The Future of Nuclear Energy R&D at the Department of Energy

Prepared Remarks of
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Good afternoon and thank you for participating in this very important event. Before I begin my remarks, I would like to thank both Congressman Joe Knollenberg and Dr. Artie Bienenstock for taking the time to appear this morning and for their remarks regarding the importance of nuclear energy. I look forward to working with Mr. Knollenberg and other members of Congress in determining the future course of Federal activities in the development of nuclear energy. I would also like to recognize the many and very important efforts of Dr. John Ahearne, not just for leading the Program Committee that supported us in making the event a reality, but also for his contributions to the report issued late last year by the Panel on Federal Energy R&D of the President's Committee of Advisors on Science and Technology (PCAST), which in large part set us on the direction of creating a new approach to conducting nuclear energy research in the Department of Energy.

The timing for a new look at Federal nuclear energy R&D is auspicious. The United States is engaged in a comprehensive discussion affecting future energy use and production -- issues such as electric utility restructuring and global climate change are receiving extensive national attention.
The nuclear power option avoids combustion emissions that contribute to environmental problems, while also contributing to security of energy supplies that are not dependent upon oil imports. Nuclear power also faces real challenges.

Here I will outline relevant national energy strategy objectives; review the energy and environment considerations shaping our nuclear R&D initiatives; briefly characterize those initiatives and the obstacles they must address; and conclude with some reflections on the larger U.S. role involving nuclear power.

A Comprehensive National Energy Strategy

Energy is a vital component of our societal infrastructure and national economy. The United States spends more than $500 billion annually for energy, accounting for over 7.5 percent of our gross domestic product. The annual electricity bill for American consumers is roughly $200 billion and the cost of energy for U.S. manufacturing industries alone stands at $100 billion per year.

Commensurate with the importance of energy to the United States, the Department of Energy recently completed a *Comprehensive National Energy Strategy* that provides a framework for the specific actions that will be taken by the Federal Government to ensure that the Nation's current and future energy requirements can be met in a way that continues to grow the economy while improving protection of the environment and the health and safety of the American people. The strategy sets forth the following five common sense, high-level goals:

Goal I. **Improve the efficiency of the energy system.**
Goal II. **Ensure against energy disruptions.**
Goal III. **Promote energy production and use in ways that respect health and environmental values.**
Goal IV. **Expand future energy choices.**
Goal V. **Cooperate internationally on global issues.**

Under the goals are a tiered series of objectives and strategies. For instance, under Goal I on efficiency is an objective to "support competitive and efficient electric systems." Under that objective is a strategy to "improve the reliability and performance of the operating nuclear plants, which number more than 100, to help meet the Nation's future electrical power needs more efficiently."

The Department adopted that strategy because U.S. nuclear power plants should see improvements in operating capacity -- as much as 10 percentage points in the next several years (from 76 percent to 86 percent) -- with further technological developments. A performance improvement of this amount in the operating plants would offset as much as 10 gigawatts of new electrical output capacity. (Similarly, if nuclear plants are shutdown in the coming years, losing that capacity would make meeting Kyoto targets more difficult.)

Under Goal III, promoting energy production, the Department adopted a strategy to "maintain a viable nuclear energy option." We believe that nuclear power may be an essential element in the overall energy supply mix of the United States and the world.

Under Goal IV, developing technologies to expand long-term energy options, the Department specifically supports development of low-cost proliferation-resistant nuclear fission reactor technologies. This will sustain future options.

Under Goal V, concerning international cooperation, the Department recognizes the importance of the United States being an active participant in the International Atomic Energy Agency and the Nuclear Energy Agency.

Lastly, with regard to the Comprehensive National Energy Strategy, the Department recognizes implementation requires a shared commitment among the various levels and branches of government. But this commitment must also extend beyond government to the private sector and to the nonprofit sector in order to mobilize sufficient resources to achieve our energy goals. As a step in this direction, I recently signed together with Mr. Kurt Yeager, President of the Electric Power Research Institute (EPRI), a *Joint DOE-EPRI Strategic Research and Development Plan to Optimize U.S. Nuclear*

Power Plants, which is intended for a broad audience.

Energy and the Environment

Discussion of the linkage between energy and the environment is especially timely. Energy production and use are principal contributors to local, regional and global environmental problems. Smog, acid rain and particulates affect quality of life at local and regional levels. On a global scale, there is no serious doubt that human activities associated with energy production and use, primarily of fossil fuels, have over the last few decades significantly altered the composition of atmospheric gases. Under a "business as usual" projection, world carbon emissions are expected to increase by 3.5 billion metric tons over current levels by 2015, if world energy consumption reaches the levels projected by the Energy Information Administration (EIA). Although a detailed understanding of regional impacts awaits further research, scientific analysis suggests that we should be concerned about the possibility of major societal dislocations. Prudence demands a measured but strong response in ensuring that sustained technological innovation positions us for continued prosperity and quality of life.

One of the most important jobs of the Department of Energy is, through its energy R&D programs, to enhance the Nation's economic, environmental and national security. To do this job, the Department maintains a diverse R&D portfolio. Because no single energy option can solve all our problems in the decades ahead, many energy options could become part of the solution. This philosophy underpins the Department's advanced energy technology initiative.

Our success in reaching our energy and environment goals tomorrow depends on our energy R&D investments today. This is complicated by the time scales involved. We must consider the time scales of conducting R&D, with that of building new technology, with that of having an impact on carbon emissions. With the very best technologies, society can use energy resources efficiently and responsibly and still realize great economic and environmental gains. We are identifying energy "technology road maps" to help define the wide range of generic technologies that could be developed to enhance our energy goals over time -- all these pathways are designed to help us realize each of the goals found in our *Comprehensive National Energy Strategy*.

Nuclear energy is an important element of this strategy. Nuclear power plants are today obviously a very important component of the energy supply mix of both the United States and the world. Nuclear energy currently provides almost 22 percent of U.S. electricity generation and can continue to contribute a significant portion for many years to come. Nearly half of the 50 U.S. States receive over 25 percent of their electricity from nuclear power. Nuclear energy generates approximately 17 percent of the world's electricity from more than 440 nuclear plants in 30 countries.

Worldwide, 15 countries generate at least 30 percent of their electricity from nuclear energy; 77 percent in France, 33 percent in Japan, and 26 percent in the United Kingdom.

Nuclear energy generates electricity without producing carbon dioxide, sulfur oxide, or nitrous oxide

emissions that occur with the use of fossil fuels. It therefore can be an important part of an energy technology portfolio necessary to reduce greenhouse gas emissions and to ensure that we maintain a flexible and diverse energy supply.

The DOE 11-Lab Study

Yesterday, on Earth Day 1998, the Directors of 11 of the Department's National Laboratories issued a study called *Technology Opportunities to Reduce U.S. Greenhouse Gas Emissions*. The study was prepared at the request of Secretary Peña, who charged the lab directors to identify technologies that could be used to meet the challenge of reducing greenhouse gas emissions in the United States.

In the report to the Secretary, 47 technology pathways are described that have significant potential to reduce carbon dioxide emissions. It is clear that we will need to pursue many of these pathways, and pursue them sooner rather than later, if we are to provide the choices and flexibility necessary to meet our emissions reduction goals.

Two of the technology pathways identified in the 11-Lab study are of particular interest. The first is *Lifetime Extension and Generation Optimization for Nuclear Power Plants.* The Lab Directors recommend that the near-term approach to the use of nuclear energy should be to provide technologies to increase electricity generation and extend the lifetimes of the existing nuclear power plants. If the United States were to have to replace these existing plants with fossil-fueled plants, carbon dioxide emissions would increase by about 100 metric tons of carbon per year. Both the renewal of plant licenses and increases in plant capacity factors can be enabled by new nuclear and non-nuclear technologies. The Department's proposed Nuclear Energy Plant Optimization, or NEPO, program would address this recommendation.

The second technology pathway related to nuclear power is *Next-Generation Fission Reactors*. The Lab Directors recommended the installation of evolutionary and advanced fission reactors as a mid-term approach to the use of nuclear energy. This approach could involve either the direct production of electricity using nuclear power, or could involve a concept such as a nuclear-hydrogen cycle in which nuclear heat is used for the production of hydrogen, with subsequent use of hydrogen as an energy source. The development of more innovative fission reactors is one of the areas of investigation proposed for the Nuclear Energy Research Initiative, or NERI, which is the focus of this workshop.

In addition to these technology pathways, the Lab Directors identified key federal actions that are critical to maintaining the viability of nuclear power in the United States. These actions include continuing to maintain support for improved nuclear safety in the former Soviet countries to reduce the risk of another major nuclear accident, and providing assistance to maintain a healthy nuclear energy technology and education infrastructure. The Department has an International Nuclear Safety Program and a University Support Program that responds to these recommendations.

All of the studies we have seen in the last year that address the shape of future Federal participation in nuclear energy R&D reflect the need for both short and long term research efforts. The Department, in its fiscal year 1999 budget request, has proposed NEPO to address both the imperative of enabling the United States to meet its environmental goals in the 2010 time frame and NERI for developing technologies needed for the longer-term future, well after 2010.

PCAST, NEPO, NERI

Nuclear power faces some serious obstacles to its continuation as a major resource in the United States. The President's Committee of Advisors on Science and Technology (PCAST) identified these obstacles as nuclear waste disposal, cost, reactor safety and the potential for weapons proliferation. The PCAST recommendations for the Department's future R&D portfolio were organized around these issues. Of these obstacles, the waste issue is among the most immediate: it is hard to imagine any new plants being commissioned until this problem is solved. With regard to the country's operating nuclear power plants, PCAST recommended that the Department "work with its laboratories and the utility industry to develop a program to address the problems that may prevent continued operation of current plants." With regard to preserving the nuclear option for the future -and this was the PCAST's major recommendation on fission energy, PCAST recommended that the Department establish a new program that "would competitively select among proposals by researchers from universities, national laboratories, and industry to address these issues affecting the future of fission energy including:

- Proliferation-resistant reactors or fuel cycles;
- New reactor designs with higher efficiency, lower-cost and improved safety to compete in the global market;
- Lower-output reactors for use in settings where large reactors are not attractive; and
- New techniques for on-site and surface storage for permanent disposal of nuclear waste."

Reinforcing the PCAST report was a study conducted by seven of the Department's national laboratories. Their report to Secretary Peña identified three vital challenges:

- Continuing U.S. influence in international technical and policy arenas as other countries implement the nuclear energy option;
- Maintaining technical competencies in areas key to nuclear energy and security; and
- Ensuring a viable nuclear energy option for the nation to address environmental and energy security issues.

To address these challenges the DOE lab directors stated that the Department must have a strong nuclear energy R&D portfolio in five key areas:

- Nuclear Energy Basic Research (Joint University/National Laboratory)
- Nuclear Energy R&D to Meet U.S. Carbon Emissions Reduction Goals
- Enhanced Proliferation Resistance of the Nuclear Fuel Cycle

- Cooperative Development of High-Efficiency Nuclear Fuel
- International Nuclear Cooperation

The Department has embraced these recommendations by PCAST and the seven lab directors and seeks to implement the essence of them through our proposed Nuclear Energy Plant Optimization (NEPO) and Nuclear Energy Research Initiative (NERI) programs. NEPO will be conducted in cooperation with the Electric Power Research Institute through the previously mentioned *Joint DOE-EPRI Strategic Research and Development Plan to Optimize U.S. Nuclear Power Plants*.

With regard to NERI, the Department is committed to developing a process of selecting projects on a competitive, peer-reviewed basis. This process, which will be finalized in the coming weeks, will assure that researchers throughout the country have wide latitude to propose ideas and concepts that can address the major challenges to the future expansion of nuclear power. In particular, we hope in fiscal year 1999 to solicit proposals in five general areas:

- *Proliferation-Resistant Reactors and Fuel Technology*, which will focus on technologies that can address proliferation concerns associated with the export of nuclear power systems to developing countries, such as small, "lifetime core" power systems and advanced proliferation-resistant fuels;

- *New Reactor Designs with Higher Efficiency, Lower Cost, and Improved Safety*, which could provide the United States with an advanced energy option superior to existing nuclear plants;

- *Lower-output Reactors*, which could be used for special domestic applications or overseas in countries that lack large expensive infrastructures that are needed to operate existing, large nuclear power plants;

- *New Technologies for On-Site and Surface Storage and Permanent Disposal of Nuclear Waste*, which might include interesting concepts for the long-term future such as the use of accelerator systems to transmute long-lived high-level wastes; and

- *High Efficiency Nuclear Fuel*, which could reduce the generation of spent fuel in nuclear power plants by up to 50 percent and reduce the costs and risks associated with storing, transporting, and disposing of spent nuclear fuel from U.S. nuclear power plants. Moreover, implementation of advanced nuclear fuel could extend the operating cycle of nuclear power plants from the current two years to up to three years, which would have significant positive benefits for U.S. global climate change mitigation objectives.

NERI is the central focus of our future program, which emphasizes the importance of this workshop. The Department sees NERI as a means of finding the best ideas, irrespective of where they originate and encouraging creative thinking and the development of new technologies to deal with the obstacles to the long-term expansion of nuclear energy. This workshop is a key event in the Department's effort to usher this program from a concept to a functioning research program. We hope to obtain your views today and tomorrow on a wide array of topics and to set this new initiative on a pathway to

success.

International Leadership

Historically, U.S. leadership in the development of nuclear technology has provided us a key role at the table in international discussions over the application and control of nuclear technology. We have been able to leverage our technology to make vital gains in areas such as nonproliferation and nuclear safety.

We need to continue to work with countries with substantial, mature nuclear power programs, such as France and Japan. And we need to work with those where the debate over the future of nuclear power has not concluded, but where the potential is large, such as Russia, China and Ukraine. The United States has a very important strategic interest in working wherever possible with all countries to assure that the nuclear infrastructures they build are safe and proliferation-resistant.

But future U.S. effectiveness is in part dependent upon a vigorous nuclear technology R&D program. While many countries still see the United States as the world leader in nuclear technology, this perception has eroded. The nuclear energy industrial base in the United States has diminished over the last decade; our universities are closing their research reactors and terminating or consolidating their nuclear engineering programs; and the Federal infrastructure needed to support advanced nuclear energy research and development is declining. Other nations, most notably Japan, France, and South Korea have made significant investments in and contributions to nuclear technology R&D.

The NERI program can serve as the basis of a long-term future for Federal nuclear energy R&D. We hope to engage the international community in a new dialogue over the priorities and future for nuclear energy R&D.

We hope to cooperate with Japan, France, and other countries in carrying out needed research.

We also hope to work with emerging industrial economies such as China in order to assure that the United States is fully engaged in their plans to expand nuclear capacity.

Our cooperation with Russia is particularly important, complex and worth noting here. Russia has a large nuclear growth potential and a robust nuclear technology R&D program. At the same time, there is the legacy of the Cold War to address where the U.S. and Russia are working together to disposition plutonium from weapons. The United States is embarked on a MOX strategy involving once through MOX runs in reactors for this limited but crucial purpose, anticipating that all excess weapons plutonium will be burned before there is any commercial recycling. Hence, while useful for the specific purposes of U.S.-Russian weapons plutonium disposition, economically and on nonproliferation grounds, the rationale for MOX is less compelling for nuclear commerce more generally. Success in achieving nuclear materials security and reducing the nuclear danger are a critical backdrop to commercial nuclear power in the future.

Using NERI as a base, we can preserve essential nuclear options and achieve work needed with other nations in preparing for the next century.

Conclusions

As I said earlier, nuclear power faces significant challenges: cost, proliferation, safety and most importantly waste. The Department of Energy, for its part, can help foster the development of new technologies to address these problems. But the nuclear power industry must also deal with the non-technical aspects of these issues. In that regard I urge the industry to engage in more dialogue with a wider representation of our society. It is particularly important that the nuclear industry work with environmental organizations to hear and address their concerns.

Despite its problems, nuclear power is an essential part of today's domestic and world energy systems. Nuclear power remains the only major source of baseload electricity available to us today that does not produce carbon dioxide and this makes it an obvious option as we consider how to stabilize and reduce greenhouse gas emissions. The industry is moving in the right direction in making its plants more efficient and cost-effective producers of electricity.

This is a critical moment in defining the future of nuclear energy R&D. There is a play on the old adage that "if you don't know where you are going, any road will get you there," namely, "if you don't change direction, you'll end up where you are headed," that comes to mind. We need strong, competitive proposals to revitalize the nuclear option.

If we are able to address its problems, nuclear power could continue to be a major source of energy throughout the next century. This workshop represents an important symbol of the Federal effort to make nuclear energy's potential as a clean, safe, reliable, proliferation-resistant, and cost-effective option available for future generations.