustain our economic prosperity. As part of this restraint, it is important that total discretionary and non-security spending be held

to levels proposed in the Fiscal Year 2006 Budget. The budget savings and reforms in the budget are important components of achieving the President's goal of cutting the budget deficit in half by 2009 and we urge the Congress to support these reforms. The Fiscal Year 2006 Budget includes more than 150 reductions, reforms, and terminations in non-defense discretionary programs, of which six affect Department of Energy programs. The Department wants to work with the Congress to achieve these savings.

Of these six programs, two programs are from the Office of Nuclear Energy, Science and Technology: the Nuclear Energy Plant Optimization (NEPO) and the Nuclear Energy Research Initiative (NERI) programs. Research conducted under the NEPO program is designed to assure the ability of currently operating nuclear power plants to remain in service up to and beyond their licensed operating period. No funding is requested for the NEPO program in fiscal year 2006 because industry is committed to continuing the research begun under NEPO without DOE support, allowing DOE to focus on higher priority activities. No stand-alone funding is requested for the NERI program as the Department's principal nuclear energy research and development (R&D) programs (Generation IV Nuclear Energy Systems Initiative, Advanced Fuel Cycle Initiative, and Nuclear Hydrogen Initiative) will be sponsoring NERI research projects within the Nation's university research community to enhance the research cooperation between academia and our national laboratories and to strengthen our mainline R&D programs.

For most of our Nation's history, America's vibrant economy and society have benefited from the abundant energy options we have had available. Even though we experienced oil price shocks in the 1970's and 1980's, the vast majority of the energy used in the United States is, even today, produced in the United States. Our coal, oil, natural gas, nuclear, and renewable resources all contribute to a diversified and reliable energy picture.

However, we are entering a new era in energy supply. As highlighted in the President's National Energy Policy, forecasts indicate that our need for energy—even with ambitious implementation of energy efficiency measures across all sectors of the economy—will continue to grow as our economy grows. The Energy Information Administration forecasts that by 2025, the United States will import 38 percent of all of its energy and 68 percent of its energy for transportation uses. Buried in these estimates is an ominous fact that has escaped casual notice—the United States will, over this period, begin a steadily increasing dependence on imports for fuels needed for electricity generation that may, over the coming decades, follow the patterns of our accelerating dependence on imports required for the transportation sector.

To meet these challenges while still assuring America's access to reliable baseload electricity—while setting a path toward reduced emissions—we must apply advanced technologies. New technology can help us to exploit renewable energy sources when they are practical, and enable coal to continue as a viable, long-term element of our energy supply. And as the President conveyed in his State of the Union address, we must consider new nuclear energy as part of our long-term energy picture.

The Department of Energy's nuclear energy program has made significant progress over the past several years. From the time, not so many years ago, when it appeared that the United States might abandon advanced nuclear research and development, we have been successful in reasserting U.S. leadership in this area around the world. Representing the United States, I have been elected by my international colleagues to serve as the chair of two important international bodies—the Organization of Economic Cooperation and Development Steering Committee on Nuclear Energy and the Generation IV International Forum.

We continue to build on our leadership. Just a few weeks ago, we celebrated the launch of the Nation's central laboratory for nuclear research and development—the Idaho National Laboratory (INL). This new national laboratory combines the resources of the former Idaho National Engineering and Environmental Laboratory (INEEL) and the former Argonne National Laboratory-West (ANL–W). The INL will lead much of the Department's exploration into advanced nuclear reactor and fuel cycle technology. We have set an aggressive goal for the new INL to become the world's premier center for nuclear energy research and education within a decade.

Developing a central research laboratory is a major step forward for the nuclear energy program. We, like other key energy programs at the Department, have created a central, dedicated research site at which we can consolidate our infrastructure investments and build the expertise needed to accomplish our long-term program goals. A central lab also helps us minimize the shipment of nuclear materials across the country and allows us to bring our nuclear materials together in a single, secure location. In addition, we expect that our new central, dedicated research laboratory will become a major player in the education of the next generation of nu-

clear energy technologists that this Nation will need to assure our energy security in the future.

The Department's fiscal year 2006 request for the nuclear energy program proposes a $511 million (an increase of $25 million compared to fiscal year 2005) investment in nuclear research, development, education and infrastructure for the Nation's future that is designed to continue this progress. This budget request demonstrates our commitment to support the President's priorities of enhancing the Nation's energy independence and security while limiting air pollution. Our request supports the development of new nuclear generation technologies and advanced energy products that will provide significant improvements in the economics, sustainability, safety and reliability of nuclear-based energy, as well as its resistance to proliferation and terrorism.

We are committed to efficiently managing the funds we are provided. We have abandoned outdated field office and laboratory management paradigms and have integrated the Idaho Operations Office with our headquarters organization, enabling us to closely manage our responsibilities in the field to achieve greater quality and efficiency. We are enhancing our expertise in critical areas such as project management through training and certification of existing staff and the acquisition of experienced, proven managers. We are also applying international and public-private partnerships in the implementation of our research and development programs as a way of leveraging our investments and assuring the utility of our programs. We believe these steps must be taken to assure our program's ability to make the best use of the taxpayer dollars.

While we have made great progress in all these areas, much remains to be done. Our fiscal year 2006 request moves us in the right direction.

NUCLEAR POWER 2010

Today, American utilities operate 103 nuclear power plants. These facilities operate reliably and efficiently and provide a fifth of the Nation's electricity. These plants are emissions-free and can operate year-round in all weather conditions.

Over the last 15 years, nuclear utilities in the United States have been increasingly better managed, improving both efficiency and safety. In the early 1990's, U.S. plants were available to produce energy only 70 percent of the time on average. These plants are now producing power over 90 percent of the time. More efficient operation has allowed nuclear plant operators to produce more energy than ever before, adding the equivalent of 25 new nuclear plants to the U.S. grid since 1990 without building any new nuclear power plants.

Consolidation of nuclear plant ownership to a fewer number of excellent operators has made the operation of U.S. plants safer than ever, more cost-effective, and more reliable. Companies acquiring nuclear plants are the leaders in the nuclear industry with high marks in operating performance. These utilities bring newly acquired plants the benefit of economies of scale, experienced staff, well-honed management processes. As a result of this success, essentially all U.S. nuclear plants are expected to apply for renewed licenses that will keep most plants in operation into the middle of the century. There will also be some new generation, with The Tennessee Valley Authority rebuilding a plant that ceased operating in 1985. TVA expects to invest $1.8 billion to bring a 1,065-megawatt plant on-line by 2007.

With renewed interest from industry, the Department is investing in the Nuclear Power 2010 Program. This program's basic missions are to cost-share with industry demonstration of new, untested Nuclear Regulatory Commission licensing processes, finding sites on which to build new plants, and certifying state-of-the-art (or "Generation III+") designs for new nuclear power plants. The program also conducts economic studies and analysis that help point to the barriers facing the construction of new plants.

While it is too early to determine success, this program appears to be on the right track. Three utilities are cooperating with the Department to obtain "Early Site Permits" for three sites across the country—the first time this important regulatory tool has ever been used. The Nuclear Regulatory Commission is currently reviewing the utilities' applications and is expected to issue these permits during fiscal year 2006. Once done, these utilities will have sites that are pre-approved by regulators to host new plants. This process will avoid the problems in siting that vastly escalated the cost of some plants in the 1980's and led to the abandonment of others (most notably the Shoreham plant in New York).

In November 2004, the Nuclear Power 2010 program took its next major step by awarding two major projects to utility-led consortia to implement plans that could lead to the construction and operation of new U.S. nuclear plants. Central to this effort, these projects will demonstrate—again, for the first time—the Nuclear Regu-

latory Commission's combined Construction/Operating License (or "one-step" license) process. These projects could result in a new nuclear power plant order by 2009 and a new nuclear power plant constructed by the private sector and in operation by 2014.

In addition to regulatory barriers, it is also important to deal with the financial barriers facing new nuclear power plant projects. Under the Nuclear Power 2010 program, DOE sponsored an independent study by the University of Chicago's Department of Economics. This study found that the first few nuclear power plants built in the United States would be too costly for utilities to build because of early plant costs. These high initial costs arise because the United States has not built nuclear plants in a very long time—the resulting new design, construction, licensing, and financial uncertainties are reflected as higher costs. However, the study found that once these early plant costs are absorbed, new nuclear power plants may be less expensive to build and operate than either coal-based power plants or natural gas-fired plants.

The need to deal with these early plant costs is expected to become a central issue for the industry as the Nuclear Power 2010 program addresses the institutional barriers. Without the construction of new plants, the contribution of nuclear power as a percentage of the Nation's total energy mix will steadily decline. Supporting nuclear power helps to maintain a more diversified energy supply and, because it is emissions-free, will not contribute to air pollution—nuclear power today comprises almost 75 percent of all the non-emitting power generation in the country. The President's Budget supports continuation of the Nuclear Power 2010 initiative in fiscal year 2006 with a request of $56 million (an increase of $6.4 million compared to fiscal year 2005).

GENERATION IV NUCLEAR ENERGY SYSTEMS INITIATIVE

Our Generation IV effort continues to make significant progress. Since the Generation IV International Forum (GIF) and the Nuclear Energy Research Advisory Committee (NERAC) issued their joint report, A Technology Roadmap for Generation IV Nuclear Energy Systems, the members of the Forum have expanded to include Switzerland and the European Union. The now eleven members (Argentina, Brazil, Canada, the European Union, France, Japan, the Republic of Korea, the Republic of South Africa, Switzerland, the United Kingdom and the United States) have organized into interest groups associated with each of the six selected Generation IV.

A landmark international framework agreement for collaborative research and development among the GIF member countries was signed in Washington, DC, by the United States and its GIF partners on February 28, 2005. The Framework Agreement for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems, which has been under negotiation for the past year, will allow the United States and its partner countries to embark on joint, cost-shared research and development of Generation IV nuclear energy systems. These next-generation nuclear technologies offer the potential for significant improvements in sustainability, proliferation resistance, physical protection, safety and economics. The agreement will further the development of advanced technologies that are widely acceptable; enable the Department to access the best expertise in the world to develop complex new technologies; and allow us to leverage our scarce nuclear R&D resources.

With this agreement in place, we are moving forward with these countries to develop advanced reactor technologies that could be made available in the 2020 to 2030 timeframe. Generation IV concepts offer significant improvements in the sustainability, proliferation resistance, physical protection, safety and economics of nuclear energy. These advanced systems will not only be safe, economic and secure, but will also include energy conversion systems that produce non-electricity products such as hydrogen, desalinated water and process heat. These features make Generation IV reactors ideal for meeting the President's energy and environmental objectives.

We will explore a range of Generation IV concepts, including the Supercritical Water-Cooled Reactor, the Gas-Cooled Fast Reactor and the Lead-Cooled Fast Reactor. Our efforts will focus on establishing technical and economic viability, and developing core and fuel designs, and advanced materials for these concepts. We request $45 million (an increase of $5.3 million compared to fiscal year 2005) support our investigation of technical and economic challenges and risks, including waste products, to inform a decision on whether to proceed with a demonstration of the Next Generation Nuclear Plant (NGNP), which would use very high temperature reactor technologies to economically produce both electricity and hydrogen gas. The

President's Budget supports advanced research into the systems, materials, and fuels that are needed to bring Generation IV concepts to fruition. Key to the strategy for conducting all Generation IV research and development is the multiplication effect derived from international collaboration. By coordinating U.S. efforts with those of the GIF partner nations, our funding is leveraged by a factor of 2 to 10, depending on the reactor concept involved.

We are also working in close cooperation with the Department's Office of Science through the "Materials for Advanced Energy Systems Initiative" to coordinate the research advanced materials for use in Generation IV nuclear energy systems, fusion energy systems, and advanced energy technologies such as hydrogen production systems. Through a joint working group, the offices are coordinating on energy materials related issues with the purpose of investigating materials behavior in high temperature, radiation, and hostile corrosive environments, as well as the fabrication and non-destructive evaluation or monitoring of such materials. As common projects are identified, the offices will work to establish research objectives and cooperative work plans to leverage research funding.

NUCLEAR HYDROGEN INITIATIVE

Hydrogen offers significant promise as a future domestic energy source, particularly for the transportation sector. The use of hydrogen in transportation will reduce U.S. dependence on foreign sources of petroleum, enhancing national security. Hydrogen can be combusted in a traditional internal combustion engine, or can produce electricity in a fuel cell. Significant progress in hydrogen combustion engines and fuel cells is bringing transportation using hydrogen closer to reality. Before hydrogen can become a significant part of the Nation's energy infrastructure, the cost associated with the production, storage, and delivery of hydrogen must be reduced considerably.

Today, through electrolysis, we can convert water to hydrogen using electricity. Without using a non-emitting technology, such as nuclear or renewable energy, to produce the electricity, the environmental benefits of electrolysis are negated. We believe that for the future, Generation IV systems coupled with advanced hydrogen production technology offer a more efficient technology for production of large quantities of hydrogen without release of greenhouse gases. This technology could pave the way for the commercial production of clean-burning hydrogen for transportation purposes—reducing our reliance on imported fossil fuels and supporting the President's vision for a future hydrogen economy.

The DOE Hydrogen Posture Plan and the Nuclear Hydrogen R&D Plan outline our plan for integrating and implementing technology research, development and demonstration activities needed to cost-effectively produce, store, and distribute hydrogen for use in fuel cell vehicles and electricity generation. These documents are revised periodically and used to inform our annual budget requests. Technology development work to date, which has been conducted in accordance with these plans, has proven successful. For example, last year, experiments were successfully completed on individual high-temperature electrolysis cells for hydrogen production. Since the results show that the hydrogen output of the cells closely matched the theoretical calculations, this year we are evaluating the performance of stacks of cells to achieve higher hydrogen production rates. In fiscal year 2006, the program will proceed with the plan to test cell stacks for long-duration and transient operation. As a result of these achievements, the fiscal year 2006 budget request includes an increase of $11 million to conduct research and development on processes that operate across a range of temperatures for various advanced reactors being considered under the Generation IV Nuclear Energy Systems Initiative.

ADVANCED FUEL CYCLE INITIATIVE

In addition to leading the development of a new generation of nuclear power plants, the Department is developing and demonstrating technologies that will enable the United States and other advanced countries to implement an improved, long-term nuclear fuel cycle that provides substantial environmental, nonproliferation, and economic advantages over the current once-through nuclear fuel cycle. The Advanced Fuel Cycle Initiative is a research program to develop new technologies for reducing the volume, toxicity, and longevity of the high-level nuclear wastes that result from the production of energy from nuclear power plants. The initiative is designed so that these technologies can be made available to support the operation of current nuclear power plants, Generation III+ light-water reactors, and Generation IV advanced reactors in order to achieve a significant reduction in the amount of high-level radioactive waste requiring geologic disposal; to significantly reduce the

amount of plutonium accumulated in civilian spent nuclear fuel; and to extract more useful energy from nuclear fuel.

Under all scenarios, the Nation will need to establish a permanent geological repository to deal with the radioactive wastes resulting from the operation of nuclear power plants. Substantial growth in the use of nuclear energy in the United States will require the construction of additional geologic repositories to address the nuclear waste generated over time. The advanced research conducted under the Advanced Fuel Cycle Initiative, if successful, could provide an alternative to building multiple "Yucca Mountains" while still supporting an expanding role for nuclear power in the United States. In the longer term, the Advance Fuel Cycle Initiative could enable us to extend the useful life of the Yucca Mountain repository and reduce the radiotoxicity of the wastes it contains such that it would decay to the toxicity of natural uranium ore in less than 1,000 years—instead of over 100,000 years as is the case with untreated spent fuel. This technology could also allow nuclear plants to exploit a far higher fraction of the energy contained in uranium ore, potentially expanding the lifetime of the world's nuclear fuel resources from around 100 years up to 1,000 years.

The Advanced Fuel Cycle Initiative, with an investment of $70 million for fiscal year 2006 (an increase of $2.5 million compared to fiscal year 2005), will continue the progress made in the development of proliferation-resistant treatment and transmutation technologies that can reduce both the volume and toxicity of spent nuclear fuel. These technologies would support both national security and energy independence by reducing inventories of commercially-generated plutonium while recovering residual energy value from spent nuclear fuel. If successful, these same technologies offer benefits of enhancing national security by reducing inventories of commercially-generated plutonium and enhancing energy independence by recovering the energy value contained in spent nuclear fuel.

The program has already enjoyed considerable success. We have proven the ability of our URanium EXtraction (UREX) technology to separate uranium from spent fuel at a very high level of purity. We have demonstrated the ability of a derivative technology, UREX+, to separate a combined mixture of plutonium and neptunium that can serve as the basis for a proliferation-resistant fuel for light water reactors. While the UREX+ process has great potential to address the spent fuel challenges associated with today's light water reactors, we have also been investigating an alternative separation technology called pyroprocessing. This technology is a highly efficient, proliferation-resistant non-aqueous approach to separate the actinides in spent fuel from fission products. Among other potential applications, pyroprocessing could support the reduction of the radiotoxicity of nuclear waste through the transmutation of minor actinides in future Generation IV fast spectrum reactors providing the means for closure of the fuel cycle for Generation IV fast reactors.

For the Advanced Fuel Cycle Initiative to be successful, advanced fuel treatment and transmutation research and development must be integrated with the development of Generation IV nuclear energy systems, particularly with those reactor technologies that can produce the high energy neutrons needed to transmute a wide variety of toxic radioactive species. We have organized our national labs, universities, and international collaborations in a manner that will enable the success of the Advanced Fuel Cycle Initiative.

UNIVERSITY REACTOR INFRASTRUCTURE AND EDUCATION ASSISTANCE

In addition, the Department has paid close attention to developments impacting university research reactors. The research conducted using these facilities is critical to many national priorities. Currently, there are 27 operating university research reactors at 26 campuses in 20 States. These reactors are providing support for research in such diverse areas as medical isotopes, human health, life sciences, environmental protection, advanced materials, lasers, energy conversion and food irradiation.

The most exciting development in University Reactor Infrastructure and Education Assistance is the Innovations in Nuclear Infrastructure and Education (INIE) Program established in fiscal year 2002. The consortia have demonstrated remarkable collaborative efforts and strong formation of strategic partnerships between universities, national laboratories, and industry. These partnerships have resulted in increased use of the university nuclear reactor research and training facilities, upgrading of facilities, increased support for students, and additional research opportunities for students, faculty and other interested researchers. Today, the Department funds six INIE consortia, providing support to 32 universities in 23 States across the Nation.

To complement INIE and the other university assistance programs, the University Reactor Infrastructure and Education Assistance program provides assistance to universities to improve the operational and experimental capabilities of their research reactors and provides for the fabrication and shipment of fresh fuel to their research reactors.

Grants are provided to universities to purchase equipment and services necessary to upgrade the reactor facilities, such as reactor instrumentation and control equipment, data recording devices, radiation, security and air monitoring equipment, and gamma spectroscopy hardware and software. Each year, as many as 25 universities request and receive this assistance. The Reactor Sharing program enables universities with reactors to "share" access to their facilities with students and faculty at their own institutions, with universities that lack such a facility, and with visiting students from other local institutions including high schools and middle schools. The reactors are made available for use in research, experiments, material irradiations, neutron activation analysis and training, and for facility tours and other educational activities.

The growth of nuclear energy in the United States is dependent on the preservation of the education and training infrastructure at universities. The Department has played a substantial role in reversing the decline in undergraduate enrollments in this area of study. In 1998, the United States saw only around 450 students enroll as nuclear engineers—down from almost 1,500 in 1992. After several years of focused effort, the United States now has nearly 1,600 students studying nuclear engineering. That number is set to increase further, as strong programs—such as at Purdue and Texas A&M—continue to grow and we see new programs start at schools such as South Carolina State University, the University of South Carolina, and the University of Nevada-Las Vegas. Given the very large number of retirements expected in the nuclear field over the next 5 to 10 years, industry, government, and academia find that this upswing in student interest comes at a critical time.

The Department provides tuition, stipends, and a practicum to outstanding graduate students studying nuclear engineering and health physics and scholarships and a practicum to undergraduate students pursuing a nuclear engineering course of study. This highly competitive program has produced outstanding graduates who have become leaders in nuclear research and university education. Also, within the fellowships and scholarships program is the University Partnership program, which encourages students enrolled at minority-serving institutions to pursue a nuclear engineering degree at universities with nuclear engineering programs. There are currently six university partnerships consisting of 13 institutions working cooperatively in this innovative program. South Carolina State University (SCSU) and the University of Wisconsin were involved in the pilot program and now SCSU administers the program for all university partnership members. SCSU has also added two nuclear engineering faculty members and has become the only historically black college or university in the United States with an accredited nuclear engineering program.

We continue our small but important effort to provide scholarships and graduate fellowships to students studying the vital and too-often overlooked discipline of health physics. The Department is concerned that the Nation may soon not have the trained health physicists who are needed to assure the safety of vital nuclear and radiological activities. This program will help heighten the visibility of health physics as a viable career opportunity and strengthen the health physics pipeline to replace retiring professionals.

The Nuclear Engineering Education Support program prepares students for nuclear engineering and science careers and assists universities with special needs to improve their educational infrastructure. This program is helping to address the knowledge gap of incoming college freshmen in the area of nuclear science and engineering. In fiscal year 2005 a nuclear science and technology education pilot was established between the Department and the Pittsburgh Public School System to provide advanced placement high school science students an intensive educational experience in the field of nuclear science and technology. This effort provides course materials, tours to nuclear facilities, and lectures from internationally-recognized experts. In fiscal year 2006, the program will expand its efforts to enlist local organizations in sponsoring the model used in the Pittsburgh pilot program to other school systems across the country, thereby strengthening the understanding of nuclear science in our public schools.

The President's Budget supports continuation of the University Reactor Infrastructure and Education Assistance Program in fiscal year 2006 with a request of $24 million (an increase $190,000 compared to fiscal year 2005).

RADIOLOGICAL FACILITIES MANAGEMENT

In addition to nuclear research and development programs, we have the responsibility to maintain and enhance the Nation's nuclear science and technology infrastructure. This budget request also includes $64.8 million (a decrease of $3.7 million compared to fiscal year 2005) to fund the management of the Department's vital resources and capabilities at Oak Ridge National Laboratory, Los Alamos National Laboratory, Sandia National Laboratory, and Brookhaven National Laboratory in a safe, secure, and cost effective manner to support national priorities. The mission of the Radiological Facilities Management program is to maintain these critical user facilities in a safe, environmentally-compliant and cost-effective manner to support national priorities. These funds assure that NE facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Actual operations, production, research, or other additional activities are funded either by other DOE programs, by the private sector, or by other Federal agency users.

The Department is responsible for maintaining the necessary nuclear material and infrastructure that is required to deliver plutonium-238 fueled radioisotope power systems (using plutonium-238) to various Federal users. These systems are an irreplaceable enabling technology for deep space exploration missions and national security missions. As part of the Department's emphasis on consolidating nuclear material, increasing nuclear security, reducing nuclear risks, and addressing secure transportation issues, we are currently performing an environmental review to assess the consolidation of all of our plutonium-238 operations. DOE has identified consolidation at the Idaho National Laboratory as the preferred alternative for this proposed action.

In addition, the Radiological Facilities Management program assures appropriate oversight of the operations and maintenance of the Department's Paducah Gaseous Diffusion Plant uranium enrichment facilities to assure that USEC Inc. meets its commitments under the 2002 DOE-USEC Agreement and that the government's rights and options are being preserved.

The fiscal year 2006 $64.8 million budget request includes $18.7 million to prepare the final design, procure equipment, and begin facility modifications for the Uranium-233 Disposition Project at Oak Ridge National Laboratory. This project is aimed at stabilizing materials left over from the Cold War to address a Defense Nuclear Facilities Safety Board recommendation, while extracting isotopes from the uranium that are needed for very promising medical research.

IDAHO FACILITIES MANAGEMENT AND IDAHO SITEWIDE SAFEGURDS AND SECURITY

The Idaho Facilities Management program maintains the Department's facilities at Idaho in a safe, secure and environmentally compliant condition for a range of vital Federal missions. The Idaho Site-wide Safeguards and Security program supports activities that are required to protect the Department's Idaho complex assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts which may cause unacceptable adverse impacts on national security, program continuity, the health and safety of employees, the public, or the environment.

We have now established the Idaho National Laboratory (INL), which combines the resources of the former Idaho National Engineering and Environmental Laboratory (INEEL) and the former Argonne National Laboratory-West (ANL–W). This new lab began operations on February 1, 2005, and will lead much of the Department's exploration into advanced nuclear reactor and fuel cycle technology. We have set an aggressive goal for the new INL to become the world's premier center for nuclear energy research and education within a decade.

Developing a central research laboratory is a major step forward for the nuclear energy program. We have now joined the other key energy programs at the Department by having a central, dedicated research site at which we can centralize our infrastructure investments and build the expertise needed to accomplish our program goals. A central lab also helps us minimize the shipment of nuclear materials across the country and allows us to bring our nuclear materials together in a single, secure location. In addition, we expect that our new central, dedicated research laboratory will become a major player in the education of the next generation of nuclear energy technologists that this Nation will need to assure our energy security in the future.

Our funding request of $80.1 million from Energy Supply and $17.8 million from Other Defense Activities for the Idaho Facilities Management program maintains and operates the Department's facilities at Idaho in a safe, reliable, and environmentally compliant condition for a range of vital Federal missions. The overall funding for the Idaho Facilities Management program decreases from fiscal year 2005

to fiscal year 2006 because of a $43.4 million one-time cost associated with restructuring the INL complex and supporting site infrastructure services. This decrease is offset by an increase of $19.7 million for maintenance and recapitalization projects to support the goal of achieving and maintaining an expenditure rate of 2 to 4 percent of Replacement Plant Value, a level recommended by the National Academy of Sciences and incorporated in Departmental guidance, for the facilities at INL. One of the essential facilities for ongoing and planned national security and energy research programs at the INL is the Advanced Test Reactor (ATR). Replacing the ATR with a new test reactor with similar capabilities would exceed $2 billion dollars and likely take at least 10 years to build. An independent review group of reactor experts studied the ATR and provided their perspectives on the life extension of the reactor. This review prompted several projects, most notably an exhaustive safety basis reconstitution to assure that all safety related systems meet modern standards. This project is in progress and results to date are favorable.

The recommendations of this review and other analyses will be incorporated into the INL Ten-Year Site Plan (TYSP), which is the foundation for INL facilities and infrastructure strategic planning and the cornerstone of the Program's initiative to restore the INL and the other essential facilities on the site. The TYSP provides recommendations for short- and long-term recapitalization of existing mission essential facilities and infrastructure. The TYSP identifies and prioritizes the project, activities, and mission resource requirements for real property assets that cover a 10-year planning horizon as well as includes a prioritized list of maintenance, repair, and recapitalization projects necessary to correct the maintenance backlog.

Our budget request of $75 million (an increase of $17.3 million compared to fiscal year 2005) from the Other Defense Activities appropriations account for the Idaho Sitewide Safeguards and Security program supports activities that are required to protect the Department's Idaho complex assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts which may cause unacceptable adverse impacts on national security, program continuity, the health and safety of employees, the public, or the environment. As a result of merging the former INEEL and ANL–W sites into the INL, the two existing safeguards and security programs at the Idaho site will be merged into a single program. This integration will continue in fiscal year 2005 with additional changes anticipated to increase efficiency and contain costs for safeguards and security for the site.

The Department issued a revised Design Basis Threat in October 2004. These requirements will be implemented using a risk-informed approach to physical upgrades and by seeking efficiencies associated with combining the two contracts. The Department believes that early investment in improved positions for defending forces, more capable detection systems, and technological deterrent devices at target locations will result in cost avoidance over the lifetime of enduring facilities by reducing the number of additional protective force members needed to counter the revised threat. The fiscal year 2006 request reflects increased funding of $17.3 million to permit these investments.

CONCLUSION

Our Nation cannot rely on any single energy technology to secure its future. A broadly diverse energy supply has served us well in the past and must be available for the future. Nuclear energy should be a part of that diverse portfolio as look to support our growing economy while limiting air emissions and enhancing America's energy independence.

The Department of Energy's goal is to work with the private sector, our overseas partners, and other agencies to assure that the benefits of nuclear technology continue to increase the security and quality of life for Americans—and other citizens of the world—now and into the future.

This concludes my prepared statement. Your leadership and guidance has been essential to the progress the program has achieved thus far and your support is needed as we engage the tasks ahead.

I would be pleased to answer any questions you may have.

Senator DOMENICI. Thank you. Dr. Orbach, we appreciate having you here, and even before you testify, I want to thank you and congratulate you on your excellent work on behalf of our country.

Dr. ORBACH. Thank you.

Senator DOMENICI. Please proceed. You've already, did you have anything further to add, Doctor?

Dr. ORBACH. No, thank you.

LINEAR NO THRESHOLD MODEL

Senator DOMENICI. Well, I wanted to start with you, Doctor, and just ask you—or congratulate you—and ask you to comment a little bit. As you know, this subcommittee started a research program to determine whether the low dose radiation standard that we had—which is commonly known as the Linear No Threshold model, LNT—whether it was the appropriate model to determine risk, and thus to use to set standards for clean up and exposure. You're familiar with the research that's been done in the Department, and are you the supervisor of that, or what is your role?

Dr. ORBACH. Yes, as Director of the Office of Science, I'm responsible for that program. It works through our Office of Biological and Environmental Research directed by Dr. Ari Patrinos. They have made major strides in that area, thanks to your support. They have now, I think, more or less laid to rest the LNT model. It is not an adequate method of determination of low dose effects, it works entirely on isolated cells—which we know not to be typical of tissue. We believe that the results of our own research that you have helped initiate and support, point to collective interactions in tissue, and as Dr. Patrinos informed you last week, we believe that within 5 years, we can determine the genetic susceptibility and also the difference of response between isolated cells and tissues, leading to—what we believe would be—robust models which could serve as vehicles for a credible prevention of radiation injury standard for this country.

Senator DOMENICI. Now, all of this, from somebody who has been really looking at it, thinking about it, sounds like it's really something significant. In terms of what's going on in the country, what might it mean if there is a new standard? Take some things happening in the country that we might be overdoing, or that we might be doing that we don't need to do, and could you give us some examples?

Dr. ORBACH. I can think of two immediate examples, first of all, nuclear energy, where the low dose radiation is simply estimated incorrectly by the LNT model. Others would be in clean up areas——

Senator DOMENICI. Let's just stop at the first one.

Dr. ORBACH. Yes.

Senator DOMENICI. So, it's currently incorrect, which means that we are setting standards which are not necessary in terms of protecting public health from the low dose?

Dr. ORBACH. Yes, Senator.

Senator DOMENICI. So, from a practical standpoint, what does that mean with reference to nuclear power, or nuclear activities?

Dr. ORBACH. It means that we could be spending a great deal more money than is necessary to protect human health. We still have to determine the effects of low dose, but we believe that there are differences between individuals, and that remarkably, tissues seem to be able to repair themselves by cell death when a cell does suffer radiation, something which is actually a measure of protection, built into the way tissues behave. But the consequence of that is that we do not have the appropriate standards, and we may be spending billions that we don't need to, to protect human health.

Senator DOMENICI. You had a second one.

Dr. ORBACH. The second one is involved in clean up, where we have background radiation, and also radiation from the sites themselves. The same situation applies, we need to understand the real effects of low dose—this is low dose radiation—it is simply incorrect to use this isolated cell results to set that.

I should say, with regard to the latter, again with your encouragement and support, we are developing microbes which can be very effective in terms of clean up, so we have a microbe called geobactor, which can change uranium from soluble to insoluble, so as to remove the problem of contamination in the soil over large distances. We believe through our Genomes to Life program, we can be very effective in both of these efforts.

Senator DOMENICI. So, about 8 years ago, the Department of Energy brought us a flow sheet as to what it might cost to clean up Hanford, the great leftovers in the Savannah River, Rocky Flats, and the predictions were maybe over 20 years, $180 billion—I'm just guessing—but huge. Now what we're talking about—maybe, most probably—those estimates, if they were using the Linear No Threshold dosage as the guide against which you would measure the cleanup, that may be a very inaccurate number in terms of cost. Is that, in a sense, what we're saying?

Dr. ORBACH. Yes, yes, Mr. Chairman, that is exactly what I'm saying.

Senator DOMENICI. So that means without harming the public, we could do things completely different, or somewhat different, and it would cost a lot less money?

Dr. ORBACH. Yes.

Senator DOMENICI. Well, I know this is kind of a threshold issue for a lot of people, especially those who are frightened to death of radiation, period, and thus oppose nuclear power, oppose anything like that. This is going to have to be scientifically sound, or it will be a useless endeavor. Are you taking care that this program is being properly peer reviewed, and only the best of scientists, and they are not—in any way—prejudiced toward nuclear—or any other source—of radiation?

Dr. ORBACH. Mr. Chairman, all of the research that's done in this area is peer reviewed by the community, and only the highest ratings are funded. My statements on the failure of the LNT is a strong statement, but it is backed by the best research in science, and I will stand behind that research as fully supportive of scientific rigor.

Senator DOMENICI. Your strong statement can be summarized one more time, with reference to the Linear No Threshold is what?

Dr. ORBACH. The results of our research, which show the Linear No Threshold radiation limits, or radiation dosage, and effect, are incorrect for low dose radiation, and—though supported by isolated cells—do not, in fact, describe what happens in tissue, or in groups of cells.

Senator DOMENICI. Now, why do you need 5 more years?

Dr. ORBACH. Because of that very rigor which I mentioned to you. We need to establish models which will be based on the scientific results. I'm hopeful it could be more rapid, but I'm trying

to be as careful as I can. These models, then, would be used to assess radiation levels which will protect human health.

Senator DOMENICI. We have some other detailed questions; we'll submit them to you, Doctor.

Mr. Magwood, let me ask you, I've been saying—not here for the first time—but, I've been saying that within 5 years, we should have a license application for a nuclear power plant in the United States, we should have one of those completed, and the site location plan improved and completed in 5 years. Is that a—in your opinion, as one who is working in that area—if that's not a correct statement, would you tell us what you think?

Mr. MAGWOOD. I think it's a very correct statement, I think it's entirely possible that we could see that happen before 5 years. The utilities we're working with through the Nuclear Power 2010 program have established plans, that if they are brought to fruition, would see the one-step licenses for new nuclear power plants completed, around 2008, 2009, certainly within the 5 years you mentioned.

Senator DOMENICI. Now, I guess there's always a risk when—you're ready to move from a stalemated application of technology, which is where we've been, and you want to start up again—there's always a risk that in the meantime, you're trying to do something so new, and so different, that instead of expediting, you waste time, because you're trying to get the next, and then the next, and you don't decide on what you're going to use. I read a little bit that there might be a risk of us trying to prove up too much in terms of a new reactor, instead of being ready with something in this 2-, 3-, 4-, 5-year range. What about that?

Mr. MAGWOOD. I don't think that's a danger, Mr. Chairman. The utilities, as a group have—in this country—concluded that they will build, most likely, one of three designs, and the very high probability of one of two designs, or maybe two of those designs, and I think that the field has narrowed considerably. There's always going to be discussion on other possible technologies, but the serious utilities are focused on a very, very small number of technologies that are out that are very much available to the market today.

Senator DOMENICI. Mr. Garman, with reference to hydrogen and transportation, I notice you've told us how much the budget is, and it's a pretty robust program, at least it sounds like it. I would assume in terms of dollars the automobile manufacturers are spending in this area, there's a lot more money being spent than just our money.

Mr. GARMAN. That's correct.

Senator DOMENICI. Do you have any way of describing for us, for the record, what's going on overall?

Mr. GARMAN. It's very difficult—with any precision — to estimate what the private sector is spending, because it's proprietary, and a lot of automobile companies don't really want others, or their competitors to know, with precision, but I believe General Motors has made the public statement, for example, that they have committed over a half a billion dollars to fuel cell technology in vehicles. I have been to Japan, I have seen what Toyota, Nissan and other Japanese companies are doing; I've been to Europe and have

seen what those companies are doing. I think it's fair to say that billions and billions of dollars have been committed for this effort.

Senator DOMENICI. Okay, with all that going on, so that we have some idea what is probable, and what isn't, what do you think we're looking at in terms of the timeframe when we might have a variety, something to choose from, or the public might be involved in using?

Mr. GARMAN. I think the original 2020 timeframe that we've expressed continues to hold true today. Some auto makers have said they might, General Motors in particular, maybe they can go a little quicker than that, but I still see substantial technical obstacles. We have some technical challenges, which include things such as storage on board the vehicles that have to be overcome. I think the 2020 estimate is a good one; I don't think auto makers will be in a position before 2015 to really be able to make a business case decision on whether or not to proceed with the investment that will be needed in both the infrastructure and the vehicles, so 2020 is still what we're looking at.

Senator DOMENICI. We have CAFE standards which apply to fleets, but what's happening aside from that in terms of automobiles being produced that are either hybrids or get better mileage performance? Is there some headway being made by either American manufacturers, or by those who sell cars in America?

Mr. GARMAN. There's a great deal of headway, it's just that the efficiency improvements have generally been turned into performance. The four cylinder vehicle that you buy today has the performance of the eight cylinder vehicle that I bought when I was a teenager. And there are a number of different technologies that are available, and in use today, such as hybridization, continuously variable transmission, variable valve timing, even people are beginning to think about camless engines, and a new trend on the horizon is what I call the "dieselization" of the gasoline engine—a compression ignition engine. There are still a lot of efficiency improvements that can be made to internal combustion engines, and those types of technologies are—let me put it this way—I've driven some things on automotive proving grounds that I can't talk about, because I signed a non-disclosure agreement, but technologies are being developed, they are available, and they can be geared toward greater efficiency, or greater performance, or both.

Senator DOMENICI. We're going to have five stacked votes, so if we were to leave you here waiting, you'd be stacked here all afternoon, so I'm just going to ask Dr. Orbach a question.

In your capacity as the head of the Office of Science, are you—in any way—charged with looking at what the state of dependence on crude oil by America, in terms of the future, might be? Or do you not involve yourself in that?

Dr. ORBACH. We are committed to support the Department of Energy's energy security responsibility. Two years ago we held a major conference on energy security, and basic research needs of this country in order to approach energy security. Last year we had a major conference on hydrogen. Mr. Garman has talked about the hydrogen initiative; we are working together with EERE on the issue of hydrogen generation, storage, and fuel cells, from a basic research perspective, and this spring we are having a solar energy

conference to look at alternate ways, improved ways of taking solar energy and producing electricity, or hydrogen.

We are attempting to support the full panoply of Departmental responsibilities through basic research, and through opportunities. In that sense, we are providing our own contribution to energy security for this country.

Senator DOMENICI. Well, I would just like to share with you, and then we'll close the meeting down with some questions to all of you, and you can turn them in within a week, 10 days, something like that. In preparing for this ANWAR debate, I have had to gather up as much information as I can with reference to the United States—how much we use, how much we're projected to use by way of petroleum products, products from crude oil, and natural gas—and I've come to the conclusion that we are a country at great risk, right now. People don't have to—we don't have to ask you to tell us when—it's already here. Our production is going to go no where but down as a Nation, unless something dramatic happens in Alaska, and that's—every time you turn around, that's terribly difficult. We are the 12th largest, we have the 12th largest reserves of all the countries, in America, and our reserves are—from what we know—they're not going anywhere but down, because we've done everything we can, and the prices are about as high as they can be, and that's all we've got. It looks like we don't know how to cut down on the use very much. You can say conserve, therefore you won't need ANWAR, but seems to me you need both—things are in such horrendous shape. I would think somebody has to be looking at, just in basic security, from a basic security standpoint, what should we do to produce some kind of oil from some source that we don't know get it, whether it be tar sands, or oil shale, something. Because we could be in a terribly dangerous condition if the supply of oil curtailed—worldwide, if it were curtailed just a few million barrels a day—the United States would be in terrible shape—and our balance of trade is just getting slaughtered by us having to buy oil—nobody knows that—but soon we'll have 30 percent of our balance of trade will be, we keep worrying about, I think it's Chinese sales—it's crude oil as much as Chinese sales, it's almost 30 percent of the balance of trade is oil, and look at what's happening with the price.

ADDITIONAL COMMITTEE QUESTIONS

So, I think that more than one person has to be concerned in the government, and you had the wherewithal to at least look at the numbers and do the science, because it is a very serious problem. I know of your great capacity to be far sighted, and yet be practical and that's why we've laid this one before you. The work you've done on the Linear No Threshold is dramatic, and we thank you for it, we think it will change a lot of things in the country, including spending a lot less money, but it also will get rid of some fears—I would think—once doctors and others begin to accept it.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED TO THE DEPARTMENT OF ENERGY

QUESTIONS SUBMITTED BY SENATOR PETE V. DOMENICI

NUCLEAR ENERGY PROGRAMS

NUCLEAR POWER 2010 (NP 2010)

Question. Mr. Magwood, as I noted in my statement, I am disappointed in the delays in executing the NP 2010 program. It has been 4 months since the budget was passed, providing $50 million to execute the agreements. Two weeks ago in the Energy Committee, I asked Secretary Bodman to look into the delays in finalizing the agreements between your office and the two utility consortia. When will your office execute the agreements and begin funding the cooperative these agreements? What are the terms of the agreements?

Answer. The Department has moved with diligence to issue the Nuclear Power 2010 cooperative agreements and associated fiscal year 2005 funding to the industry. The cooperative agreement with Dominion Energy was issued on March 31, 2005, and a project kickoff meeting was held with Dominion Energy and their partners General Electric and Bechtel with Department staff on April 26, 2005. The cooperative agreement with NuStart was issued on April 26, 2005, and a project kickoff meeting is scheduled for May 3, 2005.

The Dominion Energy decision to change its selected reactor technology to the General Electric Economic Simplified Boiling Water Reactor (ESBWR) design caused the Department and industry to re-evaluate project cost, cost share, and annual funding for both the Dominion Energy and NuStart projects. This is due in part to the fact that the GE ESBWR reactor design is part of both projects. In addition, NuStart has increased their request for fiscal year 2005 funds to accelerate the Westinghouse AP–1000 work scope. Both of these conditions required re-submittal of detailed vendor and subcontractor cost information by both reactor vendors to the Department. In addition, intellectual property rights and royalty terms and conditions required complex and lengthy negotiation with the reactor vendors.

The terms of the Dominion and NuStart agreements include a project period that begins in fiscal year 2005 and continues through December 2011, with each project requiring a 50 percent industry cost-share. The current total estimated costs for the Dominion project is $426 million, and $519.8 million for the NuStart project. In light of the changes to the program over the past several months, as noted earlier, these figures may change. Detailed baseline project budgets and schedules will be developed to determine funding requirements for each project. As part of each agreement, a DOE interface and project oversight procedure will be established in fiscal year 2005 to implement an agreed upon and prudent project management control mechanism.

NEXT GENERATION NUCLEAR PLANT

Question. Mr. Magwood, last year the Energy and Water bill contained a provision providing $25 million for the Next Generation Nuclear Plant to be located at Idaho National Lab. The language also required that the administration provide a plan as to how DOE will implement the NGNP strategy consistent with the President's hydrogen initiative. In reviewing the budget for fiscal year 2006, I find no mention of either the $25 million or the implementation plan. Is this administration committed to building a Next Generation Nuclear Plant at Idaho National Lab?

Answer. The Department's fiscal year 2006 budget request provides $45 million for the Generation IV Nuclear Energy Systems Initiative. This represents a $5 million increase over the 2005 enacted level of funding and allows the Gen IV program to continue long-term, high reward research and development. This research and development work will investigate technical and economic challenges and risks and will help inform a decision on whether to proceed with a demonstration.

Question. What has the administration done with the $25 million provided for the NGNP project? Does the administration intend to send up the required report?

Answer. Our primary focus at this time is to assure that the Generation IV research program is able to answer the basic viability questions regarding this advanced technology. We will continue research and development on various Generation IV reactor designs to determine their compatibility with the desired goals of sustainability, economics, and proliferation resistance. This includes work on materials performance as well as evaluating the waste products associated with various reactor designs. As these questions are answered, we can consider additional steps in the future. The Department has provided the report titled "U.S. Generation IV

Implementation Strategy", in response to Congressional direction contained in Senate Report 107–220.

ADVANCED FUEL CYCLE

Question. Mr. Magwood, the Advanced Fuel Cycle Initiative coupled to fast reactors is needed to support a long-term diversified and sustainable energy policy. What is the Department's plan for the development of advanced fast spectrum systems, and will the Los Alamos National Lab's Material Test Station be an integral part of that program?

Answer. The Department is investigating, through its Generation IV Initiative, the development of advanced fast-neutron spectrum reactors. We currently have an active R&D program for the development of a gas-cooled fast reactor concept and a lead/lead alloy-cooled fast reactor concept. A third fast reactor concept under evaluation by the Department in consultation with the Generation IV International Forum is a sodium-cooled fast reactor concept. The U.S. interest in this concept is limited to the development of transmutation fuels—a mission of the Advanced Fuel Cycle Initiative (AFCI) program.

The Material Test Station (MTS) has the potential to be an integral part of the Generation IV and AFCI programs due to its capability to provide fast reactor type irradiation conditions needed for advanced fuels and materials development. We have requested that Los Alamos National Laboratory and Idaho National Laboratory coordinate to develop analysis and plans that will inform the Department's future decisions regarding fast-neutron irradiating capabilities.

ADVANCED FUEL CYCLE—EBR–II FUEL/EM CLEANUP

Question. Mr. Magwood, I understand that your office is responsible for managing the EBR–II spent fuel treatment activities under the Advanced Fuel Cycle initiative. Does this fuel contribute to the underlying research program, or is this a way for the Office of Environmental Management to keep yet another waste stream out of their portfolio and off their books?

Answer. Experience gained in processing spent metallic fuel from the EBR–II sodium-cooled fast reactor has contributed to the development of pyrochemical processing technology. We are working with Idaho National Laboratory to establish the most efficient approach to meeting our R&D goals while adhering to all the Department's commitments to the State of Idaho.

Question. How much did the Office of Nuclear Energy pay to safely store this material last year? How could this funding could be better applied if it were not obligated to maintaining this cleanup responsibility?

Answer. Twenty-five metric tons of EBR–II spent fuel are stored at the Idaho National Laboratory (INL). Two of these tons are located at the Idaho Nuclear Technology and Engineering Center (INTEC), which is the responsibility of the Office of Environmental Management; the Office of Nuclear Energy, Science and Technology (NE) does not fund the storage of that material. An additional 23 metric tons of EBR–II spent fuel is stored at the INL Materials and Fuels Complex and is the responsibility of NE. The annual storage cost to the Office of Nuclear Energy is $40,000. The charge is part of NE's general infrastructure maintenance function and is not the responsibility of its research programs.

Question. Mr. Magwood, the Nuclear Energy Engineering Research (NEER) Program restarted in fiscal year 1998 has the goal of strengthening the academic community's nuclear engineering infrastructure. The mechanism for doing this is by funding research at U.S. universities and colleges with nuclear engineering degree programs. The Department announced in March 2004 that it was awarding $3.6 million from fiscal year 2004 funding to universities through the NEER. I have been told that the Department has still not released this $3.6 million—from fiscal year 2004. Have you disbursed funding fiscal year 2004?

Answer. I believe your question relates to our Nuclear Energy Research Initiative (NERI). In fiscal year 2004, the Department issued a NERI solicitation and 160 proposals were received from U.S. universities. In December 2004, 35 projects were selected from the 160 proposals after a rigorous peer review. The selected projects will be conducted at 25 U.S. universities in 22 different States and many of the participants represent institutions that have not participated in DOE nuclear technology programs in recent years. Funding for the 35 projects included $3.6 million from fiscal year 2004 and $3.3 million from fiscal year 2005. As of April 15, 2005, all fiscal year 2004 funds have been disbursed, and all projects funded with fiscal year 2005 appropriations, except one, have been awarded and appropriate funds disbursed.

Question. What is the status of the fiscal year 2005 award process for this program?

Answer. All projects funded with fiscal year 2005 appropriations, except one, have been awarded and the funds have been distributed. The Department plans to conduct a workshop in June 2005 to inform universities of our future research plans. A new solicitation will be issued in the summer of 2005 for awards scheduled for issuance in fiscal year 2006 with fiscal year 2006 appropriated funds.

Question. Can you provide this subcommittee with a listing of which universities received an award and the status of those funds being disbursed?

Answer. Yes, the list of universities that received Nuclear Energy Research Initiative awards is attached. All projects funded with fiscal year 2004 appropriations have been awarded. As of April 15, 2005, all fiscal year 2004 funds have been disbursed, and all projects funded with fiscal year 2005 appropriations, except one, have been awarded and appropriate funds disbursed.

NUCLEAR ENERGY RESEARCH INITIATIVE—FISCAL YEAR 2005 APPLICATIONS SELECTED FOR AWARD NEGOTIATIONS

[In thousands of dollars]

University	Title	Fiscal Year 2005 Award	Total
University of California—Berkeley.	Development of a Risk-Based and Technology-Independent Safety Criteria for Generation IV Systems.	148	457
University of California—Berkeley.	Development and Analysis of Advanced High-Temperature Technology for Nuclear Heat Transport and Power Conversion.	191	576
Washington State University	Selective Separation of Trivalent Actinides from Lanthanides by Aqueous Processing with Introduction of Soft Donor Atoms.	281	859
Washington State University	Selective Separation of Americium from Lanthanides and curium By Aqueous Processing with Redox Adjustment.	245	847
Oregon State University	Plutonium Chemistry in the UREX + Separation Processes	272	764
Rensselaer Polytechnic Institute.	Development of Modeling Capabilities for the Analysis of Supercritical Water-Cooled Reactor Thermal-Hydraulics and Dynamics.	119	374
State University of New York—Stonybrooke.	Novel Processing of Unique Ceramic-Based Nuclear Materials and Fuels.	272	817
University of California—Santa Barbara.	Development of High Temperature Ferritic Alloys and Performance Prediction Methods for Advanced Fission Energy Systems.	180	549
University of Cincinnati	BWR Assembly Optimization for Minor Actinide Recycling	129	400
Utah State University	Validation and Enhancement of Computational Fluid Dynamics and Heat Transfer Predictive Capabilities for Generation IV Reactors Systems.	217	600
Arizona State University	Determination of Basic Structure-Property Relations for Processing and Modeling in Advanced Nuclear Fuels: Microstructure Evolution and Mechanical Properties.	150	451
Clemson University	The Sulfur-Iodine Cycle: Process Analysis and Design Using Comprehensive Phase Equilibrium Measurements and Modeling.	289	856
Colorado School of Mines	The Application of Self-Propagating-High-Temperature Synthesis (SHS) to the Fabrication of Actinide Bearing Nitride and Other Ceramic Nuclear Fuels.	150	462
Illinois Institute of Technology ..	In-Situ X-ray Spectroscopic Studies of the Fundamental Chemistry of Pb and Pb-Bi Corrosion Processes at High Temperatures: Development and Assessment of Composite Corrosion Resistant Materials.	250	914
Iowa State University	Detailed Reactor Kinetics for CFD Modeling of Nuclear Fuel Pellet Coating for High-Temperature Gas-Cooled Reactors.	182	449
Johns Hopkins University	Silicon Carbide Ceramics for Compact Heat Exchangers	300	902
Total, Awards	.....	6,870	21,077

NATIONAL ACADEMY OF SCIENCES

Question. Mr. Magwood, in the President's Budget Request, there is $1 million for the National Academy of Sciences to undertake an evaluation of the Office of Nuclear Energy's research programs. I asked Secretary Bodman 2 weeks ago about this request on the President's budget, and he didn't know. Do you know today why this request was made?

Answer. The fiscal year 2006 Budget requests funding for the National Academy of Sciences, to undertake a comprehensive, independent evaluation of the nuclear energy program's goals and plans, and to validate the process for establishing program priorities and oversight (including the method for determining the relative distribution of budgetary resources). The evaluation will result in a comprehensive and detailed set of policy and research recommendations and associated priorities (including performance targets and metrics) for an integrated agenda of research activities that can best advance NE's fundamental mission of securing nuclear energy as a viable, long-term commercial energy option to provide diversity in energy supply. An interim evaluation will be completed in time to inform NE's 2008 budget planning, with a final report completed before May 2006.

URANIUM FUEL

Question. Mr. Magwood, what are the Office of Nuclear Energy plans for ensuring that sufficient uranium supplies are available to power the future commercial nuclear facilities?

Answer. The Department continually monitors the domestic and global nuclear fuel markets to ensure that U.S. utilities can obtain available supplies of uranium, conversion and enrichment to meet their needs now and in the future.

Question. Has DoE looked at using blended-down material from nuclear weapons' program in a timeframe that would be of benefit to: new plants, non-proliferation and global nuclear security?

Answer. The Department of Energy continues to review the disposition of its surplus highly enriched uranium in a manner that maximizes the return on the Government's uranium assets and contributes to the Department's mission of eliminating the proliferation threat from stockpiles of surplus fissionable materials. The National Nuclear Security Administration and the Office of Nuclear Energy, Science and Technology are beginning to explore whether a majority of the low-enriched uranium derived from 17 metric tons of surplus highly enriched uranium planned to be down blended during 2006–2008 could be used in support of the Nuclear Power 2010 program. Legislation may be required to authorize the use of the material.

Question. What issues are associated with such an idea? Does the DoE 2006 budget include proposals that would safely implement such a program while ensuring that current market is protected during such activities?

Answer. The Department recognizes that the blending down of surplus highly enriched uranium to low-enriched uranium must be done in a manner that does not adversely impact the domestic uranium, conversion and enrichment industries. The Department's fiscal year 2006 budget does currently contain funding for down blending of surplus highly enriched uranium within the initially declared 174 metric tons. Specifically, the National Nuclear Security Administration has requested $103 million under the U.S. Uranium Disposition program for the down blending of highly enriched uranium to low-enriched uranium. This program already manages the amount of low-enriched uranium down blended in a safe manner that does not adversely impact the domestic uranium, conversion and enrichment industries. Any future efforts to down blend additional highly enriched uranium will take into consideration the same industries.

NUCLEAR PEBBLE BED REACTOR

Question. Have you considered developing a high temperature gas cooled nuclear pebble bed reactor in the 5 to 50 MW range to power ships and ocean going tugs or as a portable generator in the field?

Answer. The Office of Nuclear Energy has not investigated a high temperature gas-cooled reactor in the 5 to 50 Megawatt power range for portable land or sea application.

ENERGY EFFICIENCY AND RENEWAL ENERGY PROGRAMS

ELIMINATING REDUNDANCY AMONG DOE

Question. Mr. Garman, now that we have consolidated the jurisdiction for the Department of Energy within the Energy and Water subcommittee, we can work to eliminate redundancy and improve communication among program managers that may exist as a result of diving the jurisdiction between two subcommittees. Since you have managed the Energy Efficiency program for the past several years, and you have also served as the Under Secretary, you have a unique perspective on the management and scientific research ongoing among the offices of Science, Energy Efficiency, Fossil Energy, Energy Conservation and Electric Transmission. What of-

fices or activities would you recommend the subcommittee focus on consolidating in order to reduce unnecessary overhead and focus additional resources on scientific research?

Answer. The consolidation of the Office of Electric Transmission and Distribution and the Office of Energy Assurance, undertaken at the request of the Appropriations Committees, is a good example of an office consolidation that should reduce duplication and enhance coordination. I am not yet convinced that there are additional examples where complete office consolidations/eliminations will yield similar benefits, but I hope to explore the possibilities with you.

We have also worked to reduce redundancies in our research activities. For instance, prior to EERE's reorganization, Biomass R&D activities were undertaken in each of the old offices of Power Technologies, Industrial Technologies, and Vehicle Technologies. While the program funding for biomass R&D had been artificially split between two appropriations accounts until last year, we have been managing it as a consolidated program since the reorganization. Similarly, we have been managing hydrogen R&D as an integrated activity among Energy Efficiency and Renewable Energy, the Office of Science, the Office of Nuclear Energy, and the Office of Fossil Energy.

Should I be confirmed as Under Secretary, I expect to create an overarching Energy, Science and Environment (ESE) management and field management apparatus to meld these different organizations into a more coordinated ESE entity, with a goal to undertake better planning, budgeting and coordination. For example, all of the ESE offices engage in materials research of one kind or another that are probably not as coordinated and synergistic as they should be. By engaging in better portfolio management across the ESE office boundaries, we should be able to address duplication and unnecessary overhead.

HYDROGEN FUEL INITIATIVE

Question. Mr. Garman, the President's budget makes the Hydrogen Fuel Initiative a top priority. The budget request provides $259 million, up $33 million from fiscal year 2005 levels and up $104 million from fiscal year 2004. Since DOE has failed to adopt a 5-year budget outlook as the NNSA has, it is unclear how much funding is necessary to develop hydrogen fuel as a competitive domestic energy resource in the future. What can you tell me about the budget for the Hydrogen Fuel Initiatives over the next 5 years?

Answer. The President announced the Hydrogen Fuel Initiative (HFI) with a budget of $1.2 billion over the 5-year period from fiscal year 2004 through fiscal year 2008. The Office of Management and Budget maintains a funding profile for the HFI through fiscal year 2008 that meets this commitment. To date, $381 million has been appropriated by Congress for fiscal year 2004 ($156 million) and fiscal year 2005 ($225 million). The fiscal year 2006 budget request is $260 million, and similar increases are planned for fiscal year 2007 and 2008 budgets. Funding beyond fiscal year 2008 will be required to meet the HFI goal of developing the technologies to enable an industry commercialization decision by 2015.

HYDROGEN RESEARCH

Question. Mr. Garman, the budget supports funding for Hydrogen research from renewable resources, nuclear energy and fossil energy. Which fuel do you believe shows the most promise in producing hydrogen in a cost-effective fashion?

Answer. Currently, the most cost-effective and mature technology for producing hydrogen is the reforming of natural gas. Distributed production of hydrogen from natural gas will likely be the predominant approach during the initial transition to a hydrogen infrastructure. Research is underway to make other promising approaches cost-effective to ensure that the large quantities of hydrogen needed in the longer term are produced from diverse, domestic resources with near-zero greenhouse gas emissions. These approaches include the use of coal with carbon sequestration; renewables such as biomass, wind, and solar; and nuclear. The ultimate mix of resources and technologies that will be utilized for hydrogen production will depend on the degree of technical advancements and relative costs of the various options over the next decade.

HYDROGEN PRODUCTION

Question. Mr. Garman, what other factors other than economics should be considered in producing hydrogen?

Answer. The key drivers for the President's Hydrogen Fuel Initiative are energy security and environmental quality. It is important to ensure that when large quantities of hydrogen are produced, it is produced from domestic resources with tech-

nologies that result in near-zero net greenhouse gas emissions. "Well-to-wheels" energy efficiency, the measure of the energy efficiency of the complete energy chain from the production of hydrogen from basic feedstocks to its consumption in the vehicle, is also a consideration.

HYDROGEN TECHNOLOGY DEVELOPMENT

Question. Mr. Garman, which technologies show the most promise, and which office within DOE will be responsible for supporting hydrogen technology development?

Answer. Currently, the lowest cost option for hydrogen production is natural gas reformation. Using "well-to-wheels" analysis, this option results in a 60 percent reduction in greenhouse gas emissions when utilized in a fuel cell vehicle compared with a conventional gasoline internal combustion engine vehicle.

Promising approaches for the production of the large quantities of hydrogen needed to power a hydrogen economy with near-zero greenhouse gas emissions include coal-based production with carbon sequestration, supported by the Office of Fossil Energy (FE); nuclear-based production, supported by the Office of Nuclear Energy, Science and Technology (NE); and renewable-based production such as biomass, wind, and solar, supported by the Office of Energy Efficiency and Renewable Energy (EERE). In addition, the Office of Science (SC) supports basic research addressing the more long-term methods of photoelectrochemical and biological hydrogen production. All of these approaches show at least some promise. It's too early to tell which is the "most promising." Indeed, depending on R&D advances and region-specific economics, more than one approach may ultimately be used for commercial-scale hydrogen production.

The DOE Hydrogen Program Manager, located in EERE, is responsible for coordinating all the Department's hydrogen activities, including the FE, NE, and SC work.

SOLID STATE LIGHTING

Question. Mr. Garman, it is my understanding that you have an active technology program for solid state lighting with the Energy Conservation, building technologies account. Can you please explain why this program is important for the U.S. lighting industry and what impact this may have on our Nation's energy security?

Answer. The Department emphasizes the importance of efficiency, cost and lifetime of solid state lighting (SSL) technologies in its work, enhancing the value to consumers and the lighting industry. SSL sources have already replaced conventional technologies in niche applications such as traffic lights, exit signs, and airplane taxiway edge-lights. Further technology advances will drive the development of "white-light" sources that could ultimately replace incandescent and fluorescent lamps used for general illumination. Cost-effective "white-light" has the potential to significantly affect the baseload requirement for electricity generation. SSL technology can improve the Nation's energy security by reducing demand for natural gas, imports of which the Energy Information Administration (EIA) projects will increase over time.

INDUSTRIAL TECHNOLOGIES

Question. The President's funding request for Industrial Technologies is $56.5 million, a reduction of $18.3 million from fiscal year 2005. The Industrial Technologies Program seeks to reduce the energy intensity of the U.S. industrial sector through research, development, validation, and deployment of energy efficient technologies and operating practices. The current budget proposes to focus less on specific energy intensive industries—such as forest and paper products, metals, glass, and chemicals—than it has in recent years. Why does the Department propose to decrease energy efficiency efforts in specific, key industries that provide basic materials?

Answer. Industries, particularly our core domestic energy-intensive industries, are succeeding in their attempts to be more energy efficient, in part because of the past successes of the Industrial Technologies Program and because of the obvious economic incentives they face to cut energy costs. Continuing activities in the Industries of the Future (Specific) program that you reference will focus on bringing existing projects to successful commercialization and evaluating opportunities for greater performance in fiscal year 2006.

CONSERVATION EFFORTS

Question. Aren't these the industries that should be emphasized in energy conservation efforts, to maximize the return on our Federal investment?

Answer. Because industry is less likely to invest in R&D toward long-term energy-savings technologies, our Industrial Technologies Program is focusing on a fewer number of higher-risk, higher-reward technologies, and our budget reflects that. Fortunately, the industrial sector of the economy is already quite energy efficient, since it has an economic incentive and the financial means to reduce energy use as a component of its overall cost of production.

FREEDOMCAR INITIATIVE

Question. Mr. Garman, it is my understanding that vehicles account for 54 percent of total oil usage. The FreedomCAR initiative and the Vehicle Technologies accounts support R&D efforts to improve gas mileage, create cleaner burning fuels, and improve materials to safety without impacting mileage. The budget provides $166 million to support research and development to improve engine technology, increase efficiency and lower emissions. Can you please update the subcommittee on the FreedomCAR initiative and the results your office achieved to increase efficiency and reduce our dependence on foreign oil?

Answer. The Department's FreedomCAR activities, representing 61 percent of the Vehicle Technologies Program budget, are on track to meet their 2010 and 2015 technology goals. The goals of FreedomCAR are to develop the component and infrastructure technologies necessary to enable significant improvements to the energy efficiency of the full range of affordable cars and light trucks.

FreedomCAR has already been instrumental in developing and transferring to the automotive industry a range of technologies that can help achieve higher energy efficiencies. Examples of these successes include the development of: nickel metal hydride battery technologies used in all commercially-available hybrid electric vehicles; the super plastic forming of metals, a process used by General Motors to manufacture body parts at lower cost and with lighter materials; and the technical foundation for low sulfur fuels, enabling a new generation of high efficiency diesel engines to enter the market with potential large oil savings within the United States.

Cost-competitive advances in batteries, power electronics, electric motors, lightweight materials, renewable fuels and advanced combustion that are supported by FreedomCAR could contribute to future vehicles being significantly more efficient than those sold today. However, it is important to note that technological advances we develop with industry will not necessarily translate into a more fuel efficient fleet. For this reason, the administration supports incentives to help accelerate the large-scale introduction of more efficient hybrid and advanced combustion technologies.

BIOMASS FUNDING PROGRAM

Question. Mr. Garman, I have noticed that the Biomass funding within the Energy Supply account has dropped and you have recalibrated your program to support the improvement of existing technology, as opposed to using funds to support new ideas or the thermo-chemical platform. What is the rationale behind these reductions, and how much funding is required to support thermo-chemical platform research efforts in order for the Department to begin considering next generation biomass technology?

Answer. Since fiscal year 2002, the Biomass Program has experienced a significant increase in Congressionally-directed activities that has limited the program's ability to focus on a full biomass R&D portfolio, including thermochemical platform research. Due to this reduction, the Office of Energy Efficiency and Renewable Energy (EERE) has focused its biomass efforts to meet its top priority, reducing our dependence on foreign oil, and funded those efforts most likely to increase alternative fuels production. We are leveraging Federal dollars to lower the technical and financial risks of developing new biorefineries along with the chemicals and products needed for cost-effective and efficient biorefineries.

ENERGY CONSERVATION PROGRAM DIRECTION

Question. Contained in the fiscal year 2006 budget request is $2.9 million to improve budget transparency and accuracy within the Energy Efficiency budget. Please explain how you intend to use this funding and if you intend to use a portion of this funding to determine how you can merge the various activities, functions and offices that have been separate as a result of the dual committee jurisdiction.

Answer. The $2.9 million funds the Office of Energy Efficiency and Renewable Energy's (EERE) cross-cutting planning, analysis and evaluation activities in support of renewable energy programs. EERE's Office of Planning, Budget and Analysis has traditionally conducted these activities in the past and will continue to do so. No merging of functions or offices is planned. Funding for these activities, however, will

now be requested at the corporate level, rather than funded through the budgets of individual renewable energy programs as was done in the past. Explicitly budgeting for these cross-cutting activities will provide increased transparency and more accurate organizational alignment. In addition, the merging of activities funded by the Energy and Water Development and the Interior and Related Agencies Appropriations should result in more consistent funding allocations for these cross-cutting activities.

FOSSIL ENERGY PROGRAMS

Question. In the administration's budget request, we see an important new effort within the Solid State Energy Conversion Alliance (SECA) fuel cells program to develop megawatt-scale SECA Hybrid Systems. As I understand this, the program envisions combining a fuel cell with a turbine in a hybrid system that will achieve new levels of electric power generation efficiency with low emissions. What activities in this area do you envision in fiscal year 2006, and what is the Department's plan for this program beyond fiscal year 2006?

Answer. The SECA program is aimed at developing advanced enabling fuel cell technology at relatively small modules (3 to 10 kilowatts), which can be used as the building blocks for larger fuel cell systems. In fiscal year 2006, the program will continue developing SECA core technology R&D to resolve crosscutting technical issues and to enhance individual subsystem components and overall system performance, with small and large-scale applications to independent modules and integrated "hybrid" systems.

In fiscal year 2006, the SECA program will also continue MW-scale SECA fuel cell and fuel cell hybrids work in support of coal-derived gas-based systems. The hybrid program is focused on translating the SECA results into large scale systems for use in central coal plants, like FutureGen. The hybrid activities in fiscal year 2006 will include continuation of work under the recent solicitation for Fuel Cell Coal-Based Systems, addresses large (>100 MWe) fuel cell power systems that can contribute to systems that produce affordable, efficient and environmentally-friendly electrical power at greater than 50 percent overall efficiency (HHV) from coal to acpower, including CO_2 separation preparatory to sequestration.

Beyond fiscal year 2006, the Department plans to continue research on a cost-shared basis with its industry partners on core technologies for distributed generation applications and on fuel cell hybrids. Potential areas of research on fuel cell hybrids could include stack scale-up, pressurization, aggregation, selection of reforming technology, development of control/operating strategy, coupling air flow to fuel cell with turbine, elimination of components like air blower, simplifying operation and cost reduction, assessing tradeoffs among all subsystems, simplifying operation and cost reduction, and addressing the turbine development needs for hybrid use. The hybrid part of the SECA program is targeted to providing proof-of-concept fuel cell hybrid systems beginning in 2012 in concert with FutureGen.

Question. The administration's budget request for Distributed Generation—Fuel Cells provides that funding in the Solid State Energy Conversion Alliance (SECA) program will be used to "continue MW-scale SECA fuel cell and fuel cell hybrids work." What activities in this area do you envision in fiscal year 2006, and what is the Department's plan for this program beyond fiscal year 2006?

Answer. The SECA program is aimed at developing advanced enabling fuel cell technology at relatively small modules (3 to 10 kilowatts), which can be used as the building blocks for larger fuel cell systems. In fiscal year 2006, the program will continue developing SECA core technology R&D to resolve crosscutting technical issues and to enhance individual subsystem components and overall system performance, with small and large-scale applications to independent modules and integrated "hybrid" systems.

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Question. Integrated Gasification Combined Cycle (IGCC) technology is a key to enabling the nationwide use of our abundant coal resources for electric power generation. One challenge to the deployment of IGCC technology on a large commercial scale is the need for engineering for first of a kind plant designs and technology integration. Unique engineering challenges must be resolved if this technology is to be capable of using all ranks of coal. What do you see as the Department of Energy's role in addressing these engineering challenges?

Answer. The Department's role in addressing these engineering challenges is to conduct research, development and demonstration in a cost-shared partnership with industry to improve the performance and cost of IGCC. That research will be aimed at subsystem and component improvements that enhance the overall system's environmental performance, improve the reliability and the cost-competitiveness, and to provide concepts that will allow for the adaptation of these systems to carbon dioxide capture as the foundation for essentially zero emission coal based gasification plants for the future. This research includes the development of low-cost, longer life refractory materials for the gasifier that can improve reliability and also be used for different ranks of coal; advanced oxygen membrane technology to lower cost and improve efficiency; low-cost, ultra-clean gas stream cleanup systems; development of more efficient, low-cost gasifiers that can run on low rank coals; advanced catalysts for shift reactions to produce hydrogen and synthesis gas for use in advanced turbines; advanced combustion turbines that can run on high hydrogen content while producing ultra-low levels of nitrogen oxides (less than 3 parts per million). Also, innovative design configurations that include advanced sensors and controls will provide the basis for follow-on generations of lower-cost, more efficient, and higher reliability IGCCs. Finally, component integration and system scaling issues can be addressed, along with over system viability, by integrating system demonstration under the Clean Coal Power Initiative, including the FutureGen project.

Question. There is renewed and growing interest in all regions of the country in the use of coal for baseload electricity generation. DOE programs in the mid-1990's demonstrated the technical feasibility of Integrated Gasification Combined Cycle (IGCC) technology, but not the commercial viability of the technology using all ranks of coal. The Department has a number of coal programs that focus on long term, high risk technologies for coal utilization. At the same time that the Department is addressing the development of new technologies for coal-based power generation through FutureGen and the Clean Coal Power Initiative, shouldn't we also be taking steps to assure that the nearest term technology—IGCC—is deployed as rapidly as possible?

Answer. We agree that we should and we are taking steps to conduct research, development, and demonstration that will foster deployment of IGCC technology. The primary impediment to early deployment of IGCC is its higher cost compared to conventional power plants, somewhat lower reliability (which is true of all new technologies until they mature) and the historic absence of a utility system supplier prepared to provide a "wrap-around" warranty for IGCC performance. In this context, the Department is pursuing the development of technology that would drive down the costs of IGCC and improve the reliability of initial systems. In addition, the Department greatly accelerates IGCC deployment by providing up to 50 percent of the cost for new IGCC plants proposed under the Clean Coal Power Initiative (CCPI). Two such IGCC plants demonstrated under the Clean Coal Demonstration Program have entered commercial service (and are the only two commercially operating IGCCs in the Nation). Two more IGCCs were selected to be demonstrated under the CCPI Program and will enter commercial service upon completion of their demonstration phase. With regard to "wrap-around" warranties, one U.S. equipment supplier has informally indicated plans to do so shortly. Considerable progress is being made across the board.

In the R&D Program, the Department, working with its industrial partners, is developing new materials (e.g., refractory liners, high temperature measurement and control instrumentation) that will lower operating and maintenance costs and improve equipment reliability, and plant availability, which are key steps for improving today's IGCC technology. Additionally, the Department is actively engaged with the gasification industry to develop new technologies to significantly reduce the cost and improve the operational effectiveness and thermal efficiency of future plants.

Question. What role can DOE play in getting IGCC technology that is commercially ready now into operation at a number of sites across the country?

Answer. In addition to the DOE actions already taken and discussed in the answer above, there are several possibilities, which include:

—*Share information*.—We can make available relevant non-proprietary information on IGCC in a useful structure and summarize the information in formats useful to various decision-makers that play a role power plant approval, or other important decisions regarding IGCC. These decision-makers would include Public Utility Commissions, State Legislators, media organizations, and permitting authorities.

—*Work with regulators*.—We have been meeting for several months with EPA on ways we can facilitate permitting of new IGCCs.

Question. The Office of Fossil Energy will have spent $324 million on fuel cell research and development (R&D) over the past 5 years (including the fiscal year 2006 request of $65 million—fiscal year 2006 Congressional Budget page 103). The fuel cell "SECA" R&D effort has six participants, many of whom are not meeting programmatically imposed technical and financial metrics. When will there be a significant down-select of partners?

Answer. The SECA program is structured with three phases. Each phase has progressive goals to ensure that appropriate progress is made before approval to continue to the next phase. At this time SECA is entering a critical evaluation period for the first phase. All teams that qualify will be permitted to continue, subject to the availability of funds.

The SECA teams are pursuing various designs for stationary and auxiliary power market applications. Having multiple teams significantly reduces the overall risk of the government's investment, creates competitions among the teams for early market entry, increases the potential range of products and public benefits associated with those products, and should create competitive pricing that will make fuel cells affordable to consumers.

The development efforts of each team are described below:

General Electric (GE) is developing a compact natural gas 5-kW, planar, 700° C to 800° C, anode-supported solid oxide fuel cell (SOFC) unit for residential power markets. GE is evaluating several stack designs, and is especially interested in extending planar SOFCs to large hybrid systems. GE has achieved 307 mW/cm^2 in a radial planar, 21-cell 800°C stack. GE has already achieved over 400 mW/cm^2 in a single cell exceeding its Phase I SECA targets for stack power density and utilization. Prototype testing will occur in 2005.

Delphi, in partnership with Battelle/PNNL, is developing a compact 5-kW, planar, 700° C to 800° C, anode-supported SOFC unit for the distributed generation and auxiliary power unit (APU) markets. Delphi is working on a third generation design that has achieved 420 mW/cm^2 in two 30-cell stacks. Delphi is expert at system integration and high-volume manufacturing and cost reduction. They are focused on making a very compact and light-weight system suitable for auxiliary power in transportation applications. Prototype testing will occur in 2005.

Cummins is the world's largest manufacturer of generators to the recreational vehicle market. Cummins and SOFCo EFS are developing a 10-kW product for recreational vehicles that would run on natural gas, diesel and propane using a catalytic partial oxidation reformer. The team has produced a conceptual design for a multilayer electrolyte-supported SOFC stack assembled from low-cost building block components. The basic cell is a thin electrolyte layer (70 to 120 microns), fabricated by tape casting. Anode ink is screen-printed onto one side of the electrolyte tape, and cathode ink onto the other. The printed cell is sandwiched between layers of dense ceramic that will accommodate reactant gas flow and electrical conduction. The assembly is then co-fired to form a single repeat unit.

Siemens Westinghouse Power Corporation (SWPC) is developing 5- to 10-kW products to satisfy multiple markets. SWPC has developed a new tube design for their 5-kW units that use flattened oval, high power density, cathode-supported tubes. This allows for a shorter tube length with twice the power output, compared to their current cylindrical tube. The SWPC flattened high power density tubes have achieved a 300 mW/cm^2 at 85 percent fuel utilization at 1,000° C.

Acumentrics uses a micro-tubular anode-supported design, and is already offering early units for field testing. They are interested in the information technology applications and uninterruptible power supply markets, and have conducted over a dozen early unit field tests. The advantages of smaller diameter tubes are higher volumetric power density and rapid start-up because they are less susceptible to thermal shock. Acumentrics units have already achieved 63 thermal cycles.

FuelCell Energy Inc., (FCE) has brought its history of successful fuel cell development to a team that includes Gas Technology Institute (GTI) and Versa Power Sys-

tems. The acquisition of Canada's Global Thermoelectric, provided a 5 MW per year manufacturing facility and over 25,000 hours of testing experience on their RP–2, 2 kW units. At the beginning of fiscal year 2005, FCE combined its Canadian SOFC operations, into its lead product development sub-contractor, Versa Power Systems. This consolidation provides a greater opportunity to commercialize SOFC products under SECA.

Question. The Office of Fossil Energy has requested an $11 million increase over fiscal year 2005 for its Innovative System Concepts Subactivity ("Hybrid Program") (fiscal year 2006 request is $64.3 million—fiscal year 2006 Congressional Budget page 104 and 105). This program's goal for fiscal year 2006 is the issuance of a competitive solicitation to advance megawatt-scale fuel cell hybrids. However, according to the Fuel Cell Power Association and meetings with a number of Fortune 500 stakeholders, we've learned that the upcoming solicitation is once again focusing on and requiring work on basic "cell and stack". Why after investing 5 years and $324 million through the fuel cell program does the Innovative System Concepts activity (Hybrid Program) need to spend more time and another $64.3 million on basic "cell and stack" R&D?

Answer. The focus on cell and stack research is the key to providing fuel cell systems, whether as SECA fuel cells or in a hybrid system, that can achieve the power and durability performance at a cost target of $400 per kilowatt. This continues to be the most challenging part of the fuel cells program, and the industry is making substantial progress towards that goal. In fiscal year 2006, the program will continue developing SECA core technology R&D to resolve crosscutting technical issues and to enhance individual subsystem components and overall system performance, with small and large-scale applications to independent modules and integrated "hybrid" systems. The recent solicitation for Fuel Cell Coal-Based Systems, is focused on the development of large (>100 MWe) fuel cell power systems that will produce affordable, efficient and environmentally-friendly electrical power at greater than 50 percent overall efficiency (HHV) from coal to AC power, including CO_2 separation preparatory to sequestration.

The large scale, low cost fuel cell systems subprogram element is developing technologies for fuel cells that utilize coal gases to produce electricity for applications that are currently serviced by natural gas fueled gas turbines and diesel generators, but with significantly lower emissions.

This subprogram element will address stack scale-up, pressurization, aggregation, selection of reforming technology, development of control/operating strategy, coupling air flow to fuel cell with turbine, elimination of components like air blower, assessing tradeoffs among all subsystems, and addressing the turbine development needs for hybrid use.

The overall goals of this subprogram element are to simplify operation and lower cost by pursuing a systems approach that iteratively explores tradeoffs between system and subsystem. Subsystem development is done with the objective of determining operating parameters and development goals for each subsystem that optimize the entire system in cost/performance.

OFFICE OF SCIENCE PROGRAMS

HYDROGEN RESEARCH—OFFICE OF SCIENCE

Question. Dr. Orbach, the President's budget provides $259 million in total funding for the Hydrogen Fuel Initiative. Much of the basic research to support the hydrogen program is done through the Basic Energy Sciences (BES) program within the Office of Science. The budget proposes $32.5 million for BES research to support the Hydrogen Fuel initiative. Enormous gaps remain between our capabilities in hydrogen production and storage, and the capabilities required for a competitive hydrogen economy. Given the need for basic research to generate breakthroughs, does the President's budget provide sufficient funding for basic research?

Answer. Yes, the fiscal year 2006 request provides sufficient funding for basic research in hydrogen. The Department believes, as does the National Research Council, that a continuum of basic science, applied research, development, and "learning" demonstrations is necessary for the successful transition to a hydrogen economy. Applied research and technology demonstrations are critical to meeting the technology milestones leading to the 2015 industry commercialization decision and to begin the transition to a hydrogen economy. Basic research is critical to understanding the underlying science that will lead to more economical production, greatly improved storage, and improvements in fuel cell technology in the near-term and potentially "breakthroughs" in the long-term. The President's Budget Request for fiscal year 2006 puts forward a balanced portfolio of basic science, applied research,

development, and demonstrations that seeks to address both the short-term showstoppers and the long-term grand challenges.

LOW DOSE RADIATION RESEARCH

Question. Dr. Orbach, last week I received an update on the progress of the low dose radiation research your office has been conducting over the past 3 years. I proposed this study because I believe policy makers were setting radiation standards based on poor quality data, especially when it came to low dose radiation. The Linear No-Threshold model became the basis for policy decisions since scientists knew very little about the effects of low-dose radiation on the human body. That model assumes that every unit of radiation exposure will result in an incremental increase in damage. Many experts believed this model to be flawed, but didn't have enough data to support their conclusions. In order to fill in the gaps, I initiated the low-dose research program in 1998. What are the significant findings of the DOE Low Dose Radiation Program and how do these finds affect the Linear No-Threshold Model?

Answer. Low dose radiation studies have traditionally been conducted on isolated cells, the majority of which have been conducted by the DOE Low Dose Radiation Research Program. The responses of those cells were then used to estimate low dose radiation effects in tissues and whole organisms. DOE-funded research has shown that cells in tissues respond very differently to radiation than isolated cells. These differences are greatest for very low dose radiation exposures or for very low dose rate exposures where most cells in a tissue are not irradiated at all and the few irradiated and potentially-damaged cells are generally surrounded and outnumbered by unirradiated/undamaged cells. We now know that tissues can "protect" themselves from abnormal cells, such as radiation damaged cells, by stimulating defective cells to undergo "altruistic suicide." If cell "suicide" occurs after tissue irradiation, the effect of that radiation would be less than predicted from simply knowing the number of irradiated cells and the biological effect of radiation on isolated cells.

The DOE Low Dose Radiation research program is beginning to use these whole system or tissue concepts to understand and interpret radiation induced biological effects such as bystander effects, adaptive response, and genomic instability. The program has shown that bystander effects result from communication between irradiated and unirradiated cells. Bystander effects are an early biological response that seems to be programmed into tissues as tissues attempt to re-establish homeostasis and eliminate abnormal cells. The program has also shown that adaptive response and radiation-induced genomic instability appear to result from persistent perturbations of normal regulatory networks that control cell and tissue behavior following radiation exposures. Using genome-based technologies we are now learning how cells communicate with each other in tissues in response to radiation, what causes cells and tissue to undergo different biological responses to radiation at different times, and how some people may be more sensitive to radiation while others are relatively resistant.

Emerging data from the DOE Low Dose Radiation research program suggest that for low dose radiation exposures it is the networked, multicellular responses, rather than the damage to the individual cells per se, that dictate whether homeostasis is restored or if pathology ensues. High dose exposures may corrupt normal signaling and moderate doses of chronic irradiation may persistently alter cell phenotypes, compromising the surveillance of abnormal cells and enabling aberrant cells to accumulate and proliferate. Taken together, these new data are no longer consistent with the Linear No-Threshold (LNT) Model for cancer risk for low doses and dose rates of radiation.

Question. If the Linear No-Threshold model is inaccurate, when will we have enough information from the new biological studies to confidently set radiation protection standards?

Answer. This new paradigm for understanding radiation response, based on systems biology principles of interconnectivity and the cell microenvironment, is founded on the research currently supported by the DOE Low Dose Radiation Research Program. These critical new studies are rapidly evolving, stimulating new research as well as the new concepts for developing computational models of the effects of low doses of radiation on biological systems. We anticipate that scientific advances during the next 5 years will enable regulators to critically re-evaluate and, if appropriate, begin to modify current radiation protection standards.

GENOMES TO LIFE PROGRAM

Question. Dr. Orbach, It is my understanding that one of the results of the Human Genome Program was the creation of the Genomes to Life project. One goal

of the program is to develop biotechnology-based solutions to aid in the cleanup of the Department of Energy environmental legacy. What are your scientists working on, and will these microbe solutions be safer than current environmental cleanup methods so that risks to workers and the public are reduced?

Answer. Common approaches to environmental remediation involve the excavation, transport and disposal of contaminated media in an engineered structure. This approach is safe, effective, relatively inexpensive and has regulatory acceptance for small areas of high level contamination. However, there are many areas for which such an approach is not practical for financial or engineering reasons, including large areas of low-level contamination and inaccessible areas such as underground aquifers and deep subsurface sediments. Currently, such areas are managed through access controls or via expensive active technologies such as pump and treat. Microbial-based solutions are particularly attractive for such areas because they offer the possibility of remediating contaminants in place in otherwise intractable settings. Microbes naturally found in the subsurface possess a diverse set of metabolic capabilities which include the capability to degrade organic contaminants and to transform many inorganic contaminants to insoluble forms. Understanding the biomolecular processes that control such microbial activities promises the ability to take advantage of such capabilities in a given environment or to introduce such capabilities where they do not otherwise exist. As such, microbial-based solutions may offer remediation solutions where none currently exists, thereby reducing otherwise unmanageable risks to workers and the public. Anticipated microbe-based solutions would involve the conversion of contaminants from toxic forms or mobile forms that can move into groundwater supplies to nontoxic forms or immobile forms that stay in place and do not move into ground water supplies. These remediation approaches would reduce risks of human and environmental exposure that result from digging up, and thus disturbing, contaminants. However, the overall safety and desirability of these microbe-based remediation strategies will need to be independently investigated as part of the Ethical, Legal, and Societal Issues (ELSI) research component of the Genomics: GTL research program.

INTERNATIONAL THERMONUCLEAR REACTOR (ITER)

Question. Dr. Orbach, the administration continues to support ITER, but at the expense of the U.S. Fusion research program. Funding for the international partnership to build a large-scale fusion reactor is $46 million fiscal year 2006. By prioritizing funding for ITER, it will delay the completion of Princeton University's fusion facility, reduce facility run-time to just 17 weeks a year and eliminate materials research funding—a critical component when dealing with the intense heat from fusion energy. For the past 2 years the six ITER partners have been unable to break the 3-to-3 tie vote to locate ITER in either Japan or France. Based on the current delays and tight budgets, I don't believe this is the best time to send our initial U.S. investment to the ITER project. Can you give us a status of the ITER project and the rationale for cutting the underlying domestic fusion research and education program to funding a project with no site location?

Answer. Regarding the status of the ITER project, all six Parties are proceeding with technical preparations for the project in the areas of design, R&D and qualification of industrial vendors. The negotiations on the site selection have been delayed; however, recently the two principal Parties involved, the European Union and Japan, have agreed that their views are converging towards a common position and that they will aim at reaching an international agreement involving all six Parties on the ITER site issue before the G–8 summit in early July 2005. As of May 5, the European Union and Japan have agreed on a common statement of the roles of the Host and Non-Host, defining the terms of a win-win solution for both of them. Now, each side will consider these terms and prepare for a political decision on who is Host and Non-Host by the end of June, as agreed earlier by Prime Minister Koizumi and President Chirac.

In the fiscal year 2006 President's Budget we are beginning the transition of the domestic fusion program around a central focus on burning plasma physics (i.e., full U.S. participation in ITER as the major fusion research facility world-wide), which is a change repeatedly endorsed by the National Academy of Science. In making this transition, we have chosen to preserve the critical program areas so that we will be prepared to participate in ITER when it operates.

OFFICE OF SCIENCE FUNDING

Question. Dr. Orbach, I am disappointed to see the President's budget would decrease funding to the Office of Science by nearly 4 percent. The Office of Science is the largest source of government support for research in the physical sciences.

Although we are clearly in a period of budget constraints, I question whether cuts in physical science research are in the long-term interests of the United States. The Office of Science budget request also reflects a higher priority placed on operating funds for scientific user facilities than on grants to researchers. In fact, the Office of Science budget proposes a 10 percent cut for research grant funding overall. What are the reasons for the larger cuts in research grant programs relative to user facility operating funds?

Answer. In this overall budget climate, we are continuing to position the Office of Science for the future, with investments in new facilities needed to stay at the forefront of science. However, these investments in facilities and their operations have short-term consequences affecting our ability to fund research. Facility operations are not reduced as much as research in fiscal year 2006 primarily because we have several new facilities coming on line. The Spallation Neutron Source at Oak Ridge National Laboratory will begin operations in fiscal year 2006, as will 4 of the 5 Nanoscale Science Research Centers: the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory, the Center for Integrated Nanotechnologies at Sandia and Los Alamos National Laboratories, the Molecular Foundry at Lawrence Berkeley National Laboratory, and the Center for Nanoscale Materials at Argonne National Laboratory. The Spallation Neutron Source will provide the most intense, by an order of magnitude, neutron beam in the world for cutting-edge research, while the Nanoscale Science Research Centers will provide tools found nowhere else in the world for exploration at the atomic level, offering huge potential for the discovery of entirely new ways to build materials.

Question. Do you expect this trend to continue in future years?

Answer. Over the next several years, we will work to ensure that an appropriate balance between research and facility operations is maintained.

JOINT DARK ENERGY MISSION

Question. Dr. Orbach, I am very interested to learn more about the Department's commitment to the Joint Dark Energy Mission (JDEM). This committee has articulated its support for this program in our past three appropriations bills recognizing that JDEM will help scientists answer the most fundamental question of the day—what is the universe made of. Although multi-agency collaborations are wonderful when they work properly, they can be disastrous when the agencies don't cooperate, when funding levels are not appropriately matched and when the commitment of one agency doesn't match the commitment of the other. Is DOE serious about seeing this program succeed?

Answer. Yes. The Department is very much dedicated to the science of the JDEM experiment. Determining the nature of dark energy is one of the most exciting areas of particle physics today. The Department plans to spend $3 million in fiscal year 2006 on R&D for the SuperNova/Acceleration Probe, or SNAP as it is called, which will be one of the proposals for the dark energy science investigation for JDEM. These funds will be used to finalize the SNAP R&D for technology needed to provide a mission concept. The DOE needs NASA as a partner for critical financial, intellectual, and technical reasons; in particular, DOE needs NASA's expertise in the development of space-flight qualified hardware. It is our understanding that NASA plans to continue to support ongoing planning efforts for the project, including appropriate research and development, technology development, and mission concept studies.

Question. What is your strategy to ensure that both DOE and NASA move forward to make this project happen in a timely manner?

Answer. With the help and guidance of the White House Office of Science and Technology Policy, NASA and DOE are continuing a dialogue on this subject. At a recent meeting with NASA to discuss their strategic plan development, we emphasized the importance of JDEM to DOE and our commitment to the project. NASA assured us that JDEM is very important to them as well. We will continue discussions with NASA aimed at bringing this very important science project to fruition.

Question. As described in the fiscal year 2005 Energy and Water bill, this program has organized a tremendous team of talented scientists and engineers; failure to move forward quickly may endanger this dynamic group. Does DOE intend to move forward aggressively to ensure this program does not wither on the vine?

Answer. Yes. DOE plans to continue to provide R&D funds for SNAP, and we continue to pursue discussions with NASA about this exciting program.

SOLID STATE LIGHTING

Question. Dr. Orbach, you had a very important workshop last March on the "Nanoscience Research for Energy Needs", and you know that one of Nanoscience Research Centers is located in New Mexico. Can you please explain the importance

of solid state lighting as a nanoscience thrust area from this workshop and these Nanoscience Research Centers?

Answer. "Solid state lighting at 50 percent of the present power consumption" emerged from this interagency workshop as one of nine research targets in energy-related research in which nanoscience is expected to play a key role. At present, electricity use accounts for about one-third of total energy consumption in the United States. Of that, about 20 percent of all electricity consumed goes for lighting. However, today's lighting is remarkably inefficient. For incandescent lighting, only about 5 percent of the electrical energy is converted to visible light; for fluorescent lighting, this increases to 25 percent. By comparison, building heating is typically 70 percent efficient, and electrical motors typically 85–95 percent efficient. Lighting therefore represents a large target for improved energy efficiency. Cutting the amount of electricity needed for lighting in half would result in a savings roughly equivalent to the annual energy production of 50 nuclear reactors. The use of semiconductor-based light emitting diodes (LEDs) for general illumination is a rapidly developing technology that offers the potential of immense energy savings to the Nation and the world within a decade or two. For colored lighting, LED's have already replaced over one third of the traffic lights in the United States, resulting in a savings of about $1,000 per intersection per year. However, a number of science and technology obstacles must be overcome in order for solid-state lighting to reach its potential. The research target now is to bring this new technology to the general white-lighting applications where the potential impacts are tremendous. However, before new devices can be made commercially available, improvements are required, particularly involving materials designed at the nanoscale and integrated into real-world devices. We expect one or more of our Nanoscale Science Research Centers to become actively involved in this energy challenge.

NUCLEAR PHYSICS

Question. Dr. Orbach, the Office of Science 20-year facilities plan, released in November 2003, ranks the Rare Isotope Accelerator B called RIA B as one of its highest priorities. Yet the Department recently removed the draft RFP for RIA from its website. What is your timeline for proceeding with RIA?

Answer. The Department published a draft Request for Proposal (RFP) for RIA and comments from potential offerors have been incorporated into a final version. However, a Request for Proposals will not be issued at this time.

As you know funding for domestic programs will be constrained in the future and the decision to proceed with RIA must be made in the context of competing priorities and the needs of the Nation. Before proceeding with a project like RIA that requires a significant investment by the U.S. Government, the funding to construct and operate the proposed facility needs to be identified and the decision to proceed must be made in the context of other Departmental and national needs and priorities. Under the fiscal year 2006 request, necessary research and development work will continue on the RIA project. The Nuclear Science Advisory Committee has been asked to examine the future of RIA in the context of constrained budgets and competing priorities. Their report is due in the summer of 2005.

STRATEGY ON ADVANCED COMPUTING

Question. Dr. Orbach, the Department has made a significant investment in both NNSA's and the Office of Science's efforts to improve speed, efficiency and capacity in advanced computing. Can you give us your strategy for the Civilian Computing Program, and what is your plan for reaching a 100 teraflop machine for non-weapons related research?

Answer. The Office of Science strategy for advanced computing is focused on delivering the best science for the United States. This strategy is built on four principal elements:

—(1) The Office of Science's world leading research program in applied mathematics and the computer science of high performance computers. These efforts have resulted in most of the mathematical algorithms and software that underpin high performance computing for science. The improvements in scientific computing that have resulted from these efforts have yielded an increase in capability over the past 2 decades that equals all of the increases due to Moore's law for microprocessors.

—(2) Our investments across the Office of Science in the Scientific Discovery through Advanced Computing (SciDAC) effort. This effort, which we initiated in fiscal year 2001, ensures that we transfer the results of our research in applied mathematics and computer science to the other scientific disciplines as quickly and effectively as possible. This effort has resulted in significant improvements

to many scientific applications, in fields that range from astrophysics to magnetic fusion to global change. For example, in one astrophysics code the time to solution was reduced by 75 percent. We are expanding SciDAC in fiscal year 2006 with a competition for SciDAC institutes that can be high performance computing software centers.

—(3) Significant enhancements to our high performance capacity computing at NERSC and our connectivity to the research community through ESnet. We expect to nearly double the capacity available for scientific discovery at NERSC by the end of fiscal year 2006.

—(4) Finally, we have established the Leadership Computing Facility (LCF) at Oak Ridge National Laboratory, which will field a 20 Tflop Cray X1e and a 20 Tflop Cray Red Storm (now called XT3) computer as resources for science. These computers will each support a small number of competitively selected teams that are poised to use these resources for breakthrough science.

Our programs balance all of these elements to deliver the most and best science for the country; therefore, we are not focused on achieving a specific level of peak performance. We hope to be able to increase the capability of the LCF in future years as improved computers that can deliver their performance on scientific applications become available; however, we believe that these increases must be part of a balanced program to deliver the mathematical, software and computer hardware tools that computational scientists will need.

QUESTIONS SUBMITTED BY SENATOR THAD COCHRAN

BIOMASS RESEARCH AND DEVELOPMENT

Question. Mr. Garman, it is important to implement a regional approach to biomass research because of the diversity in the United States. Biomass sources and techniques in Mississippi are much different than the biomass opportunities available in the Midwest. How do you perceive the Department's role in facilitating a regional approach to research and development?

Answer. The Department strongly supports State and regional partnerships to advance our biomass research. In looking at developing our domestic energy resources from a national perspective, the Department can help to identify and support State and regional efforts that contribute to meeting our national energy needs. State-regional partnerships are currently conducting work in many areas of biomass research, including bio-renewable fuels, bio-based lubricants, and bio-chemicals. Such partnerships will continue to be critically important to our efforts to develop technologies that will enable a robust biomass-based industry.

BUILDING NEW NUCLEAR POWER PLANTS

Question. Mr. Magwood, Mississippi is home to the Grand Gulf Nuclear Station. What do you see as the main issues facing U.S. generating companies who might wish to build new nuclear plants? Do you believe Congress can help the Department of Energy to build new nuclear plants?

Answer. We believe that the main issues facing U.S. generating companies are:

—*Permanent Nuclear Waste Disposition*.—Orders of new nuclear plants are dependent upon steady progress toward a clear disposition path for spent nuclear fuel;

—*Price-Anderson Indemnification*.—Although plants currently operating continue to be indemnified through the terms of their licenses, coverage is not currently available for any new nuclear power plant licensed after December 31, 2003;

—*Regulatory Uncertainty*.—Power companies lack confidence that the new licensing processes specified in 10 CFR Part 52 will prevent unnecessary and excessive delays in the construction and commissioning of new plants; and,

—*Economic Uncertainty*.—Although power companies' confidence in the estimated cost of new nuclear power plants is growing, no new nuclear plant has been ordered and built in the United States for over 30 years.

With your continued support, the Department's Nuclear Power 2010 program is making progress in addressing some of the regulatory and economic uncertainties.

QUESTIONS SUBMITTED BY SENATOR LARRY E. CRAIG

NEXT GENERATION NUCLEAR PLANT (NGNP) AT IDAHO NATIONAL LABORATORY

Question. Mr. Magwood, in recent testimony, Secretary Bodman has expressed concern about the cost of building the Next Generation Nuclear Plant at the Idaho

National Laboratory. As you know, Senator Domenici and I view the NGNP as the cornerstone of the U.S. effort to remain a leader in innovative nuclear technologies for the future. I know the NGNP plan you have developed includes significant cost sharing with private industry. Can you help explain for the subcommittee how you would like the private sector to help share in the cost of building NGNP and why you think they would do it?

Answer. Before any private sector investment can be contemplated, we must complete the viability research and development anticipated by our Generation IV program. Our primary focus at this time is to assure that the Generation IV research program is able to answer the basic viability questions regarding this advanced technology. We will continue research and development on various Generation IV reactor designs to determine their compatibility with the desired goals of sustainability, economics, and proliferation resistance. This includes work on materials performance as well as evaluating the waste products associated with various reactor designs. As these questions are answered, we can consider additional steps in the future. If the Department ultimately decides to proceed with a demonstration of a nuclear reactor technology, we would look to consult with the private sector.

IDAHO NATIONAL LABORATORY

Question. Mr. Garman, I know this is a little out of your area but as the former acting Under Secretary at DOE you have been engaged in this issue. Yesterday, I was informed that the Department of Energy would miss the self-imposed March 15 deadline to award the Idaho Cleanup Project contract. DOE will apparently miss the deadline even though the Idaho delegation urged DOE to expedite the contract award and Secretary Bodman assured us DOE would meet or beat the deadline. Can you tell me why the deadline has been missed and when DOE will make the contract award?

Answer. The Idaho Cleanup Project contract award was officially announced on March 23, 2005. Although the Department had every intention of meeting the earlier March deadline, the additional delay was necessary to allow for the completion of administrative requirements that will ensure the integrity of the procurement process and ensure the execution of a sound contract, given its magnitude and scope.

IDAHO NATIONAL LABORATORY

Question. Mr. Magwood, congratulations on a successful transition at the Idaho National Lab. I think the Battelle Energy Alliance is off to a good start and I want to work with you, Secretary Bodman, Clay Sell, Dave Garman and others to make sure we continue to make progress at the lab. Can you identify areas where you think we need to focus our attention to make sure the INL becomes the world class nuclear energy lab we want?

Answer. The laboratory will consolidate operations and the site's footprint this fiscal year, a key step in enabling a successful transformation. In concert with the consolidation, the Battelle Energy Alliance (BEA) seeks to make changes in areas that will support the laboratory within a fiscally responsible budget envelope. Areas in which the BEA could direct its attention include: attracting the best scientists and engineers to participate in the laboratory's research initiatives; building extensive international and national partnerships and robust synergistic programs in areas such as homeland security and national security; and continuing research on breakthrough nuclear technologies. In addition, the laboratory seeks to modernize and align its infrastructure with the laboratory's research portfolio and potentially invest in nuclear science and technology education. Investments in the infrastructure will be prioritized and developed in concert with the Department's budget formulation process.

Question. Mr. Magwood, I know your office has put together a 10-year site plan that assesses the infrastructure needs at the INL. Do you think future budgets will be adequate to recapitalize the infrastructure at the INL or will we need options like third party financing to get where we need to go?

Answer. Future budgets will be determined by using the Department's annual budget formulation process. This process will be used to prioritize recapitalization projects at INL and to reduce the maintenance backlog. As we develop future budgets, we will continue to update the plan to carefully prioritize the allocation of funding to the most important infrastructure projects. In addition, if appropriate, the Department may consider using third party financing.

CELLULOSIC ETHANOL COMMERCIALIZATION

Question. Mr. Garman, I believe that you are aware that a company called Iogen has developed a technology that enables them to produce ethanol from agricultural wastes such as wheat, straw, and corn stalks. They have demonstrated their technology in a 50,000 gallon facility that is producing ethanol for sale every day. Now Iogen wants to start building commercial-scale ethanol plants that will produce 50 million gallons of ethanol per year. Those plants will provide $15 or $20 of additional revenue per acre for farmers who are selling them wheat straw, and create hundreds of quality jobs in rural America. The ethanol from those plants will reduce our dependence on foreign oil and reduce our emissions of greenhouse gas. The USDA has estimated that existing residues from farming activities would support hundreds of such plants, and could offset 10 percent or more of our foreign oil consumption. You also know Iogen has gotten substantial financial backing from a multinational oil company—Shell Oil—to develop this technology. Despite this, it can not get a commercial loan for the project because lenders will not go near new technology. Like some others, this technology is trapped in the "valley of death"—the time when it is past the research and development phase—but not yet commercially proven. In the "valley of death", government grants are useless, and commercial loans are out of reach. How can the U.S. Government step up its commitment and accelerate the advent of this incredibly important new technology?

Answer. The Biomass Program within our Office of Energy Efficiency and Renewable Energy is working with commercial lending institutions to determine the additional requirements needed to turn demonstrated technology into financially viable projects. As appropriate, the Department funds cost-shared competitive solicitations aimed at demonstrating technologies to the satisfaction of commercial lenders.

Question. How can we bring this well-demonstrated technology out of the "valley of death" and into the marketplace now—and not wait 2 or 3 or 4 years?

Answer. The Department is not convinced that this technology is commercially viable at this time and therefore is unwilling to commit to accelerated deployment activities.

QUESTIONS SUBMITTED BY SENATOR PATTY MURRAY

REPLACEMENT FACILITIES AT PACIFIC NORTHWEST NATIONAL LABORATORY

Question. Dr. Orbach, for the past 2 years, Pacific Northwest National Laboratory (PNNL) has been working with the Department of Energy (DOE) Office of Science, NNSA, and DHS to prevent the loss of important R&D capabilities at risk because of accelerated cleanup of the 300 Area of the Hanford Reservation. There has been progress: in September 2004, DOE, with input from NNSA and DHS, confirmed the critical need for the capabilities housed in 300 Area through approval of Critical Decision 0 (CD–0). The Department has also requested funds in the fiscal year 2006 administration request. I want to thank you, Dr. Orbach, for your support and leadership on this critical effort. That said, the amount of funding requested is not sufficient to allow PNNL to meet the aggressive exit schedule required by the River Corridor Cleanup contract, which is still expected to be released this spring, and will require shutdown of work in the 300 Area by 2009. Can you detail the Department's plan and schedule for constructing the replacement facilities needed at PNNL?

Answer. The Office of Science fiscal year 2006 requested funding of $3 million is to complete its share of the funding of the Project Engineering and Design (PED) for the potential PNNL replacement facilities. The amount would be consistent with the overall plan for constructing the facilities by the September 2009 deadline. NNSA is also requesting $5 million of PED in fiscal year 2006 to support the project. A summary table of funding to date is shown below.

PNNL REPLACEMENT FACILITY FUNDING

[Budget authority in thousands of dollars]

	Fiscal Year 2004 Approp.	Fiscal Year 2005 Approp.	Fiscal Year 2006 Request
Office of Science	986	4,960	3,000
NNSA	600	5,000	5,000
Total, DOE	1,586	9,960	8,000

It is too early in the formal DOE project management process (i.e., the Critical Decision 1 review is scheduled for this summer) to fully address your question about the future schedule for this facility, though we are quite confident about our ability to deliver a potential replacement facility by end of fiscal year 2009 if necessary.

ENVIRONMENTAL MOLECULAR SCIENCE LABORATORY FUNDING

Question. Dr. Orbach, the Environmental Molecular Science Laboratory (EMSL), a national scientific user facility operated for the DOE and located at Pacific Northwest National Laboratory, has been operating for 7 years. Over that time, EMSL has a sustained growth rate of about 25 percent per year, and is currently fully subscribed. In 2004, more than 2,100 scientists from all 50 States and around the world utilized EMSL's extraordinary capabilities. Unfortunately, since its inception, the EMSL operations budget has remained flat except for one increase to replace its super computer. With inflation and increased space and labor costs, the "buying power" of the EMSL operations budget is now less than 84 percent of what it was in fiscal year 1998. There is thus no remaining flexibility in the operations budget, and without at least modest increases, user time and experiments will almost certainly be curtailed. How do you plan to address shortfalls in user facility funding such as those faced by EMSL?

Answer. The Biological and Environmental Research (BER) program recognizes the value that EMSL brings to scientific users engaged in molecular level research, and that the ever increasing number of users reflects that value. As a result of this recognition, the BER program has scheduled an expert peer review of EMSL's operations and funding by a subcommittee of the BER Advisory Committee in mid-May 2005. One of the purposes of this upcoming review is to examine EMSL's current capabilities and areas of scientific expertise and to make recommendations to refine the focus of molecular-level research, identify the most important capabilities to maintain and to examine opportunities to increase the efficiency of operations.

Question. Can you commit that you will support efforts in Congress to provide additional funds for Office of Science user facilities, including EMSL?

Answer. We fully support the fiscal year 2006 President's Budget request for the Office of Science.

DOE SUPPORT FOR TRAINING RADIOCHEMISTS

Question. Mr. Magwood, all of the DOE's national laboratories are projecting the need for hiring chemists with expertise in nuclear science and nuclear applications, e.g. radiochemists. These radiochemists are needed by the national laboratories to address problems such as advance nuclear fuel cycles, nuclear forensics for proliferation detection and prevention, resolving legacy environmental issues from the Cold War, etc. At the same time, most universities have allowed their programs in radiochemistry to end due to perceived limited long-term funding opportunities in the area, especially in comparison to other Federal agencies. Because of this decline in academic radiochemistry programs, universities in the United States will likely not be able to produce enough radiochemists to meet DOE's work force needs without assistance from DOE. Mr. Magwood, what plans are being made by DOE to support our Nation's universities that are currently training radiochemists and to enable those universities to significantly increase the number of students they are training?

Answer. The Department's Office of Nuclear Energy, Science and Technology initiated a grant program designed to arrest the decline in the radiochemistry discipline at U.S. universities in fiscal year 1999. We are continuing this program and expect to make awards to three or four schools in 2005. We have allocated $300,000 per year for this program. These funds will be used for recruiting and retaining graduate and post-graduate students and for the support of faculty and radiochemistry research. Our radiochemistry program continues to strengthen the discipline in the United States.

Question. Mr. Magwood, what is DOE's plan to invest in research programs at these universities and to assist these institutions in upgrading their laboratories for hands-on work with radioactive materials?

Answer. Our plans for fiscal years 2005/2006 are to continue the support of the Nuclear Engineering Research and Education (NEER) program at about $5.0 million with the number of awards varying between 15–26 each year to the Nation's universities. We will continue to upgrade facilities, including laboratories and research reactors to enable students and faculty to conduct research at universities through the Innovations in Nuclear Infrastructure and Education (INIE), involving 33 institutions in six distinct research consortia. INIE has provided and will continue to provide the means for universities to cooperate with each other in achieving research

that benefits not one university but many. In addition, the University Reactor Instrumentation program will provide funding for equipment upgrades at university reactors and associated facilities as well as for the purchase of security equipment to ensure increased facility security. All of these programs are designed to provide students the opportunities to have hands-on research throughout their academic careers.

Question. Mr. Magwood, our university research reactors in the United States are playing a vital role in supporting essential nuclear infrastructure for our country. For example, some are used by scientists in the national laboratories for nuclear security purposes, by other industries for various commercial applications, and by medical communities to develop new technologies for the diagnosis and treatment of diseases. Most of the Nation's university research reactors benefit significantly from the regional university reactor consortia described above, but some do not, especially when they are not associated with a nuclear engineering program. The facility at Washington State University serves our Nation very effectively, especially in detecting nuclear proliferation, but benefits only marginally from the Western States University reactor consortium because WSU does not have a nuclear engineering program. Mr. Magwood, what plans are being made by DOE to assist such university programs in the maintenance of this critical infrastructure for the Nation while also providing nuclear science education in areas such as radiochemistry?

Answer. The DOE Office of Nuclear Energy, Science and Technology (NE) University Programs effort is designed to support a wide variety of universities including those with radiochemistry, health physics and nuclear engineering programs. In addition, there are approximately 12 schools receiving support from NE that do not possess a nuclear engineering program. These schools, either through the Innovations in Nuclear Infrastructure and Education (INIE) program or other educational programs, are receiving funding to support students, faculty and research. We consider these institutions to be vital to the scientific infrastructure of our universities and the Nation.

SUBCOMMITTEE RECESS

Senator DOMENICI. With that, thanks for your efforts, and for your testimony, and we stand in recess.

[Whereupon, at 3:08 p.m., Tuesday, March 15, the subcommittee was recessed, to reconvene subject to the call of the Chair.]