OPPORTUNITIES AND CHALLENGES FOR NUCLEAR POWER

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

APRIL 23, 2008

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April 23, 2008

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OPPORTUNITIES AND CHALLENGES FOR NUCLEAR POWER

WEDNESDAY, APRIL 23, 2008

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:05 a.m., in Room 2318, Rayburn House Office Building, Hon. Bart Gordon [Chairman of the Committee] presiding.

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U.S. HOUSE OF REPRESENTATIVES

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Hearing on

Opportunities and Challenges for Nuclear Power

Wednesday, April 23, 2008
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Ms. Marilyn Kray
President, NuStart Energy, and Vice President, Project Development, Exelon Nuclear

Mr. Robert Van Namen
Senior Vice President, Uranium Enrichment, United States Enrichment Corporation (USEC)

Mr. Jim Asselstine
Managing Director (retired), Lehman Brothers, and former Commissioner, Nuclear Regulatory Commission

Dr. Thomas Cochran
Senior Scientist, Nuclear Program, National Resources Defense Council (NRDC)

Mr. Robert Fri
Visiting Scholar, Resources for the Future, and Chair of the National Research Council Report "Review of DOE's Nuclear Energy Research and Development Program"

Vice Admiral John Grossenbacher
Director, Idaho National Laboratory, Department of Energy

HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Opportunities and Challenges for Nuclear Power

WEDNESDAY, APRIL 23, 2008
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Wednesday, April 23, 2008 the House Committee on Science & Technology will hold a hearing entitled *"Opportunities and Challenges for Nuclear Power."*

The Committee's hearing will explore the potential for nuclear power to provide an increased proportion of electric generating capacity in the U.S. Nuclear power generation offers the opportunity for increasing electricity generation without associated increases in greenhouse gas emissions, however, challenges to this expansion remain including high costs, waste disposal, and concerns about nuclear proliferation issues. The hearing will also examine the Department of Energy's programs to support and advance nuclear technologies and their potential to address the challenges associated with expansion of nuclear power generation.

Witnesses

- **Mr. Robert Fri** is a Visiting Scholar at Resources for the Future, and the Chair of a recent study conducted by the National Academies on the Department of Energy's nuclear research and development program. Mr. Fri will testify on the findings of this report.
- **Mr. Jim Asselstine** is a recently retired Managing Director at Lehman Brothers, and a former Commissioner of the Nuclear Regulatory Commission. Mr. Asselstine will testify on the current overall state of financing for new nuclear power plants.
- **Dr. Thomas Cochran** is a Senior Scientist in the Nuclear Program at the National Resources Defense Council (NRDC). Dr. Cochran will explain NRDC's position on whether nuclear power merits additional federal support in comparison to other sources of energy.
- **Mr. Robert Van Namen** is the Senior Vice President of Uranium Enrichment at USEC. Mr. Van Namen will describe the current status of the domestic uranium enrichment industry, and provide background on advancement of uranium enrichment technologies.
- **Ms. Marilyn Kray** is the President of NuStart Energy, and also the Vice President of Project Development at Exelon Nuclear. Ms. Kray will provide the perspective of utilities on the ability for nuclear power to significantly increase its share of electric generating capacity in the U.S.
- **Vice Admiral John Grossenbacher** is the Director of Idaho National Laboratory. Mr. Grossenbacher will testify on DOE's programs to support and advance nuclear energy.

Background

Nuclear power is derived from energy that is released when relatively large atoms are split in a series of controlled nuclear reactions. The resulting heat is used to boil water which drives a steam turbine to generate electricity. The process of splitting an atom is known as nuclear fission. Nuclear power represents approximately 20 percent of the total electric generating capacity in the U.S. with 104 nuclear plants currently operating. Because they are a low-carbon emitting source of energy in comparison to fossil fuels, increased use of nuclear power is being proposed by the Administration and several electric utilities as a way to mitigate climate change while meeting the Nation's growing energy needs.

Nuclear Waste Storage

There are, however, several drawbacks to the expanded use of nuclear power. Disposal of radioactive waste produced in nuclear power plants has been a significant issue for decades. While on-site storage has become a default interim solution, the *Nuclear Waste Policy Act of 1982* (NWPA) called for disposal of spent nuclear fuel in a deep, underground geologic repository. In 1987, amendments to the NWPA restricted DOE's repository site studies to Yucca Mountain in Nevada. Technical and legal challenges have since delayed its use until at least 2017. All operating nuclear power reactors are storing spent fuel in Nuclear Regulatory Commission (NRC)-licensed on-site spent fuel pools. Most reactors were not designed to store the full amount of the spent fuel generated during their operational life. Currently, there is over 50,000 metric tons of spent fuel stored in the United States. Earlier this year, the Administration proposed draft nuclear waste legislation repealing the 70,000 metric ton limit on the amount of waste that can be stored at the repository at Yucca Mountain. It is expected that the 70,000 metric ton limit would be exceeded by the waste generated from the nuclear plants currently operating in the U.S.

Waste Reprocessing

Reprocessing spent fuel could also eventually be necessary to meet nuclear fuel demands if worldwide growth meets projected targets. The Administration has proposed a multi-billion dollar federal program called the Global Nuclear Energy Partnership (GNEP) to foster the expansion of nuclear power internationally by having a select set of nations reprocess nuclear fuel for the rest of the world. GNEP expands upon the Department of Energy's Advanced Fuel Cycle Initiative, which has conducted a program of research and development in spent fuel reprocessing since 2002. A second objective of the GNEP program is to reduce the amount of radioactive waste requiring disposal in a geologic repository.

Technologies required to achieve the goals of the GNEP program are not yet fully developed and tested. Therefore further research is required before the facilities necessary to accomplish the intended goals of the program can be constructed and operated. GNEP includes the design and construction of advanced facilities for fuel treatment, fabrication, and an advanced reactor which raises concerns about the financial risks associated with the program. In addition, reprocessing spent fuel raises concerns about the potential for proliferation of weapons-grade nuclear materials because existing reprocessing technologies separate plutonium from the spent fuel. While the plutonium can be recycled into a new fuel for use in nuclear reactors, as is done in France, it can also be used to make nuclear weapons. DOE has yet to identify a proliferation-resistant method to achieve this goal.

Nuclear Fuel Supply

The nuclear fuel cycle begins with mining uranium ore, but naturally occurring uranium does not have enough fissionable uranium to make nuclear fuel for commercial light-water reactors. Therefore, the uranium is first converted to uranium hexafluoride before it is put through an enrichment process to increase the concentration of the fissionable uranium. Finally, the enriched uranium is fabricated into fuel appropriate for use in commercial light-water reactors.

The United States' primary uranium reserves are located in Arizona, Colorado, Nebraska, New Mexico, Texas, Utah, Washington and Wyoming. According to the Energy Information Administration, five underground mines and five in-situ mines were operating in the U.S. in 2006. Much of the world's uranium supply comes from Canada and Australia. While the security of uranium supplies is a policy concern, over-production in the industry's early years and the United States' maintenance of military and civilian stockpiles of uranium have helped to provide confidence that uranium resources can meet projected demand for multiple decades.

There is one conversion facility operating in the United States in Metropolis, IL. The expansion of the facility is expected to be completed this year.

The United States Enrichment Corporation (USEC) operates the only uranium enrichment facility in the United States. Commercial enrichment services are also available in Europe, Russia, and Japan. Recently, four companies announced plans to develop enrichment capabilities in the U.S. According to March 5, 2008 testimony in the Senate Energy and Natural Resources Committee by the President of the Louisiana Energy Services, it is more than a year into construction of an advanced uranium enrichment plant in New Mexico. In addition, USEC is undertaking the development of advanced enrichment technology through the American Centrifuge Plant, which is U.S. technology originally developed by the Department of Energy.

There is an ongoing debate about the ability of the United States to ensure we maintain a reliable, domestic source of nuclear fuel. A major element of that debate is whether or not an agreement between Russia and the U.S., which limits Russian fuel imports, will be enforceable. If not, there is concern that Russian fuel would be imported without limit, potentially jeopardizing the domestic enrichment industry.

Federal Programs to Support Nuclear Energy

Another important issue with nuclear power is cost. The 2003 MIT report *The Future of Nuclear Power* discusses nuclear power as an energy source which is not economically competitive because nuclear power requires significant government involvement to ensure that safety, proliferation, and waste management challenges meet policy objectives and regulatory requirements. In addition, the success of nuclear power depends on its ability to compete with other energy production technologies. However, the MIT report points out: "Nuclear does become more competitive by comparison if the social cost of carbon emissions is internalized, for example through a carbon tax or equivalent 'cap and trade' system."

While high oil and gas prices are helping to revive interest in nuclear power and improve its economic viability, another factor adding to the interest in nuclear power is the improved performance of existing reactors. However, there is little doubt that the federal incentives included in the *Energy Policy Act of 2005* for the nuclear power industry make the economics more attractive.

The last order for a new nuclear plant came in 1973, and many in the industry have expressed that strong federal incentives are necessary to build new plants. Such incentives authorized within the last three years include: $18.5 billion in loan guarantee authority for new nuclear plants and $2 billion for uranium enrichment plants; cost-overrun support of up to $2 billion total for the first six new plants; a production tax credit of up to $125 million total per year, estimated at 1.8 cents/kWh during the first eight years of operation for the first six GW of generating capacity; and Nuclear Power 2010, a joint government-industry cost-shared program to help utilities prepare for a new licensing process.

It is expected that currently authorized loan guarantees will only cover the first four to six new plants, depending on their size, and utilities will advocate for more federal loan guarantee authority before building additional plants. In all, nearly 30 applications for new plants are expected to be submitted to the Nuclear Regulatory Commission by the end of 2009 in order to meet the eligibility criteria for the production tax credit in addition to the other incentives.

The Federal Government provides other indirect financial support for the nuclear industry as well. While costs to develop the Yucca Mountain site are primarily covered by a fee on nuclear-generated electricity paid into the Nuclear Waste Fund, the government takes full responsibility for waste storage. Because the project is decades behind schedule, DOE estimates that the U.S. Government has incurred a liability of approximately $7 billion for the department's failure to begin accepting spent nuclear fuel from existing commercial plants. The nuclear industry is also given Price-Anderson liability protection for any accident involving operating reactors. This establishes a no fault insurance-type system in which the first $10 billion is industry-funded, and any claims above that level would be covered by the Federal Government. Furthermore, any accelerated development of reprocessing technology, such as GNEP, may cost the government tens of billions of dollars.

Nuclear Workforce

As advanced technologies transform the energy industry there will be an increased demand for an appropriately skilled workforce to meet its needs. As the energy sector of our economy changes and grows, the nuclear industry faces increasing competition for engineering talent. In addition to greater demand, the Nuclear Energy Institute's 2007 nuclear workforce survey estimates that 39 percent of nuclear utility maintenance workers, 34 percent of radiation protection workers and 27 percent of operations staff may reach retirement eligibility within five years. There is a general concern that a revival in the nuclear power industry could be hampered by the availability of the necessary skilled, technical workforce. November 2007 testimony by the Assistant Secretary of Labor underscores the need for creative workforce solutions because energy industry workers are difficult to replace as training programs were reduced during the downturn of the industry in the late 1980s and early 1990s. She goes on to state that training programs have not expanded at the same rate at which the industry is rebounding. The MIT report *The Future of Nuclear Power* punctuates concerns about workforce development acknowledging that the nuclear workforce has been aging for more than a decade "due to lack of new plant orders and decline of industrial activity."

Chairman GORDON. This hearing will come to order. Good morning everyone and welcome to today's hearing on the opportunities and challenges related to the expansion of our nuclear power industry.

As usual, we have a lot going on this morning, so we will have Members coming in from their other meetings. Also, you know, this is being televised, so we have staff and other interested people watching, so your words will go out broadly, and we are glad you are here for this very good discussion.

And I would like to welcome our expert panelists, who will share with us their views about the role of the Federal Government to advance electricity production from nuclear power and its ability to help address the pressing problems of climate change. There is no doubt we are witnessing a renewed interest in nuclear power production overseas and here in the U.S.

Controls of greenhouse gas emissions, federal incentives authorized in the *Energy Policy Act of 2005,* and higher fossil fuel prices are all motivating this renewed interest. The Nuclear Regulatory Commission is anticipating over 30 U.S. applications for new reactors through 2009, and another 150 are planned or proposed globally. Existing nuclear power plants provide approximately 20 percent of our nation's electricity, and they do so as a carbon, or a low carbon emitter.

Improvements in performance at our nuclear facilities over the years have made them a reliable source of baseload electricity. However, expanded use of nuclear power won't come without some major costs. Construction of new nuclear power plants is expensive. In addition to other issues that need to be considered are the risks of nuclear weapons proliferation, management of radioactive waste generated by the nuclear power, and the cost to taxpayers of possible additional federal subsidies to the industry.

The technical challenges of expanded nuclear power production should be met with an aggressive research and development program. The Administration has been a strong advocate of expanded financial support for the industry. In my view, support for research and development to address the challenges associated with expanded nuclear power production is equally important.

I believe that we must maintain a diverse and robust energy production portfolio in the United States. We need reliable and affordable electricity generation to maintain our quality of life, and ensure we remain globally competitive. We must have a strategy that maintains our economic viability, without turning a blind eye to the tremendous challenge of climate change. The details of a national climate change program are not very clear, but I believe it is critical that we have a comprehensive and meaningful technology strategy to ensure we can meet targeted reductions of greenhouse gas emissions in a rapid timeframe.

I look forward to a lively discussion this morning about the potential for nuclear power to provide more of our electricity in the United States and abroad, and at this time, I would like to yield to my friend, the distinguished colleague from California, and our, today's Ranking Member, for his opening statement.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

Good morning and welcome to today's hearing on the opportunities and challenges related to expansion of our nuclear power industry.

I would like to welcome our expert panelists who will share with us their views about the role of the Federal Government to advance electricity production from nuclear power and its ability to help address the pressing problem of climate change.

There is no doubt we are witnessing a renewed interest in nuclear power production overseas and here in the U.S. Controls on greenhouse gas emissions, federal incentives authorized in the *Energy Policy Act of 2005,* and higher fossil fuel prices all are motivating this renewed interest.

The Nuclear Regulatory Commission is anticipating over 30 U.S. applications for new reactors through 2009 and another 150 are planned or proposed globally.

Existing nuclear power plants provide approximately 20 percent of our nation's electricity, and they do so as a low-carbon emitter. Improvements in performance at our nuclear facilities over the years have made them a reliable source of baseload electricity.

However, expanded use of nuclear power wouldn't come without some major costs. Construction of new nuclear power plants is expensive. In addition, other issues that need to be considered are the risk of nuclear weapons proliferation, management of radioactive waste generated by nuclear power, and the cost to taxpayers of possible additional federal subsidies for the industry.

The technical challenges of expanded nuclear power production should be met with an aggressive research and development program. The Administration has been a strong advocate of expanded financial support for the industry. In my view, support for research and development to address the challenges associated with expanded nuclear power production is equally important.

I believe that we must maintain a diverse and robust energy production portfolio in the United States. We need reliable and affordable electricity generation to maintain our quality of life and ensure we remain globally competitive. We must have a strategy that maintains our economic viability without turning a blind eye to the tremendous challenge of climate change.

The details of a national climate change program are not yet clear, but I believe it is critical that we have a comprehensive and meaningful technology strategy to ensure we can meet targeted reductions of greenhouse gas emissions in a rapid timeframe.

Nuclear power may very well play an important part of the climate change solution.

I look forward to a lively discussion this morning about the potential for nuclear power to provide more of our electricity in the United States and abroad.

Thank you.

Mr. BILBRAY. Thank you, Mr. Chairman. I appreciate this hearing today, and I think that this issue is one that has been waiting for a long time to have a frank and open discussion about.

Mr. Chairman, nearly a billion people around the world celebrated Earth Day yesterday, or earlier this week, and frankly, you heard a lot of communication and talk about countless alternatives for energy. We talked about alternative energy sources such as wind and the use of hydroelectric, and you can go down the whole thing. But what is interesting is if you listen to all of the talk, there was nothing mentioned about nuclear power, as if it was a black hole that was not allowed to be discussed.

And I think that when we confront the issue that, over the next 25 years, we are going to be confronted with a 30 percent increase in electricity demand, at a time that is going to potentially increase CO emissions by 16 percent, when we need to be reducing those numbers by a dramatic number within the next 30 years.

The fact is, is that if we go down and talk about solar, we talk about different items on this, the politically correct concept that we are not allowed to say the N word has to be thrown away. This is not a dogma. If we want to be truly protective of the environment and the economy, we have to approach this from a scientific base.

This is not a theology. Our global strategy for climate change control has been backed by numerous world leaders and scientific experts. The Executive Secretary of the United Nations Framework Convention on Climate Change noted, and he said they have never seen a credible scenario for reducing greenhouse gas emissions that did not include nuclear power.

Now, we can go back and say that the Intergovernmental Panel on Climate Change (IPCC), which won the 2007 Nobel Peace Prize, along with Vice President Gore, noted in their report the need for nuclear energy. And the IPCC's *Report on Climate Change, the Fourth Assessment Report of Intergovernmental Panel on Climate Change,* the Panel identified nuclear energy as being a key technology in addressing global change, and in fact, the IPCC reported that the robust mix of energy sources, including nuclear, are almost certainly to be required if we are going to reach our demands.

So, I just think we need to start off with this right out front, that let us be willing to say what needs to be said. I just had a meeting with a colleague that you may remember, Mary Nichols, who used to be at the EPA, and as a former member of the Air Resources Board, she is now the Chair of the Air Resources Board for California. California is confronted with the reality that their blanket abolition against nuclear power has to be revisited, and if they truly want to address the climate issue, they have got to be brave enough to step up and address this issue up front. So, I appreciate the fact that you have been able to have this hearing today.

The United States has not built a new nuclear power plant in 20 years, and this has really been harmful. With all of the concerns about nuclear, the alternatives are not acceptable, and so, I appreciate the fact that we are able to have this discussion, and hopefully, Mr. Chairman, this will be the beginning of a bipartisan approach. Let us say not how do we abandon a technology that is essential for our future, but how do we work together to make it work, so that we can save the climate and leave our children and grandchildren a prosperous future.

And I yield back, Mr. Chairman.

[The prepared statement of Mr. Bilbray follows:]

PREPARED STATEMENT OF REPRESENTATIVE BRIAN P. BILBRAY

Chairman Gordon and Ranking Member Hall, thank you very much for holding this timely and important hearing on the *Opportunities and Challenges for Nuclear Power.* As our nation grapples with an increasing energy demand and the need to combat global warming, nuclear power must be an option to address these issues.

Mr. Chairman, yesterday nearly a billion people around the world celebrated Earth Day. All across the television, the Internet, radio and other means of communications we were told of the countless opportunities that alternative energy sources would have to combating global climate change. There were stories on solar, wind, hydroelectric and even vegetable oil. But nothing on nuclear power's promises. Why?

Last month, the Energy Information Agency (EIA) released its outlook for 2008. EIA indicated that U.S. electricity demand would grow 30 percent between 2006 and 2030. Likewise CO_2 emissions are predicted to increase 16 percent from 2006 levels at a time when it will be essential to decrease them.

While the pain here at home is bad, the worldwide problems associated with increased population growth and energy consumption in developing nations will be catastrophic. EIA notes that "total electricity demand in the non-OECD nations is expected to grow from 2004 to 2030 at an annual rate that is nearly triple the rate of growth for electricity demand in the OECD." This increased energy demand will most likely result in increased greenhouse gas emissions and widespread global warming damage.

If we are to combat this looming crisis we will need a mixed bag of solutions. These will need to include command and control techniques including the use of renewable fuels such as wind and solar power, sequestration of fossil fuels, and most importantly the use of nuclear technology.

Nuclear energy has all the properties and benefits our world needs to successfully combat global climate change and meet our energy needs. Nuclear energy is one of the cleanest energy sources known to mankind. Nuclear energy accounts for 73 percent of the Nation's clean air generation. In 2005, U.S. nuclear power plants reduced emissions of nitrogen oxides and sulfur dioxide-pollutants controlled under the *Clean Air Act*—by 1.1 million short tons and 3.3 million short tons respectively. The amount of nitrogen oxide emissions that nuclear plants prevent annually is the equivalent of taking nearly 55 million passenger cars off the road. Even more striking is in that same year, U.S. nuclear power plants prevented the discharge of 682 million metric tons of carbon dioxide into the atmosphere. This is nearly as much carbon dioxide as is released from all U.S. passenger cars.

A global strategy of climate change control has been backed by numerous world leaders and scientific experts. Yvo de Boer, Executive Secretary of the United Nation's framework Convention on Climate Change noted that he had never seen a credible scenario for reducing greenhouse gas emissions that did not include nuclear power. Likewise, the United Nation's Intergovernmental Panel on Climate Change (IPCC), which won a 2007 Nobel Prize along with Vice President Al Gore, noted in their report the need for nuclear energy. In the IPCC's Fourth Assessment Report, the panel identifies nuclear energy as a key technology in addressing global climate change. The report states that a "robust mix" of energy sources, including nuclear energy, "will almost certainly be required to meet the growing demand for energy services, particularly in developing countries."

The United States has not built a new nuclear power plant in nearly 20 years. If we are to truly harness this great technology and solve our environmental problems, we must make a commitment to nuclear research and development as well as the production of new nuclear facilities.

Chairman GORDON. Thank you, Mr. Bilbray. I hope, as this hearing goes forward, you will let us know how you really feel about nuclear power.

I ask unanimous consent that all additional opening statements submitted by Committee Members be included in the record. Without objection.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Mr. Chairman, I thank you for holding this hearing today on the very important issue of nuclear energy. I have always been a supporter of nuclear energy and I am buoyed by the activity from the utility companies who have submitted applications to the Nuclear Regulatory Commission to build 33 nuclear plants. I hope that this truly is the start of the nuclear renaissance in our country.

We are faced as a nation and as citizens of the world with the responsibility of reducing our carbon dioxide emissions while at the same time providing affordable, reliable electricity to support our growing cities. There are very few options available to our electricity providers when it comes to emissions-free, reliable base load power, and in my opinion, nuclear power is at the top of that list if not the only energy source on that list until coal plants begin using carbon capture and sequestration technology.

I don't want my words to be misinterpreted to mean that I'm not a supporter of renewable energy because I am. I believe they definitely have a place in our energy mix, but I do not believe that they can produce the same amount of energy as reliably and as efficiently as nuclear energy. As an example, it would take 3,000 one-megawatt wind turbines on 150,000 acres of land to provide the same amount of electricity from one nuclear plant—and that's if the wind is blowing. The bottom line is that I think there's a place for all forms of energy in our current mix and that nuclear holds a secure place in that line-up.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Mr. Chairman, I am pleased that the Committee is pursuing this issue, as the issue of energy sustainability is one of the most pressing public policy issues on our agenda.

I believe we need to consider all of the energy resources and technologies available in constructing a comprehensive energy policy that satisfies our energy needs, reduces our dependence on foreign oil and protects our economy. The debate surrounding nuclear power remains—is it a safe and reliable source of domestic fuel?

The Federal Government's lack of investment in nuclear technology over the past decades has changed recently with the Bush Administration's Global Nuclear Energy Partnership (GNEP) program. I am pleased that the Committee has chosen to further examine this issue and hear testimony on the merits of federal support in comparison to other sources of energy.

As we have recently recognized Earth Day, thank you, Mr. Chairman for the timeliness of this hearing. I appreciate the Committee's efforts to explore the merits of the array of resources and technologies that can comprise our nation's energy policy. I believe the best solution will come from utilizing our domestic resources and investing in technology that will ensure a clean, efficient and diverse energy policy for our future.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. As our nation grapples with major questions regarding our energy supply, the Science Committee is tasked with major responsibilities.

This committee has the authority to drive federal investments in research and development.

Although it is good to let market forces determine the best practices, when it comes to energy, federal investments are often needed to spur beginning-stage technologies to market.

According to the Energy Information Administration, in 2004, Texas energy came primarily from coal.

Forty-eight percent of Texas energy came from natural gas; 39 percent came from coal; 11 percent came from nuclear; and three percent came from other sources.

In Texas, there are two nuclear facilities: Comanche Peak and South Texas nuclear plants.

My sense is that it is good to approach the energy problem from multiple angles. Wind, solar and other renewable energy sources are not viable for storage of energy the way fossil fuel sources are.

However, since Texas has the greatest potential for wind energy, I would like to see greater investment in that arena.

Nuclear energy is becoming a more economically viable, as the price of oil rises. Reprocessing research, infrastructure and spent fuel storage issues will be costly to address.

Most nuclear reactors were not designed to store the full amount of the spent fuel generated during their operational life. Currently, there is over 50,000 metric tons of spent fuel stored in this nation.

Another international issue is that reprocessing spent fuel raises concerns about the potential for proliferation of weapons-grade nuclear materials because existing reprocessing technologies separate plutonium from the spent fuel.

The high cost of reprocessing technology may cost the government tens of billions of dollars.

While the plutonium can be recycled into new fuel for use in nuclear reactors, it can also be used to make nuclear weapons.

The Department of Energy has yet to identify a proliferation-resistant method to achieve this goal.

On top of all of these factors, I still have safety concerns. Our technical workforce will need to be trained appropriately.

In summary, I believe that nuclear is a viable option to explore. In France, 100 percent of their energy is derived from nuclear plants.

Let us learn from others' experiences and invest appropriately to move toward cleaner and less expensive energy.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Ms. Richardson follows:]

PREPARED STATEMENT OF REPRESENTATIVE LAURA RICHARDSON

Thank you Chairman Gordon for holding this important hearing today, and our witnesses for your attendance.

There is no doubt in my mind that nuclear energy provides a critical opportunity for the United States to lessen its dependence on foreign oil. In any city in this country it is evident, the rising cost of gas is harming the livelihood of everyday Americans who have to commute to work, and shuttle their children to and from school. The high price of gasoline is something that we have been dealing with in my home State of California for some time now. In 2001 the average price of regular gasoline in California was $1.44 per gallon. Today the average price of gasoline in my home State of California is $3.82 per gallon. That is an increase of 165 percent.

Unfortunately while the price of gas, and the profit margins of big oil companies have increased the income of average Americans has not. For reasons that are not clear to me, this 110th Congress and the current Administration has not been able to rein in the price of gas. Some argue that it is simply a matter of increased demand from developing nations like India and China. Whatever the reasons may be, it is obvious to me that the time to explore alternate sources of energy is now.

Therefore I welcome this discussion about the opportunities and challenges for nuclear power. The American people do not want another Three Mile Island type of incident to occur and expect industry preeminence. Despite the fact that there were no immediate deaths or injuries to plant workers or members of the nearby community which can be attributed to the accident, the public reaction probably killed the prospects for nuclear energy for decades to come.

Likewise in a post 9/11 world we must be concerned with the proliferation of enriched uranium, a major component in the step towards developing nuclear weapons. We certainly can not allow our sworn enemies to acquire this technology. With the likelihood that more facilities will be built, there has to be some assurance that not only is the facility safe, but the personnel working in these facilities are closely monitored to prevent the transfer of technologies.

Finally any discussion about nuclear energy/power must address this issue of what to do with the waste.

I look forward to the testimony of our witnesses, and I hope we can build on this discussion in order to develop a bipartisan policy approach to nuclear energy.

Mr. Chairman I yield back my time.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman, thank you for hosting this important hearing on the potential for nuclear power as a viable energy source. As our country continues to see the consequences of high energy prices, investigating alternative sources may provide a solution.

As consumers continue to face escalating gas prices at the pump, growing heating and air conditioning bills, and increasing food costs, it is our responsibility as Members of Congress to seek ways in which we can ease these financial burdens. After personally visiting nuclear power plants in France and witnessing the possibilities this alternative presents, I believe nuclear power is worth investigating further. The long-term effects of storing radio-active waste and other possible negative consequences demand that research include attention to these environmental and safety concerns. I look forward to hearing more on the benefits and possible problems with nuclear power.

Mr. Asselstine and Dr. Cochran, I am interested to hear about the Federal Government's role in financing new nuclear power plants and whether or not, in your opinion, this is sufficient. Additionally, I look forward to hearing Mr. Grossenbacher's testimony on the Department of Energy's programs to support and advance nuclear energy.

I would like to thank today's witnesses, Mr. Fri, Mr. Asselstine, Dr. Cochran, Mr. Van Namen, Ms. Kray, and Mr. Grossenbacher, for taking the time to appear before us. I look forward to hearing your testimonies.

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

Yesterday, as we celebrated Earth Day, we were reminded of the importance of protecting our planet from harmful greenhouse gas emissions.

I strongly believe that we must refocus our energy priorities to the production of alternative sources of energy, like solar power, that will not be harmful to our environment.

Nuclear power generation also has the potential of generating electricity without increasing greenhouse gas emissions.

However, there are still many obstacles to the expansion of nuclear power generation including high costs, waste disposal, and concerns about nuclear proliferation.

I look forward to hearing from our witnesses on how the Department of Energy's nuclear technology programs could address these challenges.

I yield back.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF REPRESENTATIVE ADRIAN SMITH

Thank you, Mr. Chairman. The people of Nebraska are ready for expanded energy options, which includes nuclear power. Nuclear power has been an important energy generation tool for decades and it is a key component of our future portfolio for energy independence.

I was excited to learn from the written testimony submitted by Mr. Grossenbacher about one of the next generation nuclear technologies, the High Temperature Gas Reactor (HTGR) system. The heat generated by HTGR can be coupled with processes to hydrolyze water to produce hydrogen and oxygen, used in fertilizer, chemical, and coal gasification plants. These clean technologies will decrease our dependence on foreign oil and will definitely be beneficial to Nebraska's rural and agricultural economies.

I am encouraged to learn from the written testimony of several of our witnesses that recent legislation has reduced regulatory barriers and streamlined the process for new nuclear plants. There is still room for improvement. Investors must be assured their financial investments will not be destroyed by long delays beyond their control, such as litigation or regulatory concerns.

I am concerned that several of you mentioned the aging workforce in nuclear power and the lack of qualified replacements trained in nuclear technologies. We need to encourage young people to pursue education and careers not just in nuclear power technologies, but in science, technology, engineering, and mathematics fields in general. We need more visionary scientists, engineers, entrepreneurs, and investors in a variety of energy generation, storage, and transmission technologies.

I look forward to hearing the testimony of our witnesses.

Thank you, Mr. Chairman, and I look forward to working with you as we look to the bright future of energy technologies in the United States.

Chairman GORDON. It is now my pleasure to introduce our witnesses this morning. First, Ms. Marilyn Kray is the President of NuStart Energy, and also, the Vice President of Project Development at Exelon Nuclear. Welcome.

Dr. Robert Van Namen is Senior Vice President of Uranium Enrichment at the United States Enrichment Corporation. Welcome to you.

Dr. Jim Asselstine is the recently retired Managing Director at Lehman Brothers, and a former Commissioner of the Nuclear Regulatory Commission. We welcome you.

And Dr. Thomas B. Cochran is the Senior Scientist in the Nuclear Program at the Natural Resources Defense Council. Welcome.

And Dr. Robert Fri is a Visiting Scholar at Resources for the Future, and a Chair of a recent study conducted by the National Academies on the Department of Energy Nuclear Research and Development Program.

And finally, Dr. Admiral—or Vice Admiral John Grossenbacher is the Director of the Idaho National Laboratory. I want to compliment our Minority and Majority staff for pulling together an outstanding panel to, I think with diverse views, that will help us start this process of better understanding the role of nuclear power, as we move forward.

And I would say to the witnesses, you each will have five minutes of your spoken testimony. We want to try to be crisp with that, but we are not going to cut you off if you have more good things to say. Your written testimony will be included in the record for the hearing, and when you complete your testimony, we will begin the questions. Each Member will have five minutes to question the panel.

So, Ms. Kray, you may begin.

STATEMENT OF MS. MARILYN C. KRAY, VICE PRESIDENT, EXELON NUCLEAR; PRESIDENT, NUSTART ENERGY DEVELOPMENT

Ms. KRAY. Good morning, Chairman Gordon, Congressman Bilbray, and Members of the Committee. As mentioned, I am the Vice President with Exelon Nuclear. Exelon is the largest operator of nuclear plants in the United States.

I am here today in my role, also, as President of NuStart Energy Development. The NuStart consortium is comprised of 10 power companies and two reactor vendors. The consortium was formed in 2004, based on a shared vision, as well as a shared sense of responsibility.

The shared vision was that the nuclear industry would be called upon at some point in the future to provide additional baseload capacity, and the shared responsibility is that it was our job to take actions in order to make us ready for that.

The need for nuclear plants arises from a platform of change that has brought about by both the electricity demand, as well as mentioned, the environmental awareness. You may know the EIA projects electricity demand to increase by 30 percent by the year 2030. With respect to environmental awareness, nuclear power accounts for 73 percent of the carbon free generation. To put it in perspective also, the volume of greenhouse gas avoided by the production with nuclear power is approximately equal to 96 percent of the passenger cars that are on the road today.

Mr. Chairman, I stress that the consideration of additional nuclear is not to the exclusion of any other baseload generation, in particular, renewable, but rather, it is our attempt to uphold the current 20 percent contribution that nuclear is making, given the expected growth in demand. As the title of this hearing suggests, the opportunities for nuclear plants must be considered along with the challenges.

My testimony outlines a number of challenges, but in response to your invitation letter, I would like to address a few of those, including licensing, cost, and also, workforce development. Demonstrating the licensing process is one of the objectives of the NuStart consortium. To date, there have been nine combined construction and operating license applications submitted to the NRC. Six of these nine were submitted by NuStart members. NuStart members plan to submit an additional four applications by the end of the calendar year.

My observations to date of the licensing process is that it is going well. However, I caution that we are only a few months into a multi-year review. There are two aspects of the process, however, that I believe have yielded the success to date, but more importantly, will continue in the ongoing success of the process. They are, first, the commitment to design standardization for the new fleet of plants, and also, the communication between the NRC staff and the industry.

You may know one of the components of an application is the Final Safety Analysis Report. For the two selected technologies by NuStart, those are the Westinghouse Advanced Passive 100 reactor, and the GE/Hitachi Economic Simplified Boiling Water Reactor, the FSAR is approximately 75 to 80 percent identical for all applicants of that technology. And although the premise of plant standardization is operational safety and efficiency, it will greatly facilitate the NRC's design-centered review approach, and that is where the NRC needs to review an issue only one time. That yields, of course, the regulatory efficiency, and NuStart remains the optimum forum for this industry coordination.

The other cornerstone of the licensing process is the communication, as I mentioned. Over a year and a half ago, the NRC began to conduct public workshops, wherein they conveyed their expectations with respect to content of applications. Also during this presubmittal phase, there were numerous public visits by the NRC staff to the various sites, and also public meetings, again, wherein we could get ongoing feedback regarding the development of our application. This continued throughout the sufficiency review, and we expect that it will continue through the intense safety environmental reviews.

On the next challenge of cost, I offer you my utility perspective, and that is that any investment in a new plant will only be made if it is in the best interest to both our shareholders, as well as our customers. We are not predisposed to nuclear generation. Whether it is a Board of Directors decision, or that of a state Public Utilities Commission, a nuclear investment must be proven to be superior to the other energy alternatives. We are concerned not only with the initial cost of the plant, but the long-term stability of electricity rates over the life of the plant. Contrary to what you may hear from my fellow panelists, I believe government incentives are needed to address our energy investment crisis, and these incentives must be, must equitably treat each component of the diverse portfolio.

The third area of workforce development, while it is a challenge to new nuclear plants, it is a tremendous opportunity for students, workers, and businesses. The nuclear industry needs a wealth of engineering expertise and skilled labor to design, construct, and operate the next fleet of plants. The industry is taking aggressive action to develop its future workforce. Some of these actions include outreach efforts with professional societies, developing training programs and partnerships through high schools, unions, apprenticeship programs, community colleges, and universities. Success in these areas is needed to not only staff the existing fleet, but also, the fleets of the future.

Lastly, I want to leave you with my outlook for the expansion of nuclear power, and again, speaking from my utility perspective, I would characterize it at this point as cautiously optimistic. A few years ago, the nuclear strategy was to keep the option open, but now, based on conservative and phased decision-making, we have seen the optimism grow, as evidenced by the number of utilities that have either submitted or declared their intent to submit a license application, the placement of orders for long lead equipment, and most recently, the actual signing of an engineering procurement and construction agreement.

We thank Congress for its vision, through the Energy Policy Act, in establishing the framework through which we accomplished many of these milestones, and I thank the Committee for the interest in the expansion of nuclear power, and the opportunity to appear before you today.

Thank you.

[The prepared statement of Ms. Kray follows:]

PREPARED STATEMENT OF MARILYN C. KRAY

Chairman Gordon, Congressman Hall, Members of the Committee:

Thank you for the opportunity to appear before you today to discuss opportunities and challenges for nuclear power and to highlight NuStart Energy Development's activities to spur new reactor development in the United States. I am Marilyn Kray, Vice President of Project Development for Exelon Nuclear and President of NuStart Energy Development.

Exelon Nuclear is the largest owner and operator of commercial nuclear power plants in the United States. We have 17 reactors at 10 sites in Illinois, Pennsylvania and New Jersey, and we are developing a Combined Construction and Operating License (COL) application for two reactors in Victoria County, Texas.

NuStart is a consortium of 10 power companies and two reactor vendors[1] that was formed in 2004 with two purposes: first, to demonstrate the Nuclear Regulatory Commission's never-before-used licensing process to obtain a Combined Construction and Operating License (COL) for an advanced nuclear power plant; and second, to complete the design engineering for two advanced reactor technologies, General Electric's Economic Simplified Boiling Water Reactor (ESBWR) and Westinghouse's Advanced Passive AP–1000. NuStart activities are being funded by the Department of Energy on a 50/50 cost sharing arrangement under the Nuclear Power 2010 Program.

America's 104 nuclear power plants generate about 20 percent of our electricity. In 2007, the nuclear industry generated more electricity than ever before, and we did it more safely than ever before as evidenced by data on unplanned reactor shutdowns and the industrial safety rate. Bureau of Labor Statistics data show that it is safer to work in a nuclear plant than to work in the real estate or financial sectors.

Demonstrating the NRC licensing process and completing the engineering for new reactor designs are critical first steps toward the construction of a new generation of reactors in the United States. To date, individual NuStart member companies have submitted six COL applications to the NRC for their review and another four are planned for submittal by the end of 2008. We anticipate that the Commission will complete its review of certain applications as early as 2011, allowing a company or consortium of companies to begin construction of a new reactor with the hope of having a plant begin operation by 2017.

Opportunities

As power producers strike to maintain a reliable supply of clean, safe and economic electricity to sustain our economy, there are three primary trends that create opportunities for nuclear power to play an increasing role in meeting our nation's energy needs: first, increasing demand for baseload electric generation; second, increasing fuel costs for conventional sources of electricity; and third, the likelihood of limits on greenhouse gas emissions from power plants.

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[1] Power companies include: DTE Energy, Duke Energy, EDF International North America, Entergy Nuclear, Exelon Generation, Florida Power and Light, Progress Energy , SCANA, Southern Company and Tennessee Valley Authority. Reactor vendors include General Electric-Hitachi and Westinghouse.

Increased Demand for Electricity

Even with aggressive efforts to increase energy efficiency and conservation, demand for baseload electricity both in the United States and around the world is expected to increase significantly over the next two decades.

The Energy Information Administration's Annual Energy Outlook for 2008 projects that electricity demand will increase by 30 percent by 2030. EIA's International Energy Outlook for 2007 predicts even higher growth worldwide. Much of the increased demand in the U.S. will be for base load power and will occur in regions of the country currently served by companies with nuclear experience.

To help meet this anticipated demand, nine companies, including the six NuStart members mentioned earlier, have submitted applications for combined operating licenses with the Nuclear Regulatory Commission for 15 units. As many as 10 additional applications for 16 or more new units are possible at the NRC this year.

Increasing Fuel Prices

Increased worldwide demand has led to steep rises in fuel costs for power plants since 2000, with coal prices increasing over 250 percent; natural gas prices rising over 300 percent; oil prices growing over 400 percent; and uranium prices up nearly 1,000 percent from their all-time low. Although nuclear fuel prices have risen more than other fuels, the price of uranium remains relatively low, and nuclear fuel accounts for a small portion of operating and maintenance costs compared to fossil-fired plants. As a result, these fuel price increased have made nuclear more attractive.

The volatility of fuel prices also makes nuclear energy more attractive than fossil-fired plants. In approving FPL's recent proposal for two nuclear reactors at the Turkey Point site, the Florida Public Service Commission found that building nuclear plants instead of natural gas plants would save Florida utility customers over $94 billion in fuel costs alone over the life of the plants.

Limits on Greenhouse Gas Emissions

While some may disagree about the science of climate change, we at Exelon are convinced that there is a need to take action now to slow, stop and then reduce human-caused greenhouse gas emissions to address climate change. If policy-makers take action to reduce greenhouse gas emissions, nuclear power will play a critical role in helping meet that policy objective.

Nuclear power has played a vital role in reducing greenhouse gas emissions. Nationally, nuclear power plants account for 73 percent of all carbon-free generation. In 2006, the volume of greenhouse gas emissions prevented by nuclear plants was the equivalent of taking 96 percent of all passenger cars off the road. During the last year alone, Exelon Nuclear prevented 121 million metric tons of carbon dioxide by eliminating the need for an equivalent amount of coal-based generation.

While nuclear power will not serve as a "silver bullet" solution to the climate issue, policy-makers are increasingly recognizing that it will be exceedingly difficult—if not impossible—to reduce emissions without nuclear power. New York Mayor Michael Bloomberg's PlaNYC, the Regional Greenhouse Gas Initiative, and most recently the State of New Jersey's Energy Master Plan have all recognized that nuclear plants must continue to operate if their environmental objectives are to be met.

Challenges

In addition to a demonstrated need for new base load power, the nuclear industry has identified six preconditions to the construction of new nuclear plants:

- a demonstrated regulatory process
- completion of reactor designs for passive technologies
- confidence in a long-term solution for used fuel disposal
- public confidence in nuclear power
- a sound nuclear power infrastructure
- acceptable financial returns

I would like to touch briefly on each of these issues.

Demonstration of Regulatory Process

As noted above, one of NuStart's primary objectives is to demonstrate the Nuclear Regulatory Commission's never-before-used licensing process to obtain a Combined Construction and Operating License (COL) for an advanced nuclear power plant.

Obtaining a COL is a critical step in a potential renaissance of the nuclear power industry in the United States. By achieving this, NuStart hopes to demonstrate that the COL can be obtained on schedule and within budget, and that advanced plant designs can be approved.

Further, NuStart's efforts will provide a realistic time and cost estimate for building and operating a new nuclear plant in today's environment.

During the 1980s, nuclear plants were plagued with significant cost overruns due in large part to the regulatory uncertainty inherent in the NRC licensing process. Many major issues were argued and litigated only after plants had been constructed, in some cases delaying plant operations for years.

Congress took an important step to reform the licensing process as part of the *Energy Policy Act of 1992* with the codification of the NRC's combined Construction and Operating License regulations under 10 CFR Part 52. The COL process is designed to provide all parties with an opportunity to raise issues related to siting and plant design before a license is granted. Once a plant is built, the only question before the Commission is whether the licensee has constructed the plant in conformance with its license. On paper the process appears to be sound; however, investor confidence will not be established until the process is demonstrated, as proposed under the NuStart project.

The new licensing process also gives potential licensees an opportunity to have sites pre-approved by the Commission. The Early Site Permit (ESP) process allows a potential licensee to apply to the Commission for approval of a site for a new nuclear plant. Companies provide the NRC with extensive data on the proposed site, as well as information about the reactor design that could be built on the site. If a site is approved, a company can "bank" the site for as long as 20 years.

Also under the Department of Energy's Nuclear Power 2010 program, three companies received matching funds to develop and submit Early Site Permit applications to the NRC: Dominion's North Anna site in Virginia, Entergy's Grand Gulf site in Mississippi, and Exelon's Clinton Power Station in Illinois.

NuStart's experience with the licensing process has been positive to date. Much of the success to date is attributable to the communication between the NRC staff and the industry. The communication examples include the numerous workshops conducted by the staff to convey their expectations regarding COLA content, the frequent pre-application visits and meetings and the frequent interaction during the sufficiency reviews of the applications. Also of note is the implementation of the design-centered working group concept whereby each applicant consistently presents the standard design for a particular technology in their respective COLA allowing for efficiency in the NRC review process. The NuStart consortium serves as an optimum forum for such industry coordination, both before and during the NRC review process.

Completion of Reactor Designs for Passive Technologies

Another aspect of the revised NRC licensing regulations allows reactor vendors to submit designs to the NRC for Design Certification. This process allows the NRC to evaluate potential designs and allows for public participation in the certification process. Once a design is certified by the Commission, it can be paired with an Early Site Permit and used in the submission of a Construction and Operating License.

NuStart plans to complete the design engineering for two advanced reactor technologies, General Electric's ESBWR and Westinghouse's AP–1000. NuStart selected these technologies because they represent the optimization of operational confidence and innovation. They are natural evolutions of the designs currently in operation, yet both of these technologies adopt simplified design features and technology improvements that rely on inherent, passive safety systems. In this context, "passive" refers to design principles wherein laws of nature such as gravity feed, convective heat transfer and natural circulation are used in place of complex systems comprised of numerous pumps, valves and actuation devices. The result is an enhancement to safety because there is less reliance on equipment performance and operator action, and a reduction in cost because there is less equipment to construct and maintain.

NuStart's work with the reactor vendors to complete the one-time generic engineering work necessary for the standardized plant designs will position these technologies for deployment when needed, thereby significantly reducing the time to market for a new nuclear plant.

A Long-Term Solution for Used Fuel Disposal

While nuclear energy has a proven track record in the United States as a clean, economic and reliable source of energy, used fuel from nuclear plants must be managed to permanently isolate it from the environment.

Before new plants can be built, energy companies, investors and the public must be confident that there is a long-term solution for the disposal of used nuclear fuel. While individual companies may have different views on what constitutes an acceptable solution, it is essential that the Federal Government continue to make progress on meeting its statutory and contractual obligation to begin removing used fuel from reactor sites.

In 1982, the Federal Government codified its obligation to assure for the permanent disposal of high-level radioactive waste and used nuclear fuel. In 2002, Congress upheld President George W. Bush's designation of Yucca Mountain, Nevada, as the site for the Nation's permanent, deep geologic repository. While the Yucca Mountain project faces a number of challenges, the industry, policy-makers and regulators have recognized that used fuel can be safely stored on-site for 100 years or more.

Given the uncertainties surrounding the Yucca Mountain program and the fact that used fuel can be safely stored at reactors sites for several decades, policy-makers are examining the possibility of recycling the fuel to harvest the vast quantities of usable material that remain in the fuel and to minimize the volume of the waste product that must be permanently isolated from the environment.

Public Confidence in Nuclear Power

New nuclear power plants cannot be built without a high degree of public confidence in the safety of the technology, the competence and commitment of reactor operators, and the dedication of regulators. The industry recognizes that public confidence is based on the performance of our current fleet of plants. We must remain ever vigilant to the safety responsibility entrusted to us.

Public awareness of nuclear energy's positive contribution to energy independence, clean air, and a reliable, low-cost energy supply, has led to greater support in recent years. The nuclear industry's commitment to safe operations and its proven track record over the last 25 years have also reinforced public support for nuclear technology.

The nuclear industry's continued strong operating record has led to increased public confidence. In 2007, the industry's median unit capability factor was 91.5 percent, the eighth consecutive year that capability factors have exceeded 90 percent. A related metric, capacity factor, a measure of total power generated as a percentage of design production, was a record high 91.8 percent in 2007. The Nuclear Energy Institute reported that this record capacity factor, along with other sector-leading nuclear industry indicators, led to U.S. nuclear power plants producing a record-high 806 billion kilowatt-hours (kwh) of electricity in 2007.

A nationwide poll conducted earlier this month for the Nuclear Energy Institute found 63 percent of those surveyed favor nuclear energy. While 59 percent agreed that the country should definitely build new plants, 71 percent believe that plants are safe and secure.

Nuclear Power Infrastructure

A critical challenge for the nuclear industry is the continued presence of a strong nuclear power infrastructure. This infrastructure includes the engineering expertise and skilled labor to design, construct, and operate plants; the existence of a strong educational network at the Nation's colleges and universities; and the presence of knowledgeable and dedicated personnel to staff the Nuclear Regulatory Commission.

The lull in the construction of new nuclear power plants in the 1990s led to a decrease in the number of nuclear engineering students in American universities. As with many other businesses, the nuclear industry faces an aging workforce. If the commercial nuclear power industry in the United States is to expand, it is imperative that the Nation has a skilled workforce that is ready to construct, operate, and support new plants.

The limited availability of a skilled workforce is not unique to the nuclear industry. It affects the entire energy sector as well as the manufacturing sector. The commercial nuclear industry is taking aggressive action to develop its future work force. The industry has been pursuing a variety of initiatives to increase career awareness through direct outreach efforts with professional societies and through the Internet and other media.

The industry has also developed training programs and partnerships through high schools, union apprenticeship programs, skills centers, community colleges and universities, and we provide financial support and scholarships to students and is actively developing and engaging regional and state-based work force development partnerships.

To help American workers prepare for careers in the nuclear industry, we are taking steps to raise awareness of the impending skilled craft labor shortage and its impact on the energy sector; elevate the image, status and prestige of skilled craft careers; attract, recruit and train workers, particularly from untapped and underrepresented labor pools; align investments and work force development initiatives to ensure collaboration and coordination of government, industry and labor efforts in the develop the energy skilled trades work force; build partnerships between industry, government, organized labor and the education community that promote talent and economic development; and implement performance-based education and training programs for skilled craft workers through vocational and technical education programs in secondary and post-secondary educational environments (including high schools, pre-apprentice, apprenticeship, and community college programs).

Acceptable Financial Returns

As a final prerequisite for new plant construction, companies will have to be confident that they can provide their shareholders with an acceptable financial return on their investment and that they can provide to their customers affordable and reliable electricity. Any investment in nuclear power must look attractive not only on an absolute basis, but superior to other fuel alternatives.

While the industry is optimistic that nuclear generation can be competitive to the other alternatives, it does expect that the "first mover" investors will face significant hurdles unique to a nuclear investment. Accordingly, financial incentives such as those provided for in the *Energy Policy Act of 2005* are both necessary and appreciated.

The *Energy Policy Act* established three incentives for new nuclear plant deployment: a production tax credit for up to 6,000 MW of new plant capacity, standby insurance in the event of regulatory delay for the first six units, and the Title XVII loan guarantee that allows support for any advanced energy technology that "avoid, reduce, or sequester" greenhouse gas emissions.

These incentives are necessary for the first series of plants built employing advanced technologies under a never-before used licensing process. The new regulatory process must be proven before investors will have the confidence necessary to invest in these new technologies. Such a cooperative industry/government financing program for the first plants is a necessary and appropriate investment in U.S. energy security.

Conclusion

Trends in worldwide energy use, increases in fossil fuel costs, and the need to limit greenhouse gas emissions present the nuclear industry with the opportunity to play an increasing role in meeting our increasing need for electricity. While there are a number of challenges to realizing the full potential of nuclear power, I am confident that those challenges can be successfully managed.

Thank you for the opportunity to appear before you today.

BIOGRAPHY FOR MARILYN C. KRAY

Marilyn C. Kray is the Vice President, Project Development for Exelon Nuclear. In this capacity, she is responsible for generic licensing and engineering activities related to advanced nuclear reactors. She also serves as President of NuStart Energy Development, LLC an industry consortium formed to pursue a Combined Operating License for a new nuclear plant in the U.S.

Prior to this assignment, Mrs. Kray was the Vice President of Nuclear Acquisition Support and Integration. In this role, she pioneered the internal processes for due diligence and plant transitions by successfully completing the purchases of three nuclear plants: Three Mile Island, Clinton and Oyster Creek. Mrs. Kray served a two-year rotational assignment in the Customer Service organization where she was the department's lead for the development of the deregulation pilot program to implement customer choice. She began her career with Exelon in the licensing organization for Peach Bottom Atomic Power Station. Prior to that, she was a Reactor Engineer and a Project Manager for the U.S. Nuclear Regulatory Commission (USNRC).

Mrs. Kray is a graduate of Carnegie-Mellon University, with a Bachelor of Science degree in Chemical Engineering. Through completion of extensive simulator and training courses, she was certified by the USNRC to perform power operations inspections at nuclear reactor facilities. She has served in leadership roles as the

Company representative to various industry groups including the Nuclear Energy Institute and the Electric Power Research Institute. She is the 2005 recipient of the World Nuclear Association award for "Distinguished Contribution to the Peaceful Use of Nuclear Technology," and in 2007 received the American Nuclear Society's Utility Leadership Award. She is an active volunteer in community organizations, including serving as President of the Home and School association and referee for the Phoenixville YMCA basketball program.

Chairman GORDON. Thank you. And Mr. Van Namen.

STATEMENT OF MR. ROBERT VAN NAMEN, SENIOR VICE PRESIDENT, URANIUM ENRICHMENT, UNITED STATES ENRICHMENT CORPORATION INC.

Mr. VAN NAMEN. Good morning. My name is Robert Van Namen, and I am the Senior Vice President, Uranium Enrichment, for USEC Inc., a leading supplier of nuclear fuel for commercial nuclear power plants. Thank you, Chairman Gordon, Congressman Bilbray, and Members of the Committee, for inviting me to testify.

Today's nuclear fuel supply is in transition. While in better shape than a decade ago, much remains to be done to support the expansion of nuclear power. Domestic companies constructing new facilities face stiff competition in a market dominated by foreign, vertically integrated firms.

As we increase our capacity, U.S. companies need the assurance that their investment of resources will receive the support necessary to revive the industry to a self-sustaining position. Unless we take steps now, we will lose our ability to affect nuclear's future expansion and use.

Let us start with mining and milling of natural uranium. Since 1994, domestic sources have provided about 18 percent of the uranium purchased by U.S. reactors. Since 2003, the price of uranium has risen from $10 a pound to more than $95 a pound for long-term contracts. At this price, domestic miners have begun to expand or restart existing mines. While it is unlikely we would ever be able to supply all of our needs with domestic production, the countries with the greatest uranium reserves are close allies. The Department of Energy also maintains a large inventory of uranium in various forms.

The second step of the fuel cycle is conversion of natural uranium to uranium hexafluoride. The lone U.S. supplier of conversion, the Converdyn plant in Illinois, has recently expanded, and can now meet about 80 percent of U.S. demand.

After conversion, the uranium must be enriched to raise the concentration of the fissionable isotope, Uranium-235. The United States has one operating uranium enrichment plant, the Paducah Gaseous Diffusion Plant in Kentucky, which USEC operates under lease from DOE.

Domestic supplies come from three major sources, the Paducah plant, about 12 percent, the Megatons to Megawatts program, where USEC supplies about 43 percent of the market from LEU, blended down from Russian nuclear warhead material, and European producers make up the rest of the market needs from their overseas production.

The enrichment industry is transitioning to production based almost solely on gas centrifuge. One advantage of gas centrifuge is modularity. As contracts are signed, a plant could be expanded in increments. As we see new reactors constructed, we have the ability to expand in order to meet the demand. In the United States, USEC and another company are each building a gas centrifuge plant. Others are contemplating building here. If all are constructed, it could supply the U.S. needs, and be expanded as needed to meet growth in the market. If required, the Paducah Gaseous Diffusion Plant could also run past its planned shutdown in 2012.

I would like to speak for a moment about the American Centrifuge Plant. The ACP is the only plant to use U.S. centrifuge technology. Owned and operated by a U.S. company, it is the only technology that can be used to meet national security needs, but at the same time, does not benefit from foreign government ownership and support, as does its competitors. USEC's development and manufacturing work is based in Oak Ridge, Tennessee. Manufacturing of machine components will also take place in several other states. We are at a critical juncture as we enter in the process of deploying the plant, and are looking to have it at capacity by 2012 to meet market demand.

The final portion of the fuel cycle, fuel fabrication, is served by several plants in the United States. Currently, the market has much more supply than demand. If new reactors are built, existing fabrication facilities should have enough capacity to meet demand.

Several threats to nuclear expansion exist. One is timely and adequate financing for construction in light of current credit market conditions and uncertainty regarding the timing of any loan guarantees from the Department of Energy. The companies building here also need to be able to compete on a level playing field. The potential for Russia to dump low enriched uranium on the U.S. market is indeed a threat.

I would like to close by discussing the role that the U.S. Government can play in solidifying the U.S. based fuel supply. Despite actions by Congress to encourage the expansion of nuclear power, the implementation of legislative directives at the agency level has lagged behind market needs. Delays in implementing the loan guarantee program is one example.

Domestic producers need legislative support to ensure that the U.S. Government can effectively enforce the Russian Suspension Agreement. Additionally, support for the Paducah plant with a contract to enrich the Department of Energy's high assay tails would help meet market needs for both uranium and enrichment. DOE needs to complete its plan for managing and selling its uranium inventory to provide market clarity on how DOE's inventories will affect supply.

Our mutual goals should be the expansion of nuclear power. The domestic fuel industry is working to ensure that the fuel for nuclear reactors will be available when they come online. At USEC, we firmly believe that increasing our use of nuclear power will help our nation tackle the challenges we face, from international energy security, to the adverse effects of burning fossil fuels.

Thank you for your time, and I look forward to the questions.

[The prepared statement of Mr. Van Namen follows:]

PREPARED STATEMENT OF ROBERT VAN NAMEN

Good morning. My name is Robert Van Namen, and I am Senior Vice President, Uranium Enrichment at USEC Inc., a leading supplier of low enriched uranium for commercial nuclear power plants. Thank you Chairman Gordon, Ranking Member Hall and Members of the Committee for inviting me to testify on the current status of America's supply of uranium and nuclear fuel and the industry's ability to meet additional demand for fuel as the country prepares to increase its use of nuclear power.

Today's U.S. nuclear fuel supply industry is in transition. While it is in better shape than it was a decade ago, much work remains to be done and substantial investments need to be made before it can fully support the expansion of nuclear power in our country. Domestic fuel companies constructing new facilities face stiff competition in a market dominated by foreign, vertically integrated firms, many of which benefit from the financial and political support of their governments. As we work to increase our domestic fuel supply capacity, U.S. companies supplying the nuclear fuel cycle need the assurance that their investment of resources will receive the support necessary to revive the industry to a long-term, self-sustaining position. We must rebuild and expand our domestic fuel cycle infrastructure to put us in a position of self reliance for the future.

While America still leads the world in the amount of electricity produced by nuclear power, we long ago gave up our industry leading position on nuclear technology. Unless we take steps now to reclaim a leadership position, we will lose our ability to affect nuclear's future expansion and use worldwide or even in our own country. Now is the time for the U.S. Government to encourage the efforts of our domestic companies to rejuvenate the U.S. nuclear fuel cycle so it can meet the demand of an expanded nuclear power generating capacity in the decades to come.

U.S. Uranium Supply

Let me start with the beginning of the fuel cycle, the mining and milling of natural uranium. Since 1994, domestic sources have provided an average of about 18 percent of the natural uranium purchased by U.S. reactor operators. Our production of uranium began to decline in the mid-1990s as a flood of government inventories and material from countries in the former Soviet Union depressed prices to levels that made it uneconomical to produce the material domestically. The dimming prospects for future nuclear reactors being constructed also dampened prices and the prospects for future demand growth.

But today the situation has changed somewhat for the better. Since 2003, the price of uranium has risen from about $10 a pound up to more than $95 for long-term contracts. At this price, domestic miners have begun the process to expand or restart existing mines. NRC expects applications for 20 new mines to be filed by 2011. Concurrently, production has increased to about five million pounds a year at existing mines.

However, even if domestic production of uranium expands immensely, it is unlikely that we would ever be able to supply all our needs with domestic production. Fortunately, the countries with the greatest uranium reserves, Canada and Australia, are close allies of the United States, reducing chances of supply disruptions. Additionally, the U.S. Department of Energy maintains an enormous inventory of uranium in various commercial and non-commercial forms. This inventory can supply limited regular demand as well as serving as a strategic reserve in case of supply disruptions. The department is working on the details of a long-term policy for handling its inventory, which would bring much needed clarity to the role of these sales in the market.

U.S. Conversion Supply

The second step in the fuel cycle is the conversion of natural uranium to uranium hexafluoride. Unlike uranium mining, the lone U.S. supplier of conversion services can meet the majority of U.S. demand. The Converdyn plant in Illinois has recently expanded and can now meet about 80 percent of annual U.S. demand. Historically, conversion plants have been able to expand in step with increased demand, and the world has an overcapacity of conversion services available at facilities in Canada, the United Kingdom, France and Russia. Additionally, companies have expressed some interest in building more plants or adding onto their existing capacity at conversion facilities in these countries. A secondary source of conversion lies in the large quantity of uranium in inventories such as DOE's that have already been converted to uranium hexafluoride.

U.S. Low Enriched Uranium Supply

After conversion, uranium must be enriched to raise the concentration of the fissionable isotope U^{235} from its natural state of less than one percent to the four to five percent required for commercial nuclear reactors. The United States has one operating uranium enrichment plant, the Paducah Gaseous Diffusion Plant in Paducah, Kentucky, which USEC operates under lease from DOE. In 2008, we expect to produce approximately six million SWU at the plant. A SWU, or separative work unit, is the industry unit of enrichment. The annual fuel requirements of a typical reactor require about 100,000 SWU and 900,000 pounds of uranium. Annual U.S. demand ranges between 12 to 14 million SWU a year. USEC shut down Paducah's sister plant in Piketon, Ohio, in 2001 in the face of dumping of foreign commercial LEU and to accommodate increased supply of LEU from down-blended Russian nuclear warheads through the Megatons to Megawatts program.

U.S. reactors currently depend upon foreign sources for the majority of their LEU. The supply comes from three major sources: LEU from the Paducah plant, about 12 percent, the Megatons program, about 43 percent, and from European producers, about 43 percent. But that is about to change.

Worldwide, the enrichment industry is transitioning from production based on a mix of gaseous diffusion and gas centrifuge technologies to one based almost solely on gas centrifuge over the next ten years. In the United States, USEC and a subsidiary of Urenco, a European enrichment company, are each building gas centrifuge plants as I speak. Combined, these plants will have an initial capacity of just under seven million SWU.

Other companies, such as GE–Hitachi and the French conglomerate Areva, are also contemplating building plants here, although neither has applied for a license, selected a site, or made any other definitive commitment to build yet. If all four plants are constructed, it would provide enough LEU capacity for current and potential increases in U.S. demand. Additionally, based on current SWU prices, the Paducah GDP can run past its planned shutdown in 2012 to fill any supply gaps should the market require the additional supply.

I would like to speak for a moment about our American Centrifuge Plant. The ACP is the only plant to use U.S. centrifuge technology. USEC's centrifuge machine, the AC100, is based on a design by DOE from the 1980s, but with vast improvements in performance, materials and manufacturing processes. Because the ACP will be owned and operated by a U.S. company, it does not face the restrictions imposed on the foreign centrifuge and laser enrichment technologies that will be used in the other plants. USEC's development and manufacturing work is based in Oak Ridge, Tennessee, where we have been working since 2001 to resurrect the U.S. technology. Manufacturing of machine components will also take place in West Virginia, Indiana, Ohio and other states. Constructing the plant increases domestic capacity while also rebuilding an American industrial base for manufacturing a highly advanced nuclear technology.

One major advantage of gas centrifuge over gaseous diffusion is its modularity. As new contracts for LEU are signed with utilities, a plant can be expanded to meet demand in increments. So while our initial planned capacity for the American Centrifuge Plant is 3.8 million SWU, our Environmental Impact Statement approved as part of our NRC license covers the potential expansion of the plant to approximately double this size. If nuclear power grows as some predict, we could eventually expand the plant to four times its original size based on the available land at the site. So if we see a number of new reactors licensed and constructed, we believe we will have the ability to expand the plant in order to meet the emerging demand.

However, several threats to the expansion of the U.S. LEU capacity exist. One major issue is the availability of timely and adequate financing for construction in light of current credit market conditions and uncertainty regarding the timing of any loan guarantees from DOE. In particular, USEC would like to utilize DOE's loan guarantee program to assist with debt financing for the American Centrifuge Plant. DOE needs to move quickly to award guarantees once applications are received. Given the current credit crisis, such guarantees may be necessary to receive financing that makes the plant economical for investors.

The companies building here also need to be able to compete on a level playing field, shielded from uncontrolled dumping of foreign imports of uranium and LEU. The potential for Russia to dump LEU on the U.S. market is particularly on the minds of those of us investing here, as witnessed by the Senate hearing on the matter last month.

Other threats include the increasing costs for material and labor, the costs for recreating a manufacturing base in the U.S. to make centrifuge machines and plant components, and the need to develop a skilled labor pool to build and operate the facilities. Utilities considering building new reactors face many of these same challenges.

So if conditions permit, we may see a large and diverse domestic enrichment industry within five to ten years, one that could support the expansion of our nuclear fleet.

U.S. Fuel Fabrication

The final portion of the fuel cycle, fuel fabrication, is served by several plants in the United States, only one of which is owned by a U.S. company, and currently the market has much more supply than demand. While each reactor vendor used to be the sole source for fuel assemblies for the reactors they built for customers, today each vendor's plant can make fuel assemblies for reactors designed by competitors, leading to the current glut. If new reactors are built here, the existing fabrication facilities should have enough capacity to meet any new demand.

The Role of the U.S. Government in Expanding the Use of Nuclear Power

I would like to close by discussing the role that the U.S. Government can and should play in expanding the use of nuclear power domestically, specifically in assisting the expansion of our domestic fuel supply.

First, a few of the positives that have gotten us to this point are worth mentioning. Congress has enacted legislation, such as the *Energy Policy Act of 2005,* that has spurred utilities to consider building the first new plants in 30 years. In addition, the regulatory uncertainty of the NRC licensing process has been simplified and tested. For instance, USEC and Urenco's subsidiary LES have both successfully applied for and received construction and operating licenses for new enrichment facilities. These are the first new nuclear facility licenses issued by NRC in several decades. NRC has also worked vigorously to increase its staff in order to handle the tens of applications for new nuclear plants, fuel cycle facilities and uranium mines that is has received and expects to receive during the next decade.

Those are some of the positives, but the need for government action remains. Despite legislation passed by Congress to encourage the expansion of nuclear power, the implementation of legislative directives at the agency level has often been out of step with real-world timeframes. The delay in implementing the Loan Guarantee program, for instance, may prevent new nuclear facilities from coming online as soon as possible because companies may have to delay or cancel their projects. The NRC also faces a funding shortfall from its budget request that may force it to defer or delay the review of applications for new projects.

Specifically in nuclear fuel, domestic producers need legislative support to backup the Russian Suspension Agreement Amendment to ensure that the U.S. Government can enforce recently agreed terms that allow measured Russian access to the U.S. market while permitting our domestic industry time to secure contracts needed to secure financing for new mines and production facilities. Additionally, near- and medium-term support for the Paducah plant with a contract to enrich DOE's high-assay tails would ensure that it remains available to meet the needs of domestic utilities past 2012, a period when the new centrifuge facilities will be starting up operations. As mentioned before, DOE needs to complete its plan for managing and selling its uranium inventories to provide the market, and specifically miners and enrichers, clarity on how DOE's inventory will affect supply and demand during the next decade. Finally, any assistance with education, job development, and infrastructure improvements in the next few years will go a long way to assisting us with creating a stable, long-term nuclear fuel industry in the United States.

Our mutual goal in all of these activities should be to see the renewed expansion of nuclear power, America's primary source of clean, reliable emissions-free electricity. The domestic fuel industry has spent the past several years working to ensure that the fuel for new reactors will be available when they come online so that our nuclear plants can continue to provide us energy security and diversity. At USEC, we firmly believe that increasing our use of nuclear power will help our nation tackle the severe challenges we face from international energy security to the adverse effects of electricity generated by burning fossil fuels. Thank you for your time and I look forward to your questions.

BIOGRAPHY FOR ROBERT VAN NAMEN

Robert (Bob) Van Namen is Senior Vice President of Uranium Enrichment at USEC Inc. He heads the Company's marketing and sales department as well as operations at the Paducah and Portsmouth sites. He is also the lead USEC officer responsible for overseeing NAC International, USEC's wholly-owned subsidiary based in Norcross, GA. He previously served five years as USEC's Vice President of Marketing and Sales.

Prior to joining USEC in January 1999, Mr. Van Namen was head of nuclear fuel management for Duke Energy. His career at Duke also included seven years in nuclear design and safety analysis.

Mr. Van Namen is a nuclear engineer with 22 years of experience in nuclear power. He has served in a variety of leadership roles in industry and professional organizations including the Nuclear Energy Institute. He currently serves on the board of management of the World Nuclear Association.

Mr. Van Namen earned his Bachelor of Science and Master of Science degrees at the University of Virginia. He is a registered professional engineer in the State of North Carolina.

USEC Inc. (NYSE: USU), a global energy company, is a leading supplier of enriched uranium fuel for commercial nuclear power plants.

Chairman GORDON. Thank you. And Mr. Asselstine, you are recognized.

STATEMENT OF MR. JAMES K. ASSELSTINE, MANAGING DIRECTOR (RETIRED), LEHMAN BROTHERS; FORMER COMMISSIONER, NUCLEAR REGULATORY COMMISSION

Mr. ASSELSTINE. Mr. Chairman, Congressman Bilbray, Members of the Committee, thank you for the opportunity to appear before you today.

My testimony will provide a financial community perspective on the major issues of financial institutions regarding investment in new nuclear plants. In addition, I will discuss the role of the federal financial support in private sector decisions to invest in nuclear power.

As the companies and their investors evaluate a potential new nuclear plant project, I believe that they will need to consider several factors. First, the companies and investors are mindful of the experience with construction delays, cost increases, and licensing and litigation delays for many of the existing plants that entered commercial operation in the 1980s and 1990s. They will want to be satisfied that the causes for these past problems have been addressed for any new project.

Second, given the construction complexity and large capital investment for a new nuclear project, the companies and investors will want to be confident that a new project can be completed on budget and on schedule. Third, the companies and investors will want assurance that technology risk for the project is relatively low, because all of the new plant projects being contemplated use technology that is similar to the light water reactor designs of the existing plants, and because those plants have established a consistent track record of safe and reliable operation, I don't believe that technology risk is a significant factor.

Fourth, the companies and their investors will want assurance that the risk of cost increases due to new regulatory requirements, and licensing and litigation delays, is acceptably low. The existing light water reactor technology in use today is much more mature than it was when many of the existing plants were licensed, and we now have an extensive base of successful operating experience with the existing plants. In addition, a number of issues, such as the post-Three Mile Island changes, fire protection, equipment reliability, material condition, and metallurgy, and maintenance issues, have been addressed satisfactorily by the industry and the NRC.

Further, over the past decade, we have had a period of regulatory stability with the NRC that has contributed to the successful operation of the existing plants. Thus, although there is the potential for additional regulatory requirements to address issues such as plant security and material condition, as the existing plants grow older, the risk of costly and disruptive new regulatory requirements for new plants appears to be relatively low. Similarly, the adoption of a new licensing process by the NRC for future nuclear plants, that is intended to address the causes of delays and cost increases in the past, is encouraging, but until licensing decisions have been completed for a group of initial new plants, that new licensing process remains untested, and some uncertainty remains as to whether the process will function as it is intended.

Fifth, the companies and investors will require assurance that the price of power to be generated by a new nuclear plant will be competitive with other alternatives, including coal and gas-fired generation, and renewable energy resources. This may pose a special challenge for the initial group of new nuclear plants, because it is likely that the industry will incur $300 to $500 million in first of a kind engineering costs for each new nuclear plant design, in order to develop the detailed engineering design information required to satisfy the NRC's design certification process. Depending upon how these costs are allocated, this could significantly increase the cost of the initial new plants.

And finally, as is the case with any new proposed generating project, the companies and investors will need confidence that the power from the new plant is needed, and that the company will be able to recover its capital investment in the plant and earn a fair return on that investment.

Mr. Chairman, I believe that a number of these factors can be addressed by the industry through the contractual arrangements for construction and risk-sharing among the parties involved in designing, building, owning, and operating a new nuclear plant, but some factors, such as the magnitude, complexity, and large initial capital investment, including the engineering design costs that I mentioned, of a new nuclear project, and residual uncertainties associated with the new, but as yet untested NRC licensing process, will likely require federal financial support, to allow the companies and investors to move forward with new nuclear plant commitments.

Mr. Chairman, I believe the financial support provisions in the Energy Policy Act of 2005, if properly implemented, can provide a sufficient basis to support the development and financing of new nuclear plants in this country. As you mentioned in your opening statement, there is clear evidence, from the level of activity within the industry since the Energy Policy Act was enacted, that these provisions in the Act are having their intended effect of facilitating and encouraging new nuclear plant development.

Continued successful implementation of all three of the key financial support components in the Energy Policy Act of 2005 will be essential if this industry activity is to be converted into firm orders for new plants.

Final implementing regulations are now in effect by the Department of Energy for the standby delay risk insurance provision, and the federal loan guarantee program. In addition, final regulations are now in effect by the Internal Revenue Service for the production tax credit provision. In general, I believe that these regulations provide a workable framework for implementing the three financial support provisions in the Energy Policy Act.

In particular, though, considerable work remains to be done regarding the federal loan guarantee program, and that is the area that I believe will require some additional ongoing Congressional oversight and involvement. Again, thank you for the opportunity to testify today, and that completes my testimony.

[The prepared statement of Mr. Asselstine follows:]

PREPARED STATEMENT OF JAMES K. ASSELSTINE

Mr. Chairman and Members of the Committee, thank you for the opportunity to appear before you today.

My name is Jim Asselstine. Before my retirement last year, I served as a Managing Director at Lehman Brothers, where I was the senior fixed income research analyst responsible for covering the electric utility and power sector. In that capacity, I provided fixed income research coverage for more than 100 U.S. electric utility companies, power generators, and power projects. I also worked closely with the large institutional investors who have traditionally been a principal source of debt financing for the power industry. In addition, I served as a member of the U.S. Nuclear Regulatory Commission from 1982 to 1987, a period during which many of our existing nuclear units received their operating licenses.

Mr. Chairman, I appreciate your invitation to testify at today's hearing to explore the potential for nuclear power to provide an increased proportion of electric generating capacity in the United States. My testimony will provide a financial community perspective on the major considerations of financial institutions regarding investment in new nuclear power plants. In addition, I will discuss the role of federal financial support in private sector decisions to invest in nuclear power.

The process of planning, developing, licensing, building, and financing a new nuclear plant is likely to be one of the most complex endeavors facing an electric utility or power generation company today. As currently envisioned, this process will require a preliminary planning period of about two years, a period of three to four years to complete the process to obtain a combined construction and operating license (COL) from the U.S. Nuclear Regulatory Commission (NRC), and a construction period of from four to five years. Thus, more than a decade will be required to plan, license, build, and bring a new nuclear unit into commercial operation. A new nuclear unit will also be a large, very complex, and capital intensive construction project. In terms of its cost and construction complexity, building a new nuclear unit is likely to be similar to building a large new coal-fired generation unit. This cost and construction complexity will also be much greater than that for the gas-fired generating capacity that has represented the bulk of new power generation built in this country over the past two decades. Because the cost of a new nuclear unit can represent a substantial portion of the market value of a utility or power generation company, the decision to proceed with a new nuclear project is likely to be one of the more significant decisions facing the company's management and investors.

Further, unlike any other power generation alternative, a new nuclear unit is subject to the NRC's licensing process and regulatory oversight. This exposes a new nuclear plant project to the potential for changing regulatory requirements, and for licensing and litigation delays. Changing regulatory requirements, and licensing or litigation delays could increase the cost of a new nuclear unit, delay the recovery of the company's financial investment, and in extreme cases, prevent a completed plant from entering commercial operation. A number of our existing nuclear units experienced cost increases as a result of changing regulatory requirements, and licensing and litigation delays in the 1980s and 1990s, and one completed plant ultimately failed to enter commercial operation as a result of these factors. Since that time, the Congress and the NRC have established a new licensing process for nuclear plant applications that is intended to achieve final licensing decisions as early as possible in the process in order to minimize the risk of delay or disruption after the company has made a substantial capital investment in the plant. This new licensing process, including the use of a combined license (COL) that would authorize both construction and operation of the plant, holds great promise, but has yet to be tested to verify that it will work as intended.

As the companies and their investors evaluate a potential new nuclear plant project, I believe that they will need to consider several factors. First, the companies and investors are mindful of the experience with construction delays, cost increases, and licensing and litigation delays for many of the existing plants that entered commercial operation in the 1980s and 1990s. They will want to be satisfied that the causes for these past problems have been addressed for any new project. Second, given the construction complexity and large capital investment for a new nuclear project, the companies and investors will want to be confident that a new project can be completed on budget and on schedule. Third, the companies and investors will want assurance that technology risk for the project is relatively low. Because all of the new plant projects being contemplated use technology that is similar to the light water reactor designs of the existing plants, and because those plants have established a consistent track record of safe and reliable operation, I do not believe that technology risk is a significant factor.

Fourth, the companies and their investors will want assurance that the risk of cost increases due to new regulatory requirements, and licensing and litigation delays is acceptably low. The existing light water reactor technology in use today is much more mature than it was when many of the existing plants were licensed, and we now have an extensive base of successful operating experience with the existing plants. In addition, a number of issues such as the post-Three Mile Island issues, fire protection, equipment reliability, material condition issues and metallurgy, and maintenance issues have been addressed satisfactorily by the industry and the NRC. Further, over the past decade, we have had a period of regulatory stability with the NRC that has contributed to the successful operation of the existing plants. Thus, although there is the potential for additional regulatory requirements to address issues such as plant security and material condition as the existing plants grow older, the risk of costly and disruptive new regulatory requirements for new plants appears to be relatively low. Similarly, as I discussed previously in my testimony, the adoption of a new licensing process by the NRC for future nuclear plants that is intended to address the causes of delays and cost increases in the past is encouraging. But, until licensing decisions have been completed for a group of initial new plants, that new licensing process remains untested, and some uncertainty remains as to whether the process will function as it is intended.

Fifth, the companies and investors will require assurance that the price of power to be generated by a new nuclear plant will be competitive with other alternatives, including coal and gas-fired generation, and renewable energy resources. This may pose a special challenge for the initial group of new nuclear plants because it is likely that the industry will incur $300–$500 million in first-of-a-kind engineering costs for each new nuclear plant design in order to develop the detailed engineering design information required to satisfy the NRC's design certification process. Depending upon how these engineering design costs are allocated, this could significantly increase the cost of the initial new plants. Finally, as is the case with any new proposed generating project, the companies and investors will need confidence that the power from the new plant is needed, and that the company will be able to recover its capital investment in the plant and earn a fair return on that investment. In the case of a regulated electric utility, this confidence will depend upon the state rate-setting arrangements that are in place for the new plant. In the case of an unregulated, or merchant, generation company, this confidence will depend upon any contractual arrangements to sell the output of the plant, and upon studies of power market conditions in the region in which the plant will be located.

Mr. Chairman, I believe that a number of these factors can be addressed by the industry through the contractual arrangements for construction and risk-sharing among the parties involved in designing, building, owning, and operating a new nuclear plant. But some factors such as the magnitude, complexity, and large initial capital investment, including engineering design costs, of a new nuclear project, and residual uncertainties associated with the new, but as yet untested NRC licensing process, will likely require federal financial support to allow the companies and investors to move forward with new nuclear plant commitments.

The *Energy Policy Act of 2005* contained four provisions that were intended to facilitate and encourage industry commitments to build and operate new nuclear plants. First, the Act included a 20-year extension of the *Price-Anderson Act,* which provides insurance protection to the public in the event of a nuclear reactor accident. With the previous expiration of the *Price-Anderson Act,* insurance coverage for the public remained in place for the existing 104 operating nuclear units, but that coverage would not have been available for new plants. The 20-year extension of the *Price-Anderson Act* corrected this problem.

Second, the Act provided a production tax credit of 1.8 cents per kilowatt-hour for up to 6,000 megawatts of generating capacity from new nuclear power plants for the first eight years of commercial operation. This production tax credit is subject to an annual cap of $125 million for each 1,000 megawatts of generating capacity. A similar production tax credit was provided, and has historically been available, for certain renewable energy resources.

Third, the Act provided standby support or risk insurance for a new nuclear project's sponsors and investors against the financial impacts, including financing costs, of delays beyond the industry's control that may be caused by delays in the NRC's licensing process or by litigation. This standby risk insurance for regulatory and litigation delays provides protection for the first six new nuclear units built. Up to $500 million in protection is provided for the first two new units, and 50 percent of the cost of delays up to $250 million, with a six-month deductible, is provided for units three through six.

Finally, the Act provided for federal loans and loan guarantees for up to 80 percent of the project's cost. These federal loan guarantees were not limited to new nuclear plants, but instead were made available to support the development of innovative energy technologies, including advanced nuclear power plants, that avoid or reduce certain air pollutants and greenhouse gas emissions.

Mr. Chairman, I believe that these financial support provisions in the *Energy Policy Act of 2005,* if properly implemented, can provide a sufficient basis to support the development and financing of new nuclear plants in this country. Although no company has yet placed a firm order for a new nuclear unit, there is clear evidence from the level of activity within the industry since the *Energy Policy Act* was enacted that these provisions in the Act are having their intended effect of facilitating and encouraging new plant development. To date, the NRC has certified two new reactor designs for use, and reviews of two additional designs are currently underway. Thus, it appears likely that the industry will be able to select from at least four new NRC-certified plant designs. Further, according to the Nuclear Energy Institute, as of April 8, 2008, at least 23 companies or consortia have stated their intention to file applications with the NRC for a combined license for at least 27 new nuclear units in this country. Of these, applications for COLs for 15 units have now been filed with the NRC, and that number could grow to about 20 units by the end of this year. In addition, a number of companies are pursuing Early Site Permit applications with the NRC in order to resolve site environmental issues in advance of the COL proceeding.

Mr. Chairman, I believe that continued successful implementation of all three of the financial support components in the *Energy Policy Act of 2005* will be essential if this industry activity is to be converted into firm orders for new plants. These financial support provisions are complementary; collectively, they have the potential to reduce the residual uncertainties, risks, and costs associated with a new nuclear plant to levels that are likely to be comparable to other base load generating alternatives. The standby risk insurance provides valuable protection against licensing and litigation delay costs for the initial six units to be built, although there would be no protection for what may be a number of additional units working their way through the NRC licensing process at about the same time. The production tax credit provides a valuable financial benefit for new plants over their initial eight years of operation. This benefit can offset the somewhat higher cost of the initial plants; however, this benefit only becomes available when the unit begins operation, and the exact amount of the available production tax credit for each plant will not be known for some time. The available tax credit benefit will be spread among all of the eligible plants, and initial eligibility will be determined by the number and size of the plants for which COL applications are filed with the NRC by the end of this year. The federal loan guarantee can help to facilitate the availability of debt financing for up to 80 percent of the total cost of the plant. Given the magnitude of a new nuclear plant investment, this can be a substantial benefit for all the companies, including the regulated utilities that are considering a new nuclear project. But the loan guarantee may be essential to facilitate debt financing for the unregulated, merchant generation companies that may have somewhat less financial flexibility than the regulated utility companies. This is especially the case if the company seeks to use a non-recourse project finance structure similar to the financing structures used for many gas-fired power plant projects in the 1990s.

Final implementing regulations are now in effect by the Department of Energy for the standby delay risk insurance provision and the federal loan guarantee program. In addition, final regulations are now in effect by the Internal Revenue Service for the production tax credit provision. In general, I believe that these regulations provide a workable framework for implementing the three financial support provisions in the *Energy Policy Act.* In particular, though, considerable work remains to be done regarding the federal loan guarantee program. The Department of Energy has done an effective job in staffing its Loan Guarantee Program Office, and in my view, now has the in-house technical expertise to evaluate loan guarantee applications. Once the Administration and Appropriations Committee review process for the Department's loan guarantee implementation program is completed, the Department will solicit loan guarantee applications and begin an extensive due diligence process and the negotiation of financial term sheets. It appears this process will continue well into 2009. Further, the calculation of credit subsidies, which will determine the cost of the loan guarantee to the individual company, has yet to be finalized. Thus, the terms and cost of the loan guarantee may not be defined for some time. Finally, the currently approved funding of $18.5 billion for loan guarantees for new nuclear projects may not be sufficient to cover all those who apply. Continued Congressional oversight of the Department's loan guarantee program and the available funding for that program may be needed to ensure that the loan guarantee financial support component is successful.

Mr. Chairman, again, thank you for the opportunity to testify today, and this completes my testimony.

BIOGRAPHY FOR JAMES K. ASSELSTINE

Mr. Asselstine recently retired from his position as a Managing Director with Lehman Brothers, Inc. During his more than 18 years with Lehman Brothers, Mr. Asselstine was a senior fixed income research analyst covering the electric power industry. Mr. Asselstine was also a member of the firm's Investment Banking Division Commitment and Bridge Loan Committees, and was the global head of high grade credit research for six years. As one of five senior members on the firm's Commitment and Bridge Loan Committees, Mr. Asselstine was responsible for reviewing, approving, and monitoring all of the firm's equity, fixed income, and structured products capital commitments and bridge loan commitments. As head of high grade credit research, Mr. Asselstine directed a team of 55 research analysts covering investment grade-rated industrial, financial, and utility issuers of fixed income securities in the United States, Europe, and Asia.

Mr. Asselstine served as a Commissioner on the U.S. Nuclear Regulatory Commission from 1982 to 1987. From 1978 to 1982, he served as Associate Counsel for the U.S. Senate Committee on Environment and Public Works. While on the staff of the committee, Mr. Asselstine also served as a Co-Director of the Committee's investigation of the Three Mile Island nuclear power plant accident.

From 1977 to 1978 and from 1973 to 1975, Mr. Asselstine served as a Staff Attorney with the U.S. Nuclear Regulatory Commission, and from 1975 to 1977, he served as Assistant Counsel for the Joint Committee on Atomic Energy of the U.S. Congress.

Mr. Asselstine holds a B.A. degree in Political Science from Virginia Polytechnic Institute, and a J.D. degree from the University of Virginia.

Chairman GORDON. Thank you. And Dr. Cochran, you are recognized for five minutes.

STATEMENT OF DR. THOMAS B. COCHRAN, SENIOR SCIENTIST, NUCLEAR PROGRAM, NATIONAL RESOURCES DEFENSE COUNCIL, INC.

Dr. COCHRAN. Mr. Chairman, thank you for providing the Natural Resources Defense Council with the opportunity to testify today.

I have provided, in my testimony, a summary of recommendations for the Congress. The highest priority, I believe, is to pass a climate bill that puts stringent limits on CO_2 emissions and other greenhouse gas emissions. This is not only the best and most economically efficient way to mitigate climate change, but it is the single policy that would provide the greatest benefit for the domestic nuclear power industry.

Secondly, the Congress should stop subsidizing the construction of new nuclear power plants, and reject further subsidies for new nuclear plants in climate mitigation legislation. The economically inefficient way to mitigate climate change is to continue to subsidize new nuclear plants. This will penalize and slow investments in improved energy efficiency and energy supply technologies that can mitigate climate change in less time with less cost and risk.

Third, you should terminate the Department of Energy's misguided 100-plus year effort to close the nuclear fuel cycle and introduce fast burner reactors into the United States, and terminate funding for research on advanced nuclear fuel reprocessing. You should establish an unbiased outside commission to report on ways to improve the Nuclear Regulatory Commission's safety culture. The biggest barrier to significant improvement of U.S. nuclear plant safety is the poor safety culture of the Nuclear Regulatory Commission.

Finally, you should initiate a search, or have the Department of Energy initiate a search, for a second geologic repository for the disposal of spent fuel.

Nuclear power has both benefits and costs. On the benefits side, it is a low carbon emitter. It is a reliable generator of electricity. It provides low cost electricity from existing plants. It has a reliable and plentiful supply of fuel, and low health impacts from routine plant emissions.

On the other side of the ledger, it increases the risk of nuclear weapons proliferation. You run the risk of another catastrophic nuclear accident. It has significant, unresolved waste disposal problems. It has significant, unresolved health and environmental problems associated with uranium mining. And new nuclear plants will not be economical in the United States until competing fossil generation is required to pay significant financial penalty for its carbon emissions. Polluters should pay, and the efficient way to deal with that issue is to cap carbon emissions.

I have provided an analysis of the projections of nuclear power globally based on the World Nuclear Association's databases, and it is a snapshot of all the reactors in operation, under construction, planned, and proposed. And if you look at this future set of reactors, this snapshot, and ask what is the climate mitigation offset—the carbon emission avoided—you see it is about—over and above what it would be today if you maintained the current global level of nuclear power—six percent of what is needed to address this climate change problem.

Now, that number is very uncertain. It could certainly be twice that, because that number does not include nuclear plants from the 2030 to 2050 period, because that is beyond the horizon for companies to propose new plants. Nuclear has made a contribution to climate mitigation. It will continue to make a contribution to climate mitigation.

The issue for the Congress and for us is not whether you are for or against nuclear power. The climate issue, in terms of domestic policy, is whether Congress, the Federal Government, should continue to subsidize new nuclear plant construction. And in our view, the Congress should not. I stated earlier why I think that would actually slow the process down, by curtailing investments in technologies that can get us there sooner and at less risk.

I believe, additional subsidies are not needed. Hearing Marilyn Kray, who is the President of NuStart. The NuStart participants, the 10 utilities, own or operate two thirds of the nuclear power plants in this country. They have combined assets of—I don't know the precise figure—but I would say on the order of $400 billion. The General Electric company, which is also a participant, the second largest corporation in the world, has assets of $400 billion alone. You do not need to subsidize these people. They can provide the risk insurance for their own investments by collaborating, as they have done, in NuStart.

Chairman GORDON. Dr. Cochran, if you could, we are trying to be generous with the time, but if you might bring it to a close, then we can explore the suggestions and the questions.

Dr. COCHRAN. Well, let me just say the greatest concern I have about the global expansion of nuclear power is the proliferation risk. The international safeguards regime, the Non-Proliferation Treaty, the IAEA safeguards, and other elements, not adequate today to safeguard many of the fuel cycle facilities that are used by the nuclear power industry globally, and we see that being played out in Iran and North Korea.

And it is unfortunate, but all of the big problems with nuclear are being foisted over onto the Federal Government for various reasons. Proliferation—that is a government problem. Safety of catastrophic accidents—the government assumes the risk of catastrophic accidents. The waste is so toxic, and it contains plutonium that can be used for weapons—that is a government problem. The government is not solving these problems. These problems are endemic, and they remain.

And you have got to address these fundamental problems before we expand nuclear power significantly on a global basis.

[The prepared statement of Dr. Cochran follows:]

PREPARED STATEMENT OF THOMAS B. COCHRAN

Introduction

Mr. Chairman and Members of the Committee, thank you for providing the Natural Resources Defense Council (NRDC) the opportunity to present its views on the *"Opportunities and Challenges for Nuclear Power"* and its role in mitigating climate change. NRDC is a national, non-profit organization of scientists, lawyers, and environmental specialists, dedicated to protecting public health and the environment. Founded in 1970, NRDC serves more than 1.2 million members and supporters with offices in New York, Washington, Los Angeles, San Francisco, Chicago and Beijing.

Summary of recommendations

Congress should:

- Pass a climate bill that puts stringent limits on CO_2 and other greenhouse gas emissions—"cap carbon." This is not only the best and most economically efficient way to mitigate climate change, but it is the single policy that would provide the greatest benefit to the domestic nuclear power industry.
- Stop subsidizing the construction of new nuclear power plants, and reject further subsidies for new nuclear plants in climate mitigation legislation. The economically *inefficient* way to mitigate climate change is to continue to subsidize new nuclear power plants. This will penalize and slow investment in improved energy efficiency and energy supply technologies that can mitigate climate change in less time, with less cost and risk.
- Terminate DOE's misguided 100+ year effort to close the nuclear fuel cycle and introduce fast burner reactors in the United States, and stop funding research on advanced nuclear fuel reprocessing.

- Establish an unbiased outside commission to report on ways to improve the NRC's safety culture. The biggest barrier to significant improvement of U.S. nuclear plant safety is the poor safety culture of the NRC.
- Initiate a search for a second geologic repository for disposal of spent fuel.

Nuclear power has both benefits and costs

On the benefit side, nuclear power:

- is a low-carbon emitter,
- is a reliable generator of electricity,
- provides low cost electricity from *existing* power plants,
- has a reliable and plentiful supply of fuel, and
- has low health impacts from routine power plant emissions.

On the other side of the ledger, nuclear power:

- increases the risk of nuclear weapons proliferation,
- runs the risk of another catastrophic nuclear reactor accident,
- has significant unresolved waste disposal problems,
- has significant unresolved health and environmental problems associated with uranium mining, and
- new nuclear plants will *not* be economical in the United States until competing fossil generation is required to pay a significant financial penalty for its carbon emissions, on the order of \$40 to \$60 per ton of CO_2.

Commercial nuclear power has unique risks and the liability for these risks has been transferred to the government:

- Nuclear is the only existing energy technology that requires special international safeguards and export control regimes to prevent countries from making nuclear weapons from fuel cycle facilities and materials.
- In the United States and some other countries nuclear is the only energy technology where the government has to assume the liability for catastrophic accidents.
- Nuclear power is the only energy technology whose waste is so dangerous that the government has to assume responsibility for its disposal.

The Contribution of Nuclear Power To Climate Change Mitigation

Nuclear power plants worldwide will continue to make a modest contribution to climate change mitigation. Based on data in the World Nuclear Association data (*www.world-nuclear.org/info/reactors.html*), in Figure 1 we show a potential for worldwide growth in nuclear capacity out to about 2030.

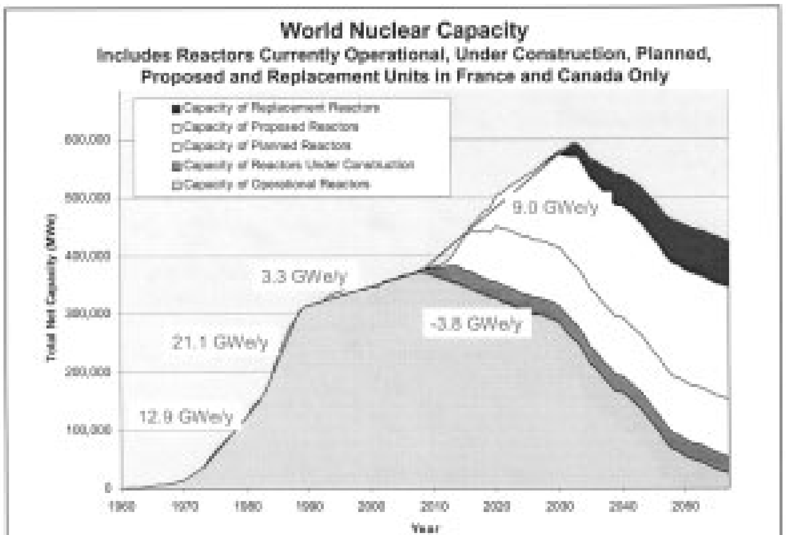

Figure 1. Global nuclear capacity based on the NRDC's data set of nuclear power plants in operation, under construction, planned and proposed, and projected replacement plants in France and Canada only, with growth rates as shown.

This is a snapshot based on current plans—not a highly accurate projection of the future. While it is adequate for the purposes of this hearing, the Subcommittee should understand that there are uncertainties in the projected data in Figure 1. Most of the operating reactors are assumed to have 60 year lifetimes. Actual lifetimes could be longer or shorter. Commercial operation dates for some reactors in the "under construction" and "planned" categories will surely slip. The plants in the "proposed" category do not have associated dates for the start of commercial operations, so we have assumed these plants may come on line between the years 2016 and 2032. Assuredly, some of these reactors will never be built, and others, not yet proposed, will be built in the future. And while we have extended the projection for 50 years, it is important to note that industry planning horizons do not stretch beyond about 20–25 years, so the shape of the "proposed' plant category cannot reasonably be calculated beyond about 2030. Nevertheless, this snapshot is probably more realistic that projections based on country specific and regional economic models.

In Figure 2, NRDC estimates the projected carbon emissions avoided by these same projected nuclear power plants displayed in Figure 1.

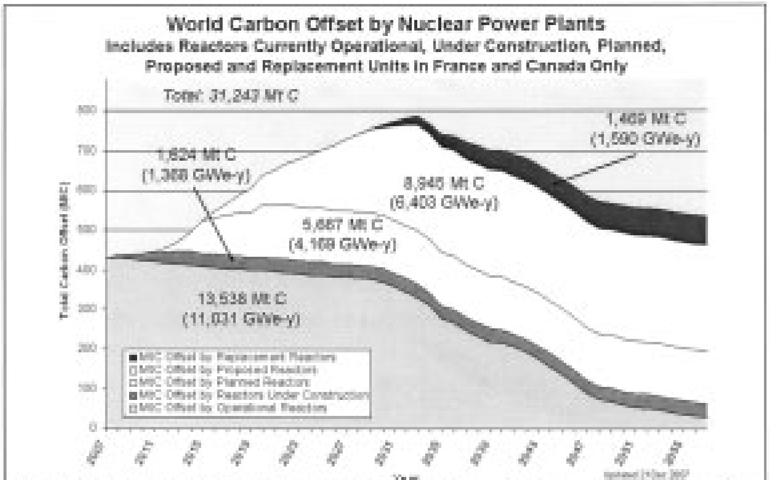

Figure 2. Projected global nuclear capacity and carbon emissions avoided based on the NRDC's data set of nuclear power plants in operation, under construction, planned and proposed, and projected replacement plants in France and Canada only.

These projections are summarized in the following table:

	Gt C	Percent of Needed Emission Reductions
Existing Plants	**13.5**	
New Plants	**17.7**	
Nuclear Total	**31.2**	
Maintain nuclear capacity at 2007 levels	**21.5**	
Difference	**9.7**	**6**

Table 1. Estimated world nuclear carbon emissions avoided, 2008-2057, based on nuclear plants in operation, under construction, planned and proposed, and projected replacement plants in France and Canada only.

The percentage of needed carbon emission is based on an assumption that approximately 175 GtC of reductions over a fifty year period would be necessary to stabilize global atmospheric CO_2 concentrations, where stabilization is defined as a reduction of atmospheric concentrations of carbon dioxide to two times the pre-industrial level. (Pacala and Socolow, "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies," *Science,* 13 August 2004, Vol. 305, No. 5686, pp. 968–972.)

What conclusions does NRDC draw from these projections? First, statements such as, "nuclear must be part of the mix," "I don't see how we can mitigate climate change without nuclear," "I support [or do not support] nuclear power," are largely irrelevant. Nuclear is part of the current mix of power generation, and it will continue to be part of the mix for the foreseeable future. Existing nuclear power plants are contributing to climate change mitigation and will continue to do so.

The real issue for the Congress is not whether one is for or against nuclear power per se. The crucial question for Congress is whether to continue, curtail, or increase federal taxpayer subsidies to a mature, polluting industry in order to spur building new U.S. nuclear plants. As NRDC demonstrates below, the answer to this question is a resounding "no."

Why Congress should cease subsidizing the construction of new nuclear power plants.

1. New-build nuclear power plants are not economical in the absence of strong carbon controls, and even with such controls they may not compete effectively against electricity supplied by renewable sources and energy efficiency programs.

Existing nuclear plants that have been largely or fully depreciated, or that acquired a new cost basis via a change in ownership at a deep discount to their original cost, are now economical to operate. The forward cost (fuel and operating and maintenance costs) average less than two cents per kilowatt-hour (c/kWh), and thus these plants produce some of the lowest cost electricity.

In strong contrast to existing plants, new plants are uneconomical due to their high cost of construction. In late-2003, the MIT study, "The Future of Nuclear Power" estimated that the cost of electricity generated by a new merchant nuclear plant would be some 60 percent higher than the cost of energy generated by a fossil-fueled plant. *See* MIT, "The Future of Nuclear Power," 2003, Table 5.1, p. 42. Since that report was published in 2003, the cost of fossil fuels and the capital cost of electricity generating plants have both increased significantly. In June 2007, the joint industry and non-profit Keystone Center report found that the levelized cost of electricity from new nuclear power plants was estimated to be in the range 8.3–11.1 c/kwh, up from the 6.7 to 7.0 c/kwh estimate in the 2003 MIT study. *See* the Keystone Report, "Nuclear Power Joint Fact-Finding," at 11.

Based on more recent data supplied by utilities and energy generating companies pursuing new nuclear plants, the low end of the Keystone estimate is no longer valid. Current cost estimates for several new reactors are in the range of 14 to 18 c/kwh (in 2007 dollars).

Electricity from new nuclear power plants in this cost range is not competitive with fossil-fueled baseload generation in today's marketplace, nor even with electricity supplied by waste heat co-generation, wind turbines, or freed-up by continuing pursuit of end-use efficiency programs. By the time the earliest of these new nuclear plants begin delivering power to the grid, several forms of solar power are also likely to be cheaper on a retail delivered-cost basis, and concentrating solar thermal plants will likely be competitive in the wholesale power market as well.

Implementation of a carbon cap that internalizes the true cost of burning fossil fuels is the single policy that would most benefit the nuclear industry, not because new-build nuclear power will necessarily be cheaper than other sources, but rather because it will make polluting fossil-fueled power more expensive. EPA has modeled the effect of the current version of the Lieberman-Warner climate bill to predict CO_2 prices using two different models. One model forecasts prices starting at $22/ton CO_2 in 2015, rising to $28 in 2020 and $46 in 2030 and continuing up from there; the other model's prices start at $35/ton in 2015 and hit $45 and $73/ton in 2020 and 2030 respectively. See *http://www.epa.gov/climatechange/economics/economicanalyses.html.* In short, enacting a carbon cap could increase the value of generating electricity from nuclear plants by 2.2–3.4 c/kwh in the near-term and more in later years.

Subsidizing new nuclear plants through direct federal cost sharing, a production tax credit, and tens of billions in federally subsidized and guaranteed debt will not remove new-build nuclear's cost disadvantage vis-à-vis other energy sources. Rather it will tend to disguise and even prolong these cost disadvantages, thereby penalizing and slowing investments in less costly demand—side energy management programs energy efficiency, and an array of electricity supply options that can provide carbon offsets more quickly, cheaply and safely than nuclear power. Unlike the wind and solar industries, after fifty years of operations, the nuclear reactor industry displays no consistent trend toward lower unit costs in manufacturing and construction, so it seems unlikely that further subsidies at this late date will serve to catalyze major cost reductions.

Given their high capital costs, and all the other non-carbon environmental liabilities and risks that attend reliance on the nuclear fuel cycle, new nuclear plants are obviously not the first, second, or even third option this body should turn to stem the buildup of carbon dioxide in the atmosphere. Put bluntly, anyone or any organization pushing for more taxpayer-funded largess for nuclear power plants in a climate bill is either seeking inappropriate windfalls for their clients, or is pursuing a poison pill strategy to protect carbon polluters by trying to kill the bill.

2. International safeguards are inadequate.

As evidenced by events in Iran and North Korea, the current international safeguards regime has major vulnerabilities. Under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), International Atomic Energy Agency (IAEA) safeguards agreements, and other elements, a non-weapon state can develop sensitive dual-purpose technologies, such as gas centrifuge enrichment plants, bring them within days or weeks of producing nuclear weapons.

Moreover, "[T]he objective of safeguards is the **timely detection of diversion of significant quantities of nuclear material** from peaceful activities to the manufacture of nuclear weapons or of other explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection." (IAEA), INFCIRC/153; emphasis added).

In non-nuclear weapon states today, this objective cannot be met at several types of facilities used by the nuclear power industry, including commercial gas centrifuge plants, nuclear fuel reprocessing plants, mixed-oxide fuel fabrication plants, and storage facilities for separated plutonium and highly-enriched uranium. The "timely warning criteria"—detecting a diversion in time to bring diplomatic pressure to reverse the course of action—simply cannot be met if these plants are located in non-weapon states such as Iran or North Korea.

There are a number of reasons for this, including for example, IAEA "Significant Quantities" for direct use nuclear materials are technically erroneous, and in the case of plutonium are too large by roughly a factor of eight. Also, at large commercial-size bulk handling facilities—e.g., uranium enrichment plants, reprocessing plants and plutonium fuel fabrication plants (MOX plants)—inventory differences exceed the amount of material required for a nuclear explosive device.

Countries that have recently announced their intent to build large nuclear power reactors include:

Albania	Nigeria
Algeria	Qatar
Bangladesh	Saudi Arabia
Belarus	Syria
Egypt	Thailand
Indonesia	Tunisia
Israel	Turkey
Jordon	United Arab Emirates
Libya	Vietnam
Morocco	Yemen

Israel already has nuclear weapons, but is not a signatory of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Presumably, most of the remaining countries, should they build nuclear plants, will do so without harboring an explicit contemporaneous objective of obtaining a nuclear weapon capability. Nevertheless, there is a significant risk that one or more of these countries will represent a future proliferation threat as Iran does today.

3. The Administration's current program for a "Global Nuclear Energy Partnership" (GNEP), built around the reprocessing and the international recycling of spent nuclear fuel, would be a disaster for international security and a multinational economic boondoggle of staggering proportions.

Even if by some miracle in thirty years GNEP's development managed to succeed on a technical level—an outcome that we do not believe is at all likely—it would still drain vital capital away from more timely and practical clean energy investments that are desperately needed *now* to avert pollution and foster human development around the world.

The Administration originally proposed GNEP to allegedly reduce the proliferation risk posed by the future spread of conventional methods of reprocessing, and to reduce the amount of waste required for disposal by closing the nuclear fuel cycle. The center piece of the GNEP vision is an elaborate scheme involving as yet unproven techniques for spent fuel reprocessing and fabricating new types of transuranic fuels, and the "transmutation" of the long-lived transuranic isotopes in this fuel using a new class of costly fast reactors.

Of course, a simpler and cheaper way to avert the proliferation risks posed by reprocessing is not to engage in it, and strongly discourage others from doing so.

GNEP is a far more elaborate scheme than the approach currently used by France , which involves reprocessing using the conventional PUREX process and burning the recovered plutonium only once in existing thermal reactors. The French approach is already a bad idea. Implementing the grandiose GNEP vision would require a century long multinational state enterprise that would cost US and foreign taxpayers hundreds of billions of dollars, and result in the importation of thousands of tons of foreign nuclear waste into the United States. By mid-century, when the best available science says we must have stabilized global CO_2 levels at no more than twice their pre-industrial levels—we would just be wrapping up the GNEP pilot projects, having already misallocated precious tens of billions of dollars merely to get GNEP to the starting line.

In reality, the whole concept is flawed technically, economically, and politically: the proposed mixture of transuranic isotopes in the transmutation fuel would still be usable in nuclear weapons; the resulting fuel cycle would not be remotely cost-competitive with conventional nuclear power, much less other modes of electric power generation; and the rest of the world is highly unlikely to sanction another shared nuclear monopoly over the civil nuclear fuel cycle to match the one currently controlled by the select group of nuclear weapon-states under the Nuclear Nonproliferation Treaty.

Both the current French and proposed GNEP approaches to closing the fuel cycle increase nuclear proliferation risks relative to—and neither is preferable to—the "once-through" fuel cycle currently used in the United States.

Compared to the once-through fuel cycle, the French fuel cycle costs more, has greater associated nuclear proliferation risks when replicated in non-weapon states, results in larger inventories of separated weapon-usable plutonium, is less safe, results in greater releases of routine radioactive emissions, produces greater quantities of radioactive waste when low-level and intermediate-level waste is included, provides no significant benefits in interim spent fuel and HLW storage requirements, and does not reduce the geologic repository requirements.

As noted in the recent Keystone Center report:

> No commercial reprocessing of nuclear fuel is currently undertaken in the U.S. The NJFF [Nuclear Joint Fact Finding] group agrees that **while reprocessing of commercial spent fuel has been pursued for several decades in Europe, overall fuel cycle economics have not supported a change in the U.S. from a "once through" fuel cycle.** Furthermore, the long-term availability of uranium at reasonable cost suggests reprocessing of spent fuel will not be cost-effective in the foreseeable future. A closed fuel cycle with any type of separations program will still require a geologic repository for long-term management of waste streams. (The Keystone Center, "Nuclear Power Joint Fact-Finding," June 2007, emphasis added.)

GNEP represents the marriage of two failed technologies—reprocessing and fast reactors. Reprocessing and closed fuel cycles have resulted in the accumulation of about 250 tons of separated plutonium in civil nuclear programs in Europe, Japan, Russia and India. In theory the GNEP vision reduces geologic repository requirements by substituting costly reprocessing plants and costly MOX fabrication plants for costly geologic repositories.

For the GNEP vision to work an estimated 40 to 75 gigawatts (GW) of fast reactor capacity would be required for every 100 GW of thermal reactor capacity. But we already know from *decades* of experience with fast reactors and failed efforts to develop commercial fast breeder reactors that fast reactors are uneconomical and unreliable—far more costly and far less reliable than existing thermal reactors. No energy company is going to order a fast reactor when it can purchase a less-costly, more-reliable light water reactor. GNEP is a recipe for further federalizing and increasing the cost of the nuclear fuel cycle.

Despite decades of research costing many tens of billions of dollars, the effort to develop fast breeder reactors has been a failure in the United States, France, United Kingdom, Germany, Italy, Japan and the Soviet Union. The flagship fast reactors in each these countries have been failures. The effort to develop fast reactors for naval propulsion was a failure in the United States and the Soviet Union, the only two navies that tried to introduce fast reactors into their respective submarine fleets. After investing *tens of billions* and decades of effort in fast breeder R&D, the Congress should ask itself why there is only one commercial-size fast reactor operating in the world today—one out of approximately 440 reactors. NRDC knows why. Fast reactors are uneconomical and unreliable.

The history of fast reactors was best summed up by the "father" of the Nation's Nuclear Navy, Admiral Hyman Rickover, when he decided in 1956 to abandon the sodium-cooled fast reactor and replace it by a pressurized water reactor in the *USS Seawolf* (SSN 575). "In Rickover's words they were 'expensive to build, complex to operate, susceptible to prolonged shutdown as a result of even minor malfunctions, and difficult and time-consuming to repair.'" (Richard G. Hewlett and Francis Duncan, *Nuclear Navy:* 1946–1962, (Chicago and London: The University of Chicago Press, 1974), pp. 272–273.) A 1995 sodium coolant leak and fire in Japan's Monju prototype fast breeder reactor has kept the facility shut-down *for the last twelve years.*

To our dismay and despite the decades of evidence to the contrary, the DOE is actively signing up countries to the GNEP vision and promoting GNEP research and development worldwide. But as the Keystone Center report noted, "The GNEP program could encourage the development of hot cells and reprocessing R&D centers in non-weapon states, as well as the training of cadres of experts in plutonium chemistry and metallurgy, all of which pose a grave proliferation risk." (The Keystone Center, "Nuclear Power Joint Fact-Finding," June 2007, p. 91.) "Could encourage" can now be changed to "is encouraging" as we are already witnessing the promotion under GNEP of closed fuel cycle R&D in South Korea.

Professor Frank von Hippel, in the most recent issue of *Scientific American,* has summarized the reasons "it makes no sense to rush into [this] expensive and potentially catastrophic undertaking." (Frank N. von Hippel, "Rethinking Nuclear Fuel Recycling," *Scientific American,* May 2008, pp. 88–93.)

In sum, Congress should pull the plug on DOE's effort to close the close the fuel cycle and stop funding research on advanced nuclear fuel reprocessing.

4. Reactor safety is a significant concern and, to a degree not matched by any other power source, continued nuclear power generation is hostage to its worst practitioners.

The most important factor affecting the safety of nuclear power plants is the safety culture at the plant. In the United States and some OECD countries the safety culture at operating plants has improved over the past two decades. While new reactor designs have improved safety and security features, over the next two to three decades, the safety and security of nuclear plants in the United States and the rest of the world will largely be determined by the safety and security of existing reactors. Several countries that already have nuclear plants, e.g., Russia, Ukraine, China, India, and Bulgaria, have notably weaker safety cultures than the nuclear enterprise merits. This is not a situation that the United States Government as a whole or this Congress can control or resolve.

Compounding the problem, expansion of nuclear power is projected to occur primarily in countries that currently have significant weaknesses in legal structure (rule of law), construction practice, operating safety and security cultures, and regulatory oversight, e.g., China and India. Securing commercial sales and "nuclear renaissance" exuberance have taken precedence over nuclear safety and non-proliferation concerns. This is evidenced by the fact that since his election in May 2007, President Nicolas Sarkozy has offered French reactors to such authoritarian, unaccountable, nontransparent, and corrupt governments as Georgia, Libya, the UAE, Saudi Arabia, Egypt, Morocco, and Algeria (*Nucleonics Week,* Vol.49. No. 7, Feb. 14, 2008). Consequently, if another catastrophic nuclear reactor accident occurs during the next couple of decades, it is more likely to occur in Russia, Ukraine, China, India, or another country with a poor safety culture, than in the United States. Several countries recently expressing an interest in acquiring nuclear reactors also have very high indices of industrial accidents and official corruption.

We concur with the findings and recommendations in the excellent report by the Union of Concerned Scientists (UCS), "Nuclear Power in a Warming World" (December 2007). As noted by UCS, "The United States has strong nuclear power safety standards, but serious safety problems continue to arise at U.S. nuclear power plants because the Nuclear Regulatory Commission (NRC) is not adequately enforcing the existing standards." (p. 3) Since the United States will continue to rely on nuclear power for substantial base load electricity generation into the foreseeable future, it is essential that the safety of U.S. nuclear plants be improved.

The biggest barrier to significant improvement of U.S. nuclear plant safety is the poor safety culture of the NRC. The Congress should establish an unbiased outside commission, similar to the Kemeny Commission, to report on ways to improve the NRC's safety culture. This commission should investigate failures to enforce regulations, staff deferral of safety inspections and upgrades so as not to impinge upon reactor operating schedules, pro-nuclear bias in the selection of Commissioners, senior NRC staff management and advisory committee members, the revolving door practice of NRC staff being hired from the industry it regulates and industry hiring of NRC staff, the curtailment of public's ability to engage in discovery and cross-examination during reactor licensing hearings, and other issues identified in the UCS report.

5. After more than fifty years of nuclear power use there is no operational spent fuel or high-level waste disposal facility anywhere in the world.

The proposed Yucca Mountain geologic repository site selection process has been severely damaged by its premature politicized designation as the sole site for detailed investigation. This error has been compounded by unsupportable manipulation of the licensing criteria for the site, and the credibility of the technical site investigation has been seriously undermined by charges of fraudulent data. In light of this record, the project either should be terminated, or the amount of wastes destined to the facility should be severely restricted, for example, by limiting its use to the disposal of defense high-level waste and R&D on spent fuel disposal. In either case, Congress should initiate a search for a second repository.

For fifty years, since the National Academy of Sciences first addressed this issue, the scientific consensus has been that high-level nuclear waste, and by implication spent fuel, should be permanently sequestered in deep underground geologic repositories, and by implication the primary barrier to prevent the release of the radioactivity into the biosphere should be the geology of the site. In this regard, some amount of spent fuel can be disposed of safely in Yucca Mountain. At this time we do not know whether this is greater or smaller than the statutory limit of 70,000 tonnes of spent fuel and high-level nuclear waste, and for reasons highlighted below, we may never know because the site selection process and the criteria for judging its long-term safety have been thoroughly corrupted.

In a separate paper I have reviewed how the Federal Government has thoroughly corrupted the geologic repository site selection and site licensing processes (See *http://docs.nrdc.org/nuclear/nuc_08010701A.pdf*). Here I will focus on a few points.

The Environmental Protection Agency (EPA) has the statutory responsibility to establish criteria for judging the adequacy of the proposed Yucca Mountain repository. The objective of these criteria of course is to protect future generations from potential releases of radioactive materials. The criteria are based on three key considerations: 1) what is the highest radiation exposure dose that will be permitted to the maximally exposed individual; 2) where will this dose limit be imposed, i.e., where will the maximally exposed individual be assumed to reside; and 3) over what period of time is the dose limit imposed. The licensing criteria being established EPA (in collusion with the NRC and the DOE through secret White House reviews overseen by the Office of Management and Budget) are far from being adequately protective of future generations. In developing the licensing criteria for Yucca Mountain it appears that the highest priority has been to ensure the licensability of the Yucca Mountain site.

First, EPA "gerrymandered" the control boundary, extending it from five to 18 kilometers in the direction that the radioactive materials is projected to leak from the repository. EPA also cut off the time period for compliance at 10,000 years. When a Federal Court ruled that the 10,000 year cut-off was unlawful because it was inconsistent with the recommendations of the National Academy of Sciences as required by law, EPA proposed to eviscerate the Court ruling by proposing a two-tiered dose limit—retaining the pre-10,000 year *mean* dose limit of 25 mrem and proposing a post-10,000 year *median* dose limit of 350 mrem. The mean dose is projected to be approximately three times higher than the median dose. Thus, EPA has proposed to allow the estimated mean exposure to the maximally exposed individual during the peak exposure period to be on the order of one rem per year. According to cancer risk estimates in the National Research Council's BEIR VII report, a lifetime exposure at this dose rate today would result in one in 12 such exposed persons getting cancer from this exposure with half of the cancers being fatal.

Some would argue that 10,000 year is a sufficient compliance period. It should be noted, however, that extending the compliance period beyond the projected life of the engineered spent fuel canisters is one way to ensure that the geology of the site will be the primary barrier preventing the release of the radioactivity into the biosphere.

DOE is required to submit its Yucca Mountain license application to the NRC. In its attempt to demonstrate that the repository will meet the EPA criteria, DOE plans to run a series of calculations to predict the release and transport of radioactivity from the site. The computer code that DOE plans to use for this purpose is so large that NRC will not be able to independently run it, and neither will any potential intervenor in the licensing process. Consequently, the NRC will be unable to confirm the validity of the DOE calculations. Instead, NRC plans to run its own transport code, but only for the purpose of developing a set of questions to be answered by DOE.

The Yucca Mountain project has repeatedly failed to meet its schedule and there is a possibility that the project will be terminated by Congress. If this occurs it would represent the third failed attempt by the Federal Government to solve the high-level waste/spent fuel disposal problem—the first failure being the salt vault project at Lyons, Kansas followed by the failed Retrievable Surface Storage Facility (RSSF).

So where does all this leave us. We have a proposed geologic repository for spent fuel and high-level waste that was selected through a corrupted site selection process, that cannot meet the original site selection criteria, that will be judged against thoroughly corrupted licensing criteria developed in collusion with DOE, the licensee, and judged with the aid of a computer simulation model that cannot be independently checked or run by the regulators or outside experts.

The Congress should require that DOE resume a search for a second repository site. Aged spent fuel can be stored safely in dry casks until a safe geologic disposal site is identified and licensed for use. However, it has been a policy of the Federal Government that we should not rely on administrative controls for more than 100 years for the management and disposal of nuclear wastes.

The Congress also should approve consolidation of spent fuel from shut down reactors, but should not support consolidation of spent fuel from operational reactors since these sites will require the on-site management of spent fuel in any case.

BIOGRAPHY FOR THOMAS B. COCHRAN

Dr. Thomas B. Cochran is a senior scientist in the nuclear program and holds the Wade Greene Chair for Nuclear Policy at NRDC. He served as director of the nuclear program until 2007. He initiated NRDC's Nuclear Weapons Databook project. He also initiated a series of joint nuclear weapons verification projects with the Soviet Academy of Sciences. These include the Nuclear Test Ban Verification Project, which demonstrated the feasibility of utilizing seismic monitoring to verify a low-threshold test ban, and the Black Sea Experiment, which examined the utility of passive radiation detectors for verifying limits on sea-launched cruise missiles. He has served as a consultant to numerous government and non-government agencies on energy, nuclear nonproliferation and nuclear reactor matters. He is a member of the Department of Energy's Nuclear Energy Research Advisory Committee. Previously he served as a member of DOE's Environmental Management Advisory Board, Fusion Energy Sciences Advisory Board, and Energy Research Advisory Board; the Nuclear Regulatory Commission's Advisory Committee on the Cleanup of Three Mile Island; and the TMI Public Health Advisory Board.

Dr. Cochran is the author of *The Liquid Metal Fast Breeder Reactor: An Environmental and Economic Critique* (Washington, D.C.: Resources for the Future, 1974) and co-editor/author of the *Nuclear Weapons Databook, Volume I: U.S. Nuclear Forces and Capabilities* (Cambridge, Massachusetts: Ballinger Press, 1984); *Volume II: U.S. Nuclear Warhead Production* (1987); *Volume III: U.S. Nuclear Warhead Facility Profiles* (1987); *Volume IV: Soviet Nuclear Weapons* (1989); and *Making the Russian Bomb: From Stalin to Yeltsin* (Boulder, Colorado: Westview Press, 1995). In addition, he has published numerous articles and working papers, including those in *SIPRI Yearbook* chapters, *Arms Control Today,* and the *Bulletin of the Atomic Scientists.* He has co-authored (with Dr. Robert S. Norris) the article "Nuclear Weapons" in the 1990 printing of *The New Encyclopedia Britannica* (15th edition).

Dr. Cochran received his Ph.D. in physics from Vanderbilt University in 1967. He was Assistant Professor of Physics at the Naval Postgraduate School, Monterey, California, from 1967 to 1969; modeling and simulation group supervisor of the Litton Mellonics Division, Scientific Support Laboratory, Fort Ord, California, from 1969 to 1971; and, from 1971 to 1973, a senior research associate at Resources for the Future. Dr. Cochran has been with NRDC since 1973. He is the recipient of the American Physical Society's Szilard Award and the Federation of American Scientists' Public Service Award, both in 1987. As a consequence of his work, NRDC received the 1989 Scientific Freedom and Responsibility Award by the American Association for the Advancement of Science (AAAS). Dr. Cochran is a Fellow of the American Physical Society and the AAAS.

Chairman GORDON. Thank you, Dr. Cochran. And Mr. Fri, you are recognized.

STATEMENT OF MR. ROBERT W. FRI, VISITING SCHOLAR, RESOURCES FOR THE FUTURE; CHAIR, COMMITTEE ON REVIEW OF DOE'S NUCLEAR ENERGY RESEARCH AND DEVELOPMENT PROGRAM, BOARD ON ENERGY AND ENVIRONMENTAL SYSTEMS, NATIONAL RESEARCH COUNCIL

Mr. FRI. Thank you, Mr. Chairman, and Mr. Bilbray, and Members of the Committee. I am here today representing the National Research Council, where I served as Chair of a committee to review DOE's nuclear energy R&D program. We submitted our report last October, and I would like to just touch on some of the highlights from it.

We examined four major R&D programs, the funding for which is on the order of $300 to $400 million per year, that are managed by the Office of Nuclear Energy in the Department of Energy. Now, they were what is called Nuclear Power (NP) 2010, which is a program cost-shared with industry to assist in the licensing of the first nuclear plants in the U.S. in over 30 years, and three real research programs, one, the Generation IV class of nuclear reactors, secondly, the Nuclear Hydrogen Initiative, and finally, the Advanced Fuel Cycle Initiative, which is a program aimed to develop technologies to close the back end of the nuclear fuel cycle.

The committee recommended that the Department give the highest priority to NP 2010. If nuclear power is to play a major role in the Nation's energy picture, it is simply essential to license, build, and operate the first of the next generation of reactors, and given the long lead times and construction periods involved, it is important to do it now. The committee also noted that the human and intellectual infrastructure needed to support this effort has been aging, and therefore, we specifically recommended first, continued support of university programs in nuclear science and engineering, and secondly, consideration of the appropriate research support for the nuclear industry, for example, through the provision of national user facilities, such as the Advanced Test Reactor at the Idaho National Laboratory.

Now, the same sense of urgency, however, did not attend the other programs we examined. There are acceptable methods of storing spent nuclear fuel safely for decades without reprocessing and fuel recycling. There doesn't seem to be a serious shortage of uranium for reactor fuel, and certainly not one that is going to emerge for many years. And moreover, we concluded that it will take considerable time for the information to be developed to change these judgments.

Now, this is not to say that research in new reactor design or hydrogen production or closing the fuel cycle should not go on. Indeed, our committee recommended that it should. However, the research program should be designed to lay the basis for deployment of these technologies some time in the future, when circumstances warrant. To this end, funding at a sustainable level over time is more important, it would seem to us, than speed, and we strongly urge the development of an independent oversight function that would help ensure that the advanced research programs stay on track over an extended period of time, and continue to be responsive to the changing external environment.

We also concluded that the development of large scale facilities for closing the nuclear fuel cycle would be inconsistent with our assessment of priorities. For this reason, and because of the very large technical risks involved in an overly aggressive construction program, we recommended against the funding of such facilities in the near-term.

Thank you, Mr. Chairman, and I look forward to your questions.

[The prepared statement of Mr. Fri follows:]

PREPARED STATEMENT OF ROBERT W. FRI

Abstract

There has been a substantial resurgence of interest in nuclear power in the United States over the past few years. One consequence has been a rapid growth in the research budget of DOE's Office of Nuclear Energy (NE). In light of this growth, the Office of Management and Budget included within the FY 2006 budget request a study by the National Academy of Sciences to review the NE research programs and recommend priorities among those programs. The programs to be evaluated were: Nuclear Power 2010 (NP 2010), Generation IV (GEN IV), the Nuclear Hydrogen Initiative (NHI), the Global Nuclear Energy Partnership (GNEP)/Advanced Fuel Cycle Initiative (AFCI), and the Idaho National Laboratory (INL) facilities. This testimony summarizes the conclusions and recommendations of the National Academies review and its report, *Review of DOE's Nuclear Energy Research and Development Program.*

Mr. Chairman and Members of the Committee:

My name is Robert Fri. I am a Visiting Scholar at Resources for the Future, an organization dedicated to improving environmental and natural resource policymaking through objective social science research of the highest caliber. Today, however, I am representing the National Research Council as Chair of its Committee on Review of DOE's Nuclear Energy Research and Development Program, which produced the report, *Review of DOE's Nuclear Energy Research and Development Program.*

The FY 2006 President's Budget Request asked for funds to be set aside for the National Academy of Sciences to review the Office of Nuclear Energy (NE) research programs and budget and to recommend priorities for those programs given the likelihood of constrained budget levels in the future. The programs to be evaluated were Nuclear Power 2010, the Generation IV reactor development program, the Nuclear Hydrogen Initiative, the Global Nuclear Energy Partnership (GNEP)/Advanced Fuel Cycle Initiative (AFCI) and the Idaho National Laboratory facilities program. Our Committee began its work in August, 2006, and completed its report in October, 2007.

In the balance of this statement, I summarize the results of our work. To avoid covering too many topics, I have not included our recommendations on the Idaho National Laboratory. However, that laboratory is intended to be the Department's center for nuclear energy research and as such plays an essential supporting role in many DOE programs.

BACKGROUND

Growing energy demands, emerging concerns about the emissions of carbon dioxide from fossil fuel combustion, the increasing and volatile price for natural gas, and a sustained period of successful operation of the existing fleet of nuclear power plants have resulted in a renewal of interest in nuclear power in the United States. One consequence of the renewed interest in nuclear power for the DOE mission has been rapid growth in the DOE research budget: it grew by nearly 70 percent from the $193 million appropriated in FY 2003 to $320 million in FY 2006.

Despite these changes in program and budget experienced by the NE research program, there are some constant features that set the context for the committee's evaluation approach. In this regard, two observations have influenced the committee's approach to this project.

Stable Major Goals: One is that while the details of the NE program have shifted considerably, its high-level goals have changed little if at all. While stated in somewhat different words in various reports, the committee believes that a reasonable summary of the goals for technology development in support of the NE mission is:

- Assist the nuclear industry in providing for the safe, secure, and effective operation of nuclear power plants already in service, the anticipated growth in the next generation of light water reactors, and associated fuel cycle facilities.
- Provide for nuclear power at a cost that is competitive with other energy sources over time.
- Support a safe and publicly acceptable domestic waste management system, including options for long-term disposal and the related waste forms.
- Provide for effective proliferation resistance and physical protection of nuclear energy systems, both domestically and in support of international non-proliferation and nuclear security regimes.
- Create economical and environmentally acceptable nuclear power options for assuring long-term non-nuclear energy supplies while displacing insecure and polluting energy sources; such options include electricity production, hydrogen production, process heat, and water desalinization.

Uncertain Future Development: A second observation is that predicting the course of nuclear technology development over the next several decades entails substantial uncertainties. Indeed, the committee heard presentations from several respected analysts about how this development might take place. Their views of the technological future differed in important ways. A major reason for this divergence is that the development of new nuclear technology requires a planning horizon measured in decades, in no small part because of the capital intensity of the commercial nuclear energy sector. Over such a time period, the committee believes that the success of various candidate technologies will depend on policy and other forces outside the control of any NE technology development program. For example:

- Waste management options and associated regulatory regimes and their likely acceptance by the public range from long-term storage at reactor sites or centralized interim storage, to direct disposal of all spent fuel in geologic repositories and the reduced waste forms envisioned by GNEP.
- Environmental policy, especially regarding climate change, not yet formulated could have decisive impacts on the attractiveness of nuclear power.
- Opinion on the cost and availability of natural uranium and associated enrichment capacity varies widely.
- Non-proliferation and physical protection regimes are in flux, especially as international agreements continue to evolve.
- The rate of near-term expansion of nuclear power plants matters, both domestically and internationally, since this rate drives the timing and need for advanced reactors and fuel cycle technology.

NP 2010

The Nuclear Power 2010 (NP 2010) program was established by DOE in 2002 to support the near-term deployment of new nuclear plants. NP 2010 is a joint government/industry 50/50 cost-shared effort with the following objectives:

- Identify sites for new near-term nuclear power plants and obtain early site permits.
- Complete detailed, first-of-a-kind design engineering on two advanced light water reactor (ALWR) plants and confirm the safety of the designs by obtaining design certifications.
- Obtain combined construction and operating licenses in keeping with the Standardization Policy of the U.S. Nuclear Regulatory Commission.
- Develop an effective inspection, testing, analyses, and acceptance criteria (ITAAC) process to assure licensing compliance during construction.
- Implement the *Energy Policy Act of 2005* standby support provisions for the construction of new nuclear plants.
- Estimate the capital costs and operation and maintenance costs, construction time, and levelized cost of electricity for the two plants.
- Evaluate the business case for building new nuclear power plants and pave the way for an industry decision to build new ALWR nuclear plants in the United States. Construction would begin early in the next decade.

NP 2010 and selected commercial research projects should be fully funded as a matter of highest priority. Unless the commercial fleet of light water reactors (LWRs) grows, nuclear power will be a diminishing energy resource for the United States and there will be little need for all of DOE's longer-term research programs.

Although increases in the NP 2010 budget are likely, they do not account for a large fraction of the total NE funding. The NP 2010 requirements should be fully supported.

In addition, DOE should augment this program to ensure timely and cost-effective deployment of the first new reactor plants. Of particular importance is the need to address industrial and human resource infrastructure issues. Specifically, DOE should support:

- *Research in support of the commercial fleet.* The committee does not recommend a large federal research program, because most of this research should be industry-supported. However, some specific projects have sufficient public benefit to warrant federal funding, for which DOE should share about 20 percent of the costs and support user facilities at incremental cost. These elements of the program should be fully funded when the NP 2010 licensing and design completion efforts come to an end.
- *University infrastructure.* A sizable buildup in nuclear energy production, research, and development necessitates strengthening university capabilities to educate a growing number of young professionals and scientists in the relevant areas. DOE should include this program in its budget at the levels authorized by the *Energy Policy Act of 2005.*

ADVANCED FUEL CYCLE INITIATIVE/GLOBAL NUCLEAR ENERGY PARTNERSHIP

Since 2002, the United States has been conducting a program for reprocessing spent fuel under the Advanced Fuel Cycle Initiative (AFCI). Then, in February 2006, it announced a change in its nuclear energy programs. Recycling would be developed under a new effort, GNEP, which would incorporate AFCI as one of its activities. If the recycling R&D program is successful and leads to deployment, GNEP would eventually require the United States to be an active participant in the community of nations that recycle fuel, because one aspect of the partnership is that some nations recycle nuclear fuel for other user nations.

At the time of our report, GNEP has two key stated technical objectives:

- Develop, demonstrate, and deploy advanced technologies for recycling spent nuclear fuel that do not separate plutonium, with the goal over time of ceasing separation of plutonium and eventually eliminating excess stocks of civilian plutonium and drawing down existing stocks of civilian spent fuel. Such advanced fuel cycle technologies would substantially reduce nuclear waste, simplify its disposition, and help to ensure the need for only one geologic repository in the United States through the end of this century.
- Develop, demonstrate, and deploy advanced reactors that consume transuranic elements from recycled spent fuel.

Three facilities were key components of the GNEP program as then planned: (1) a nuclear fuel recycling center, or centralized fuel treatment center (2) an advanced sodium-cooled burner reactor—a fast-neutron reactor; and (3) an advanced fuel cycle facility. At the time of the writing of this report, the latest information the committee had was that the baseline separation process was UREX+1a, although some other comparable separation technology, most notably pyroprocessing, may be adopted at a later stage.

The GNEP program is premised on an accelerated deployment strategy that will create significant technical and financial risks by prematurely narrowing technical options. Specifically:

- The domestic need for waste management, security, and fuel supply is not great enough to justify early deployment of commercial-scale reprocessing and fast reactor facilities. In particular, the near-term need for deployment of advanced fuel cycle infrastructure to avoid a second repository for spent fuel is far from clear. Even if a second repository were to be required in the near-term, the committee does not believe that GNEP would provide short-term answers.
- The state of knowledge surrounding the technologies required for achieving the goals of GNEP is still at an early stage, at best a stage where one can justify beginning to work at an engineering scale. However, it seems to the committee that DOE has given more weight to schedule than to conservative economics and technology. The committee concludes that the case presented by the promoters of GNEP for an accelerated schedule for commercial construction is unwise. In general, it believes that the schedule should be guided by technical progress in the R&D program.

- The cost of the GNEP program is acknowledged by DOE not to be commercially competitive under present circumstances. There is no economic justification for going forward with this program at anything approaching a commercial scale. DOE claims that the GNEP is being implemented to save the United States nearly a decade in time and a substantial amount of money. In view of the technical challenges involved, the committee believes that just the opposite is likely to be true.
- Several fuel cycles could meet the eventual goal of creating a justifiable recycling system. However none of the cycles proposed, including UREX+ and the sodium fast reactor, is at a stage of reliability and understanding that would justify commercial-scale construction at this time. Significant technical problems remain to be solved.
- The qualification of multiply-recycled transuranic fuel is far from reaching a stage of demonstrated reliability. Because of the time required to test the fuel through repeated refabrication cycles, achieving a qualified fuel will take many years.

The committee believes that a research program similar to the original AFCI is worth pursuing.[1] Such a program should be paced by national needs, taking into account economics, technological readiness, national security, energy security, and other considerations. However, considerable uncertainty surrounds the technology and policy options that will ultimately satisfy these needs. For this reason, the committee believes that the program described below should be sufficiently robust to provide useful technology options for a wide range of possible outcomes. On the other hand, the program should not commit to the construction of a major demonstration or facility unless there is a clear economic, national security, or environmental policy reason for doing so. Because of these complexities, the committee recommends DOE obtain much more external input than it so far has—in particular, an independent, thorough peer review of the program.

GENERATION IV REACTORS

DOE has engaged other governments in a wide-ranging effort to develop advanced next-generation nuclear energy systems, known as Generation IV, with the goal of widening the applications and enhancing the economics, safety, and physical protection of the reactors and improving fuel cycle waste management and proliferation resistance in the coming decades. Six nuclear reactor technology concepts were identified in the DOE-initiated, international Generation IV Technology Roadmap completed in 2002. Each of the six technologies, as well as several areas of crosscutting research, is now being pursued by a consortium of countries as part of the Generation IV International Forum. Three concepts are thermal neutron spectrum systems—very-high-temperature reactors, molten salt reactors, and supercritical-water-cooled reactors—with coolants and temperatures that enable hydrogen or electricity production with high efficiency. In addition, three are fast neutron spectrum systems—gas-cooled fast reactors, lead-cooled fast reactors, and sodium-cooled fast reactors (SFRs)—that will enable better fuel use and more effective management of actinides by recycling most components in the discharged fuel.

From 2002 to 2005, the primary goal of the U.S. Generation IV program was to develop the Next Generation Nuclear Plant (NGNP), focusing on high-temperature process heat (850°C–1000°C) and innovative approaches to making energy products, such as hydrogen, that might benefit the transportation industry or the chemical industry. At the end of 2005, DOE shifted the fundamental emphasis of the overall Generation IV program, making spent fuel management using a closed fuel cycle the main goal of the program. This new GNEP priority led to reduced funding for the NGNP programs; phasing out of the other programs, and refocusing of the SFR concept to near-term demonstration. With these changes, NGNP's very high temperature gas reactor (VHTR) remains the only major reactor concept that is not integrated into the GNEP program.

Economic benefits of early commercialization of high-temperature reactors (HTRs) and VHTRs based on NGNP technology could be realized in four market segments where HTRs could make products at a lower cost than competing technologies: baseload electricity, combined heat and power, high-temperature process heat, and hydrogen. A long-term goal for the NGNP is to demonstrate hydrogen production as an energy carrier for a hydrogen economy. However, in each of those four segments, there are specific applications where HTRs will have near-term advantages. By di-

[1] A majority of the committee favors fuel cycle and fast reactor research, as was being conducted under AFCI; however, two committee members recommend against such research.

recting NGNP and the Nuclear Hydrogen Initiative (NHI) R&D toward those specific applications, stronger near-term industry interest and investment is more likely, which in turn will support continued R&D investments for subsequent expansion of HTR technology into additional market segments and, in the longer-term, support the transition to a hydrogen economy.

The NGNP program has well-established goals, decision points, and technical alternatives. A key decision point is the nuclear licensing approach. However, little planning has been done on how the fuel for the NGNP would be supplied. There is a particle fuel R&D program, but it will take up to two decades to complete the development and testing of this new fuel. To keep to the apparently preferred schedule, which has a FY 2017 plant start-up date, some of the technical decisions must be made quickly, so that detailed design, component and system testing, and licensing can be initiated. However, it is unlikely that the plant can begin operation by 2017 owing to the significant funding gaps that developed in FY 2006 and FY 2007 and affected the scope and schedule for testing fuel and structural materials as well as the heat transport equipment. A schedule that coordinates the elements required for public-private partnership, design evolution, defined regulatory approach, and R&D results should be articulated to enhance the potential for program success.

The main risk associated with NGNP is that the current business plan calls for the private sector to match the government (DOE) funding. So far, however, not a single program has been articulated that coordinates all the elements required to successfully commission the NGNP. The current disconnect between the base NGNP program plan and the complementary public/private partnership initiative must be resolved. DOE should decide whether to pursue a different demonstration with a smaller contribution from industry or, alternatively, a more basic technology approach for the VHTR.

NE should sustain a balanced R&D portfolio in advanced reactor development. The program requires predictable and steady funding, but its goals can be more modest and its timetables stretched. A revised program can be conducted within levels recently appropriated for Generation IV and for SFR-related R&D under GNEP.

NUCLEAR HYDROGEN INITIATIVE

NHI is DOE's research program for developing technologies to produce hydrogen and oxygen from water feedstock using nuclear energy. The program includes a small effort supporting advanced low-temperature electrolysis, but its primary focus is three methods that use high-temperature process heat to achieve greater efficiency. The high-temperature methods could realize 60–80 percent greater efficiency than conventional electrolysis. These methods involve challenging high-temperature materials problems, which are being addressed with laboratory-scale research at this time. Key technology down selections to allow testing at the pilot and engineering scales are scheduled for 2011 and 2015. The NHI program is tightly tied to the NGNP program to develop a reactor capable of producing high-temperature process heat. NHI activities are coordinated with the larger DOE hydrogen program, led by the Office of Energy Efficiency and Renewable Energy, as well as with NGNP.

NHI is well formulated to identify and develop workable technologies, but the schedules and budgets need to be adjusted to assure appropriate coupling to the larger NGNP program. DOE should expand NHI program interactions with industrial and international research organizations experienced in chemical processes and operating temperatures similar to those in thermochemical water splitting. NE should also broaden the hydrogen production system performance metrics beyond economics—for example, it could use the Generation IV performance metric of economics, safety, and sustainability.

BALANCE AND OVERSIGHT

The AFCI, GEN IV, and NHI programs require steady progress and should evolve over a reasonable time. Given this need, and as a counterbalance to the short-term nature of the federal budget process, NE should adopt an oversight process for evaluating the adequacy of program plans, evaluating progress against these plans and adjusting resource allocations as planned decision points are reached.

The senior advisory body for NE has been the Nuclear Energy Research Advisory Committee (NERAC). A modified NERAC seems the obvious starting point for reestablishing oversight of the NE programs. In the committee's opinion, the key will be to ensure its independence, transparency, and focus on the most important strategic issues. The committee has not attempted to design a specific oversight capability, but the following characteristics would be appropriate for the body it has in mind:

- Encourage objectivity by recognizing that knowledgeable persons have different points of view and that balance is therefore best achieved by diversifying the membership of the oversight body.
- Avoid conflicts of interest by requiring public disclosure of members' connections with study sponsors or organizations likely to be affected by study results. Persons directly funded by sponsors are rarely appointed to such bodies.
- Ensure transparency by requiring that both the statement of task and the final report for each project are routinely made public in a timely fashion.

BIOGRAPHY FOR ROBERT W. FRI

Robert W. Fri is a visiting scholar and senior fellow emeritus at Resources for the Future, where he served as President from 1986 to 1995. From 1996 to 2001 he served as Director of the National Museum of Natural History at the Smithsonian Institution. Before joining the Smithsonian, Mr. Fri served in both the public and private sectors, specializing in energy and environmental issues. In 1971 he became the first Deputy Administrator of the U.S. Environmental Protection Agency (EPA). In 1975, President Ford appointed him as the Deputy Administrator of the Energy Research and Development Administration. He served as Acting Administrator of both agencies for extended periods. From 1978 to 1986, Fri headed his own company, Energy Transition Corporation. He began his career with McKinsey & Company, where he was elected a principal. Mr. Fri is a senior advisor to private, public, and nonprofit organizations. He is a Director of the American Electric Power Company and a trustee of Science Service, Inc. (publisher of *Science News* and organizer of the Intel Science Talent Search and International Science and Engineering Fair). He is a member of the National Petroleum Council, the Advisory Council of the Electric Power Research Institute, the Advisory Council of the Marian E. Koshland Science Museum, and the steering committee of the Energy Future Coalition. In past years, he has been a member of the President's Commission on Environmental Quality, the Secretary of Energy Advisory Board, and the University of Chicago board of governors for Argonne National Laboratory. He has chaired advisory committees of the National Research Council (NRC), including the recent Committee on Review of DOE's Nuclear Energy Research and Development Program, the Carnegie Commission on Science, Technology and Government, EPRI, and the Office of Technology Assessment (OTA). From 1978 to 1995 he was a Director of Transco Energy Company, where he served as Chair of the Audit, Compensation, and Chief Executive Search Committees. He is a member of Phi Beta Kappa and Sigma Xi and a national associate of the National Academy of Sciences. He received a B.A. in Physics from Rice University and an M.B.A. (with distinction) from Harvard University.

Chairman GORDON. Oh, it was good timing, then. Very good timing. Okay. Dr., or rather, Admiral Grossenbacher.

STATEMENT OF VICE ADMIRAL JOHN J. GROSSENBACHER, DIRECTOR, IDAHO NATIONAL LABORATORY, U.S. DEPARTMENT OF ENERGY

Vice Admiral GROSSENBACHER. Mr. Chairman, Congressman Bilbray, and Members of the Committee, good morning, and thank you for providing me the opportunity to speak with you on a subject of great importance to our country, nuclear power and the opportunities and challenges associated with it.

It is a privilege for me to represent the 3,800 scientists, engineers, skilled technicians, and support staff of the Idaho National Laboratory. At the dawn of the Nuclear Age, the Idaho National Laboratory was our nation's reactor laboratory, developing and demonstrating a range of technologies, from boiling water reactors to breeder reactors, gas cooled reactors, reactors cooled by organic coolants, over 52 different reactors.

As we consider the role of nuclear energy in our nation's and the world's energy portfolio, people of the Idaho National Laboratory are eager to collaborate with university colleagues, nationally and internationally experienced industry technical leaders, and the system of laboratories and their unique capabilities within the Department of Energy. We are eager to collaborate to answer the difficult questions that should guide our nation's and the world's choice of our future energy portfolio.

Technology provides the means to an end. We humans have chosen an energy dense existence as an end, with attendant benefits, enormous benefits, costs, and risks associated with the means. Our choices, as we modify that end and adjust those means, should be informed by discipline, technically sound research, development, and demonstration that illuminates our choices. DOE's Nuclear Energy Program attempts to do just that. Nuclear Power 2010, Light Water Reactor R&D, the Advanced Fuel Cycle Initiative, Generation IV nuclear energy systems development, and investments in our human capital, very importantly at our universities, are the elements of DOE's Nuclear Energy Program.

As has been mentioned, Nuclear Power 2010 is a public/private initiative that reduces technical, institutional, and regulatory barriers to new plant development. Light Water Reactor R&D intends to bring the enormous technical capabilities of the Department of Energy's laboratories to bear on current and future light water reactor performance issues, in partnership with industry, and engaging the creativity of our universities.

The Advanced Fuel Cycle Initiative is the domestic technology development and deployment component of GNEP, the Global Nuclear Energy Partnership, a significant policy initiative intended to develop and demonstrate advanced fuel cycle technologies that will increase the efficiency with which we use nuclear fuel, and decrease the waste burden of the nuclear fuel cycle. GNEP is intended to also provide a nuclear materials management system that addresses proliferation risks, and all in an environment that is relevant in a world where the use of nuclear energy is expanding and expanding rapidly.

Generation IV nuclear energy systems development is intended to enhance the economics, safety, physical protection, improved waste management, and reduced proliferation risk of reactors and fuel cycles beyond the Light Water Reactor technologies we use today.

The NGNP, the Next Generation Nuclear Plant, is a significant element of this program, intended to develop and demonstrate a reactor after next technology, that can expand the use of nuclear energy beyond electricity generation, to the provision of industrial process heat.

DOE's Nuclear Energy Program engages the next generation of nuclear scientists, engineers, and technicians through its university and intern programs. It is also looking to the future, in addressing how we sustain our nuclear science and technology infrastructures, both inside and outside the Department of Energy.

In conclusion, Mr. Chairman, the Department of Energy's Nuclear Energy Program is intended to provide us with informed choice and opportunities for the use of nuclear energy in our current and future energy portfolio. We at the Idaho National Laboratory are proud, as the Nation's nuclear energy laboratory, to have a leadership role in this very important work.

Thank you very much.

[The prepared statement of Vice Admiral Grossenbacher follows:]

PREPARED STATEMENT OF VICE ADMIRAL JOHN J. GROSSENBACHER

Mr. Chairman and distinguished Members of the Committee, good morning and thank you for providing me the opportunity to speak with you on a subject of such great importance to our nation—nuclear power, and the opportunities and challenges associated with it.

As Director of Idaho National Laboratory—the Nation's nuclear energy laboratory—and as former commander of the U.S. Naval Submarine Forces, I've committed most of my adult life to the safe application of advanced nuclear energy systems. Needless to say, I feel personally responsible for helping chart a prudent course toward a secure and sustainable energy future for this nation—a future enabled by a richly diverse energy portfolio that can maintain and even expands nuclear power's significant contributions.

I'll highlight the Department of Energy's major nuclear energy programs—from my vantage as INL Director—with an eye toward how they address the challenges of cost, waste management and proliferation as cited in your letter of invitation. I'll also discuss the role of the national laboratories in supporting nuclear energy research and development, what is being done to support education and work force development for the nuclear power industry, and challenges that national laboratories face in sustaining our nuclear science and technology infrastructure.

Mr. Chairman, before I get to the core of my remarks today, I'd like to ask you to consider how they conform to the spirit and intent of what you said in your news release of two weeks ago. In acknowledging the 50th anniversary of the Defense Advanced Research Projects Agency—DARPA—you stated, "Given the geopolitical instabilities that threaten global energy supplies, the skyrocketing costs of energy to consumers, the looming threat of global climate change, and the resulting costs from the likely regulation of carbon dioxide emissions, there is a critical need for groundbreaking science-based energy solutions that can be deployed in the marketplace." The Department of Energy and its network of national labs could not agree with you more. That's precisely why we have the following programs.

NUCLEAR POWER 2010

The U.S. Energy Information Administration projects that U.S. electricity consumption will increase 30 percent by 2030. This means our nation will need hundreds of new plants to provide electricity. Rising demand for energy and electricity, pressure to reduce carbon emissions along with fair consideration of the outstanding performance and economics associated with operating U.S. nuclear power plants have spurred a nuclear energy renaissance in the U.S.

Recognizing that all sources of energy will be needed to meet energy demand, the Department of Energy launched the Nuclear Power 2010 program in 2002 as a joint government-industry cost-shared program to identify sites for new nuclear power plants, develop and bring to market advanced nuclear plant technologies, and evaluate the business case for building new nuclear power plants by demonstrating untested regulatory processes. Together with incentives enacted through the *Energy Policy Act of 2005*—federal loan guarantees for low emission energy technologies, federal risk insurance and production tax credits—government and industry are working together to address the last barriers associated with building new plants: the financial and regulatory risks. These federal tools will allow first movers to address and manage the risks associated with building the first few new nuclear power plants. This year's budget request seeks to significantly increase the government's share in the NP 2010 program and to extend the period during which companies can seek loan guarantees by two years. Industry has stated that loan guarantees are essential to ensuring the first new nuclear plants are ordered and built.

Industry has responded with 17 companies and consortia pursuing licenses for more than 30 nuclear power plants in states represented by 20 members of this committee. Nuclear Regulatory Commission review of the first wave of applications has already begun and industry indicates it expects to submit 11 to 15 more applications this year. At the same time, orders are starting to be placed for long-lead items such as forgings. The signing earlier this month of a contract between Georgia Power and Westinghouse for two AP–1000 units is yet another signal that the nuclear energy renaissance has begun.

LIGHT WATER REACTOR RESEARCH AND DEVELOPMENT

The combination of low operating and fuel costs which keep electricity prices down, an excellent record of performance, and clean energy benefits means that nuclear energy will remain an important source of energy for our nation's future. The design features of the Generation III and Generation III+ nuclear power plants, which include redundant systems, automatic shutdown systems and multiple layers of protection, combined with a strong safety culture and an excellent regulator means that nuclear power will continue to be a safe and reliable source of energy.

The increased electricity from existing nuclear power plants since 1990 is enough to power 29 cities the size of Atlanta or Boston each year. The outstanding performance of the existing fleet and the prospects that market pull will demand a ramping up in new nuclear plant build projects has prompted consideration of a new government-industry cost-shared initiative in FY 2009 within the Generation IV program for light water reactor research and development. This research and development would be aimed at supporting efficient construction and operation of the dozens of new plant projects anticipated over the next decade and at maximizing the contribution of the existing fleet by further extending the licenses beyond 60 years.

In February, the Electric Power Research Institute and Idaho National Laboratory issued a joint Nuclear Power Strategic Plan for Light Water Reactor Research and Development that sets forth 10 objectives, six of which are considered to be of highest priority for this initiative. These high priority objectives include:

- Transitioning to state of the art digital instrumentation and controls
- Making further advances in nuclear fuel reliability and lifetime
- Implementing broad-spectrum workforce development
- Implementing broad-spectrum infrastructure improvements for design and sustainability
- Addressing electricity infrastructure-wide problems
- Sustaining the high performance of nuclear plant materials.

This LWR strategic R&D plan presents a framework for how industry and government should work together on research and development and is the first step in identifying the specific research to be pursued. DOE's budget request includes $10M to support LWR R&D, representing the government's share in FY 2009. Both Nuclear Power 2010 and the LWR R&D initiative will enable the Nation to do much to meet near-term domestic power needs, while continuing to avoid generation of the massive amounts of greenhouse gases that would be produced if our nuclear fleet were to be replaced with fossil-fuel plants.

ADVANCED FUEL CYCLE INITIATIVE

In much the same way that Congress has determined that it is in the best interest of our nation to boost the fuel economy of our cars, trucks, vans and SUVs—so, too, has DOE and the global nuclear industry determined that we need to raise the fuel efficiency of nuclear power, while reducing the toxicity and volume of waste that requires disposal. The Department and its system of national laboratories—working in partnership with industry and academia—are pursuing this essential goal through the Advanced Fuel Cycle Initiative.

The once-through fuel cycle used by our nation's 104 nuclear power plants is only able to extract less than five percent of the available energy from their nuclear fuel rods before they have to be replaced. By eventually closing the fuel cycle as envisioned by AFCI, much more of the available energy in nuclear fuel would be extracted, and more easily managed high-level waste would result. Admittedly, significant technology development must occur before AFCI's complete vision is realized, and additional cost analyses should be done to further understand the economics. But waiting until someone determines the economics are right to begin investing in alternate and advanced technologies tends to produce the kind of crises the world faces today with oil prices at well over $100 a barrel.

Over the near-term, the AFCI program is conducting research and demonstrating technologies that have a high probability of reducing the volume, heat generation and radiotoxicity of used nuclear fuel materials requiring repository disposal. The AFCI program is developing advanced separations processes for the treatment of used nuclear fuel from current light water reactor and advanced light water reactor systems. While plutonium burning and transmutation of some of the other transuranic elements that impact repository performance can be accomplished in thermal reactors, more complete transmutation of transuranic elements is achievable in fast reactors with a much larger reduction in decay heat and radiotoxicity per unit energy produced in a nuclear power plant. This translates into a reduction in the source term per unit energy produced and hence, more effective utilization of a geologic repository. The AFCI program is conducting R&D aimed at addressing the economics of fast reactor technology and developing the advanced fuels and associated reprocessing technologies for sodium-cooled fast reactors to enable more of the energy value of used nuclear fuel to be recovered, while destroying, and extracting energy from the transuranics.

AFCI is the first DOE Office of Nuclear Energy program to implement a Technical Integration Office model to effectively and efficiently coordinate the research and development across the DOE national laboratory complex, including with universities and international research partners. Research supporting AFCI has been organized into seven campaigns and two cross-cutting functions. The seven campaigns include advanced separations technologies, advanced fuel development, systems analysis, safeguard systems development, advanced reactor design, waste form development, and grid-appropriate reactor development. The two cross-cutting functions are modeling and simulation and nuclear safety and regulatory activities. World-recognized experts at DOE's national laboratories have been assigned to lead each of the campaigns, with much of the research conducted at the Science labs.

AFCI is the domestic R&D component of the Global Nuclear Energy Partnership. GNEP is an international initiative that seeks to enable global expansion of nuclear energy in a safe and secure manner, enabling countries to enjoy the benefits of nuclear power without having to invest in expensive and sensitive enrichment and reprocessing technologies. Although GNEP is a relatively new initiative, 21 nations have formally joined the partnership and four teams comprised of some of the most capable and respected nuclear industry firms have offered approaches to DOE on how best to implement a closed fuel cycle with advanced fuel cycle technologies. In addition, industry has told DOE that meaningful steps can be taken in the near-term to close the fuel cycle by 2020 to 2025, suggesting that government take a fresh look at nuclear waste management through an integrated approach including recycling and repositories.

The bottom line is—GNEP comes at a crucial time in the global expansion of nuclear power, and is an important initiative for addressing challenges associated with nuclear waste management. It's a comprehensive proposal to close the nuclear fuel cycle in the U.S., and engage the global community to minimize proliferation risks—while providing the mechanism for international synergy in policy formation, technical support and technology and infrastructure development.

GENERATION IV NUCLEAR ENERGY SYSTEMS

For the long-term future, the Department is working on the next generation of nuclear energy systems, technologies that represent enhancements in economics, sustainability, reduced waste intensity and proliferation-resistance over today's technologies through the Generation IV nuclear energy systems program. Additionally, the U.S. is part of the Generation IV International Forum or GIF, a multinational effort to work collaboratively on Generation IV technologies. GIF nations are exploring six advanced systems of interest. Overall, the investment of 10 nations in collaborative R&D on Generation IV technologies is over $100M per year on the first two systems.

U.S. Generation IV research is focused on reactor systems that operate at higher temperatures than today's reactors to both improve efficiency and provide a process heat source for a wide range of energy-intensive co-located industrial processes. A mid-term version of the Generation IV Very High Temperature Reactor concept, the High Temperature Gas Reactor (HTGR) nuclear system is being pursued in the U.S. through the Next Generation Nuclear Plant (NGNP) demonstration, authorized by the *Energy Policy Act of 2005.* The HTGR is an advanced nuclear technology that can provide high-temperature heat for industrial processes at temperatures up to 950°C. Coupled with developmental high temperature electrolytic or thermo-chemical technologies, this advanced HTGR technology can also be used in the production of hydrogen and oxygen from water for existing markets such as refinery upgrading of petroleum crude, chemical and fertilizer plants, as well as in processes such as coal-to-synthetic fuels and hydrocarbon feedstocks. Using the HTGR nuclear heat source will reduce dependence for producing process heat using fossil fuels such as natural gas and oil, for which the long-term prices are increasing and the availability is uncertain. This is achieved without carbon emissions, thus reducing the carbon footprint of these industrial processes.

As currently conceived, the commercialized HTGR will be inherently safe by design and more flexible in application than any commercial nuclear plant in history. The commercialized HTGR will secure a major role for nuclear energy for the long-term future and also provide the U.S. with a practical path toward replacing imported oil and gas with domestically produced clean and economic process heat, hydrogen and oxygen.

As with Nuclear Power 2010, the Advanced Fuel Cycle Initiative and GNEP, the Generation IV program in general and the Next Generation Nuclear Plant project in particular are built on a public-private partnership foundation. DOE has recently issued a Request for Information and Request for Expression of Interest seeking input from interested parties on how best to achieve the goals and meet the requirements of the NGNP demonstration project at Idaho National Laboratory.

Idaho National Laboratory, Oak Ridge National Laboratory and The Babcock and Wilcox Company are developing TRISO-coated fuel and conducting other HTGR research. The research to improve performance of the coated particle fuel recently met an important milestone by reaching a burn-up of nine percent without any fuel failure, demonstrating that the U.S. can produce high-quality gas reactor fuel. Already, significant success has been achieved with the Department's Nuclear Hydrogen Initiative with the development and testing of high-temperature electrolysis cells that take advantage of NGNP's high process heat output to efficiently produce hydrogen and customizable carbon-neutral fuels.

NUCLEAR SCIENCE AND ENGINEERING EDUCATION AND FACILITY INFRASTRUCTURE

While all of the programs I've highlighted for you individually and collectively do much to advance the state-of-the-art in nuclear science and technology, and enable the continued global expansion of nuclear power, there is a great area of challenge confronting nuclear energy's future. As with most other technologically intensive U.S. industries—it has to do with human capital and sustaining critical science and technology infrastructure.

My laboratory, its fellow labs and the commercial nuclear power sector all face a troubling reality—a significant portion of our work force is nearing retirement age and the pipeline of qualified potential replacements is not sufficiently full.

Since I'm well aware of this committee's interests in science education, I'd like to update you on what the Department and its labs are doing to inspire our next generation of nuclear scientists, engineers and technicians. Fundamentally, the Office of Nuclear Energy has made the decision to invite direct university partnership in the shared execution of all its R&D programs and will set aside a significant amount of its funds for that purpose. Already, nuclear science and engineering programs at U.S. universities are involved in the Office of Nuclear Energy's R&D, but this move will enable and encourage even greater participation in DOE's nuclear R&D programs.

In addition, all NE-supported labs annually bring hundreds of our nation's best and brightest undergraduate and graduate students on as interns or through other mechanisms to conduct real research. For example, at INL we offer internships, fellowships, joint faculty appointments and summer workshops that focus on specific research topics or issues that pertain to maintaining a qualified workforce. This year, we are offering a fuels and materials workshop for researchers and a 10-week training course for engineers interested in the field of reactor operations. Last year, DOE designated INL's Advanced Test Reactor as a national scientific user facility, enabling us to open the facility to greater use by universities and industry and to supporting more educational opportunities. ATR is a unique test reactor that offers the ability to test fuels and materials in nine different prototypic environments operated simultaneously. With this initiative, we join other national labs such as Argonne National Laboratory and Oak Ridge National Laboratory in offering nuclear science and engineering assets to universities, industry and the broader nuclear energy research community.

Finally, national laboratories face their own set of challenges in sustaining nuclear science and technology infrastructure—the test reactors, hot cells, accelerators, laboratories and other research facilities that were developed largely in support of prior missions. To obtain a more complete understanding of the status of these assets, the Office of Nuclear Energy commissioned a review by Battelle to examine the nuclear science and technology infrastructure at the national laboratories and report back later this year on findings and recommendations on a strategy for future resource allocation that will enable a balanced, yet sufficient approach to future investment in infrastructure.

CONCLUSION

All of the programs I've cited today—Nuclear Power-2010, the Advanced Fuel Cycle Initiative, GNEP, Generation IV, Nuclear Hydrogen Initiative—ultimately seek to make nuclear power better and safer. Realistically, we as a nation have no silver bullets that in the near- or mid-term can replace nuclear power as a reliable, 24/7 producer of massive amounts of cost-effective and carbon-emission-free baseload electric power and process heat for industrial processes to displace burning of natural gas and oil.

The challenges frequently associated with nuclear power—high costs, waste disposal and proliferation risks—can all, from a technological perspective, be managed. The high cost concerns actually have little to do with the fuel used in a nuclear reactor—they're more related to the rising costs of concrete, steel, copper, and project capital on large, lengthy projects like a nuclear power plant. Many of these same cost concerns apply to virtually every means of generating electricity we have. Nuclear Power 2010 and the other incentives available to first movers of new nuclear plants can effectively address these financial and regulatory challenges.

The waste stream from a nuclear reactor is hazardous and must be isolated - but we know how to handle it safely and we know the pathways we can take to reduce and manage it. The Nuclear Regulatory Commission has concluded that used fuel can be safely stored on-site for 100 years. An integrated approach to used fuel management offers the possibility of recycling the usable components, greater utilization of our uranium resources, and reduced toxicity and/or volume of used fuel requiring geologic disposal.

Finally, proliferation. The fact is that nuclear materials can be redirected for non-peaceful purposes. President Eisenhower acknowledged that a half century ago in his Atoms for Peace address. But the nuclear genie is out of the bottle. Over 430 nuclear reactors are already in operation around the world, and dozens more are under construction or in the planning process. Do we in this country wish to disengage from the global nuclear renaissance and hope for the best—or do we want to help guide the world toward the best nuclear fuel cycle possible?

These programs maintain the viability of today's nuclear reactor fleet and prepare the way for the safe, sustainable future for this large and immediately available global power source. They address the challenges facing nuclear energy, and leverage the best minds in our national laboratories, universities and industry.

As the Director of Idaho National Laboratory, I'm proud of the role my 3,800 Idaho colleagues play in carrying out these national priority programs and related efforts that contribute to our nation's energy security.

Thank you.

BIOGRAPHY FOR JOHN J. GROSSENBACHER

Mr. Grossenbacher is the Director of the Idaho National Laboratory and President of Battelle Energy Alliance, LLC (BEA). His credentials and experience include leadership and management of large institutions with substantial efforts focused on technology research and development. Before joining Battelle, Mr. Grossenbacher had a distinguished career with the U.S. Navy, achieving the rank of Vice Admiral and Commander of the U.S. Naval Submarine Forces. He earned a Bachelor of Science degree in Chemistry from the U.S. Naval Academy, and he holds a Master of Arts degree in International Relations from the Johns Hopkins University. In addition, he completed the Harvard University Graduate School of Business Administration Program for Management Development. He is a leader with a refined sense of strategy, an in-depth technical knowledge and a focus on delivering results. He is one of only a handful of officers in U.S. Navy history to be awarded both the Stockdale and David Lloyd Awards for Leadership Excellence. As Commander of the U.S. Naval Submarine Forces, Vice Admiral Grossenbacher led the integration and consolidation of the U.S. Navy's Atlantic and Pacific submarine forces. He is noted for his ability to build and lead multi-disciplinary teams, to meet complex science and technology challenges, and to achieve success in developing and sustaining collaborative relationships with multiple stakeholders.

DISCUSSION

THE GLOBAL/NUCLEAR ENERGY PARTNERSHIP (GNEP)

Chairman GORDON. All right. At this point, we will open our first round of questions, and the Chair recognizes himself for five minutes.

I have heard a variety of concerns about the implementation of the GNEP program, so I want to better understand that, and I would like for, I have some questions for Admiral Grossenbacher and Mr. Fri.

First, can either of you provide me with a cost estimate? Are we talking hundreds of millions, billions, or tens of billions of dollars?

Mr. FRI. The report uses tens of billions, although, at the time we did the report, we didn't have a really definitive process.

Vice Admiral GROSSENBACHER. I agree with that. For the long-term implementation of the technology, it is a significant investment over a long period of time.

Chairman GORDON. Well, that is a very huge investment of taxpayer dollars, and with that understanding, I would like to clarify that the Department aims to deploy commercial scale facilities at some point to accomplish two main goals: waste reduction and non-proliferation of weapons-grade materials. Has a process for recycling spent fuel that meets those goals, or the goals I stated and identified, and if so, is it ready for commercial deployment?

Mr. FRI. I think that the Committee's view, the short answer to that is not, certainly not ready for commercial deployment. There are several processes that could be examined, and what we recommended was that the Department systematically sort through those to determine the one that looks the most promising in light of what else is going on in the world—that commercial sphere.

Chairman GORDON. Do you concur with that, Admiral?

Vice Admiral GROSSENBACHER. Mr. Chairman, the only thing I want to add is that the waste reduction, that is true, and the other intention is resource utilization, remembering that the current once through fuel cycle only uses a very small percentage of the uranium.

Chairman GORDON. But in terms of recycling the fuel, that process is not ready for commercialization. Is that correct? Would you concur with Mr. Fri's——

Vice Admiral GROSSENBACHER. Not as envisioned in GNEP. Certainly, there are recycling technologies that are industrialized today, but not——

Chairman GORDON. Well, that is what I was trying to get to GNEP for——

Vice Admiral GROSSENBACHER. Yes.

Chairman GORDON. Okay, Admiral, so spending billions of taxpayer dollars on commercial scale facilities before the necessary research and development has been conducted, it is a little hard for me to understand. It has been reported that the Department is moving away from that strategy. Can you confirm that for me?

Vice Admiral GROSSENBACHER. The short answer is no, I can't—I don't know the precise details of the current discussion about GNEP. I feel—it is important to remind you that this is meant to be a development and demonstration program that is evolutionary, and that you have to start somewhere.

Chairman GORDON. Well, don't you start with research, rather than with moving forward——

Vice Admiral GROSSENBACHER. Well, sure you do the research, Chairman.

Chairman GORDON.—on a full scale, tens of billions of dollar commercialization? And with all the needs here, I mean, is this—I guess what I am trying to, with the limited dollars.

Vice Admiral GROSSENBACHER. Right.

Chairman GORDON. Is, you know, is this the best way to spend those dollars, and is this a focused way, and you know, quite frankly, there has been concern in many areas that there wasn't a lot of collaboration, that this doesn't really, it was a sort of everything for everybody, and I am concerned, again, if we are going to make this investment, I want to make it in the best possible way.

Vice Admiral GROSSENBACHER. Yes, sir. I think that is a valid point. The only thing I want to point out is, if you look at the goals of GNEP, which from a technology point of view, are ambitious, the key question is what is the timeframe, and when do you go to a full-scale industrial demonstration of that technology, what technology do you choose, and that has to be informed by both an R&D process, and the involvement of the industry. The laboratories, the scientists and engineers don't build and operate these large scale industrial facilities, so I think the issue is what is the timeframe that——

Chairman GORDON. Well, part of that issue, also, is having a broad enough buy-in, that you can keep a flow of taxpayer dollars going to—so, just real quickly, Dr. Cochran, or Mr. Fri, do you want to comment on this issue?

Mr. FRI. Well, only to say that our report, we said, while we don't see the virtue in spending a lot of money right now for the commercial facilities, it is a long-term program, the quid pro quo is, it is a long-term program, and therefore, sustained commitment and sustained funding is really important to the success of that program, and that kind of stability is not something that the nuclear R&D budget has experienced over the last several years, and it is something that I hope that the Congress will be able to do, at a reasonable level, over a long enough period of time, to incorporate outside advice, so that we can get the job done.

Chairman GORDON. Quickly, what is the appropriate outside advice, and who would that be? Or not what is it, but who is the vehicle for that?

Mr. FRI. We recommended that the Department set up an outside advisory committee, that is independent, objective, and has a strategic focus. What we have in mind, the technology that may be familiar to you, something like the Science Advisory Committees at the Department of Energy, which has a, which is composed of people of the community, but as you know, they are perfectly willing to tell the Department when they are wrong, and that is what——

Chairman GORDON. I think that is important. I don't want to abuse my time, and I know Dr. Cochran is probably squirming in his seat, so why don't you have a closing statement on this topic.

Dr. COCHRAN. Mr. Chairman, the GNEP program is doomed to failure. The vision requires that roughly, for every 100 gigawatts of thermal reactor capacity, the type of reactors we have today, you would need roughly 40 to 75 gigawatts of fast reactor capacity, and fast reactors have been under development in this country and around the world since 1946.

The programs to develop fast breeder reactors were failures in the United States, in France, in the United Kingdom, in Germany, in Italy, in Japan, and I would also argue, in Russia. The flagships of these programs were all failures. Monju had an accident, and was shut down in 1995, and hasn't restarted. Super-phoenix, in France, had a lifetime capacity factor of between six and seven percent. The Clinch River Reactor was canceled. We have left the FFTF sitting around in the State of Washington, and folded that program back into very small EBR–1 reactor, EBR–2 reactor at Idaho. The German reactor, SN–300, was canceled before it was fueled, and it has been turned into a hotel and amusement park, and is probably the only fast reactor that has ever made money. The British fast reactor program was canceled. The Italian one never got off the ground. The Russians never put plutonium in their fast reactors.

Chairman GORDON. Well, Dr. Cochran, I don't want to abuse my time. I think the short answer there is that, clearly, this needs to be rethought, to make sure that we are, with this past history, that we are spending those limited dollars wisely.

Dr. COCHRAN. One more point.

Chairman GORDON. Okay.

Dr. COCHRAN. Because this program is doomed to failure, because these fast reactors are unreliable—I didn't mention, by the way, it was a failure in two Navies, the United States Navy, Admiral Rickover jerked it out of the Seawolf, and in the Soviet Navy. But what is going to happen is the R&D is going to go forward, and the Department of Energy is promoting this R&D not only in weapon states, but in non-weapon states, and what we are doing is training people in actinide chemistry and plutonium metallurgy, and the proliferation risks are going to increase from the R&D programs, and they will never decrease from the deployment of the program.

Chairman GORDON. Thank you, and Mr. Bilbray is recognized for five minutes.

ENVIRONMENTAL CHALLENGES

Mr. BILBRAY. Thank you very much, Mr. Chairman. Dr. Cochran, I am looking at the concerns about the environmental challenges of nuclear. The Natural Resource Defense Council basically, does it support more emphasis on hydroelectric, wind, geothermal, and solar?

Dr. COCHRAN. Our highest priority is to mitigate the climate effects of global warming, and that means that our highest priority is to get a climate bill through the Congress, and that means, since it is the single policy that will do the nuclear industry the most good, we are in a situation where the Natural Resources Defense Council is an advocate for the single policy that would do the U.S. nuclear industry the most good.

Mr. BILBRAY. Well, that is a great attitude to have. I appreciate that. I think we have talked about hydroelectric, and we realize the environmental problems of dam, and the construction and whatever, and I want to make sure that, you know, your group identifies the environmental challenges of all the options.

Dr. COCHRAN. We do, and we have programs across the board to internalize the externalities associated with all of these energy technologies.

Mr. BILBRAY. When you do——

Dr. COCHRAN. Coal, nuclear——

Mr. BILBRAY. Wind, solar, and geothermal seem to appear to be a small environmental footprint, wouldn't you agree, in at least first appearances?

Dr. COCHRAN. Yes.

Mr. BILBRAY. And do you articulate at all the unseen environmental impacts of those three choices?

Dr. COCHRAN. Well, I, you know, the primary problems associated with wind today are not environmental problems, I mean, other than aesthetics, some people think it looks good, some people think it is an eyesore. But the primary problems with wind relate to its cost, and the fact that the wind doesn't blow 100 percent of the time, so the average capacity factor of a wind farm would be like 25 to 30 percent, rather than the 90 percent of the capacity of a U.S. nuclear plants, and—today. Solar, I think solar can, the main problems have to do with cost, but the environmental problems are quite small. They are not zero. I think we need to internalize the environmental costs of all of the technologies.

Mr. BILBRAY. Doctor, I have to apologize to you, because I have sort of got an inside track here. As you know, California has tried to lead on a lot of this, and one of the things that has hit my district with these supposedly very environmentally friendly technologies, is the horrendous impact, that is unseen, by the fact that most of what is perceived as being non-polluting, environmentally friendly technology, is sited a long distance from the source of the power to the receiver, which means massive amounts of transmission capability, which has horrendous environmental impact.

The greatest, probably the biggest environmental uproar right now in my county is the fact of bringing in geothermal and solar through a state park, through habitat areas, and everything else. And I only want to raise that, because when we talk about one technology, we sort of overlook the other technologies' major environmental footprint. And so, it is one of those things that I am looking at, that what would be the environmental impact of expanding facilities that already are on, in San Diego County, as opposed to so-called environmentally, the most environmentally friendly technologies, that have to be trucked in. In fact, I think you are looking at wind generation, and the whole center of the Nation being proposed, but the transmission lines are not being considered in the environmental footprint.

Do you agree that is something that we haven't addressed enough of this thing?

Dr. COCHRAN. You know, you mentioned, for example, transmission lines. That is also a problem for nuclear plants. It is a problem for importing electricity from the Palo Verdes——

Mr. BILBRAY. But you do agree that nuclear has the capability of being sited where plants are already sited, and using existing facilities, as opposed to wind, solar, and geothermal are really site-specific, and limited to certain locations, that have to be sited at those places, and thus, the transmission lines tend to be new, and easements being increased.

Dr. COCHRAN. I more or less agree with you, certainly the reason new nuclear plants are going to be sited at existing sites is because it is cheaper to do it there.

Mr. BILBRAY. Well, and it is environmentally, usually, it reduces the environmental footprint.

Dr. COCHRAN. Sure.

Mr. BILBRAY. Admiral, 20, you know, 1978, I was a 27 year old mayor down in, down along the border, and the whole issue of the

U.S. nuclear industry shifted right out from under our feet. Could you explain what has happened with that industry in the last 30 years, and is it currently in a good shape?

Vice Admiral GROSSENBACHER. Well, there are certainly people at the table that can address this more directly than I can, but I will tell you what I see from my vantage point, and I see a much more mature industry, that has learned from, learned how to deal with the complexities and challenges associated with its technology, a regulatory regime that has developed and matured, and so it operates, you know, very, very well. I think last year, and Marilyn Kray can correct me, but I think the capacity factor of the nuclear plants in the U.S. was 91.7 percent. From the point of U.S. safety, any industrial technology has hazards and risks associated with it, tragically, and we killed more people this year in refining sugar in this country than we did in operating nuclear power plants for 40 years. So, all risks have to be discussed, I think, in context and in a relative manner, but my perspective on it is that the nuclear industry is a mature industry that operates very well. It needs to be a mature industry. It needs to be extremely diligent, given the nature of the technologies.

And the only other point I will add, if I may, is in, just the previous discussion. The other thing to remember about comparisons of energy sources is the density. You know, nuclear energy provides baseload power, so it is a large, concentrated energy source, with hazards and risks associated with it. Distributed energy sources have other issues, including the complexity, including the scalability, and there is no free lunch. If we want large amounts of energy, there are going to be costs, risks, benefits associated with them, and we have to look at all of them, and do that type of comparison, I think, to make the best choices.

Mr. BILBRAY. Thank you, Mr. Chairman.

Mr. LIPINSKI. [Presiding] Mr. Bilbray. The Chair now recognizes Representative McNerney.

ECONOMICS OF NUCLEAR POWER

Mr. MCNERNEY. Thank you, Mr. Chairman.

One of my big concerns about nuclear power is the economics of the game. Now, it is very hard to get your hands around a good economic estimate for nuclear power, for a lot of reasons. One of the reasons, I understand, is that it is easy to build a cheap nuclear power plant that has low safety consideration, and then, the more safety you add on, the more expensive it gets, and so on. But I still don't understand why it is so difficult. I mean, there is going to be an initial capital cost, there is going to be a fuel cost. There is going to be maintenance costs, and there is going to be disposal costs.

Mr. Asselstine, perhaps you could address that, what the difficulty is, and where I could find good information on that that is easy to understand.

Mr. ASSELSTINE. Sure, Congressman. Let me start with the existing plants first, and operating costs. I think there, we have got a very good handle on that, as one of the previous speakers just pointed out. If you look at the existing fleet of 104 operating plants today in the United States, those plants are operating highly reliably, with capacity factors in excess of 90 percent, and if you think about the need for refueling outages, that means those plants are operating just about as efficiently as they possibly can.

We also know that fuel, operating and maintenance costs, waste disposal fees, and taxes add up to about, say $0.025 per kilowatt-hour, in that range, which again, is very comparable to what we see for large, efficient, coal-fired power plants.

Mr. MCNERNEY. So, that is your operating costs.

Mr. ASSELSTINE. Those are operating costs. That is exactly right. So, then, the real question becomes, as you look at new nuclear plants, what is the capital cost of the plant going to be——

Mr. MCNERNEY. Right.

Mr. ASSELSTINE. How confident are we that the plant will actually be built for that cost, and will enter commercial operation when it is expected to, and the variables there are first, commodity prices? We are seeing significant increases in prices for things like steel. There are, in some instances, very limited international suppliers for some of the components that are necessary for nuclear power plants. A good example is very heavy steel forgings, which are necessary for the reactor pressure vessels, steam generators, there is only one supplier in the world for that, those components today. And they control the market, and prices have been moving up as well.

Second, it has been 20 years since we have built a new nuclear power plant in this country. Many of the suppliers that supplied the existing plants are no longer available. If you went to most of the existing nuclear plants in this country, when those plants were built, virtually all of the equipment and components in those plants came from the United States. For the new nuclear plants that will be built around the world, including in the United States, if there are, if plants go forward, most of the components and equipment and supplies will come from international sources. So——

Mr. MCNERNEY. What I am basically hearing you saying is that the costs, the capital costs can be a determining factor, and it is going to be possibly high, and there is a lot of risk associated with this, so——

Mr. ASSELSTINE. Exactly.

Mr. MCNERNEY.—the lenders are going to want to take their part out of that risk.

Mr. ASSELSTINE. And the same thing is true, quite frankly, for large new coal plants, especially clean coal, using clean coal technology. You have the same risks and uncertainties. Marilyn can probably talk about how the industry and the companies are trying to get their arms around what those costs will be.

When we get to the point where companies are signing firm orders to purchase a new nuclear power plant, which will be, in most instances, probably a few years from now, we will have a better fix on exactly what those capital costs will be. The financing costs also, then, need to be determined, and for the purpose of investors, investors will look at that investment, and they will say how safe or how risky is this investment, compared to building another type of generating plant within this industry, and what is the risk premium that needs to be built in for the capital costs.

I believe that all of those costs can be dealt with, and you can end up with costs that are pretty comparable to what you would see for coal-fired generation, taking into account the financial support that the Congress provided in the *Energy Policy Act,* but we will know with greater definition exactly what those costs are, probably, in a couple of years.

Mr. MCNERNEY. I wanted to talk a little bit about disposal, too. I worked on disposal calculations as a graduate student, at the New Mexico Waste Isolation Pilot Project. Any idea where we are with regard to credibility of geologic disposal? Mr. Fri.

Mr. FRI. The credibility, in terms, the technical credibility is, I think, pretty high. I mean, the National Academy of Sciences has said that that is ultimately to dispose of nuclear waste fuel.

The actual mechanism by which that is going to happen, and the costs incident thereto are still pretty much up in the air. Yucca Mountain is an ongoing project, and the number of alternatives to storing the spent fuel, perhaps on-site, and I don't think good studies have been done of all of the array of options that are possible, or their costs.

Mr. MCNERNEY. All right. Thank you, Mr. Fri.

Mr. LIPINSKI. Thank you, Dr. McNerney. Dr. Ehlers is recognized for five minutes.

NUCLEAR WASTE, SAFETY AND TRAINING

Mr. EHLERS. Thank you, Mr. Chairman. Thank you for holding the hearing on a very important topic. Something most people don't realize the crisis we are facing. Everyone is complaining about the increase in gasoline prices, but that is going to have a direct impact on electricity consumption and production, because more and more people will do as I have done, buy a hybrid, and very shortly, we will have plug-in hybrids. They will be all the rage, because it takes less gasoline, but they do take electricity. That is just one example that we are going to face increased demand for electricity.

Well, back when all the fuss started about whether nuclear reactors were safe or not, I did my own study on the issue, comparing coal to nuclear, and frankly, and as you know, I am an environmentalist, I decided they were equally bad for the environment, but nuclear had a distinct advantage. The two biggest environmental problems, I felt, were the greenhouse gas production from the fossil fuel-fired plants, whether coal, oil, natural gas, and the biggest problem with the nuclear was the nuclear waste.

To me, it was an easy decision as to which was best, because when you are discharging gases in the atmosphere, it is awfully hard to get them back, and collect them, and deal with the problem. Whereas, with the nuclear waste, it is a relatively small solid, liquid, and theoretically, should be easier to deal with, if you can get rid of the paranoia in society about nuclear waste. And I think there are ways of doing that.

I have also, incidentally, I never talk about disposal of nuclear waste. We are kidding ourselves if we use that word. I served on a county commission, and we had, it was the Kent County Disposal System, which is a landfill, and I proposed officially that we should change it to the Kent County Waste Storage Facility, because all we are doing is storing it underground, and that is what we are talking about doing at Yucca Mountain, too. But if the Congress had written the bill, that this is going to be retrievable, monitored storage, I think we would have had far less difficulty selling it. People would still object, but it wouldn't be as bad as it is now.

But putting the requirements on, say, we have to make it safe for 10,000 years is just totally unrealistic, what we can scientifically prove, then. So, thank you for letting me vent just a little bit, but it seems to me we have a huge amount of work ahead of us. You have just heard that from the testimony, what we have to do to get construction going again, obtaining parts, et cetera, but there is another important aspect, and I fought during my first years here, to prevent the killing of the program that funded training for nuclear engineers. I lost the battle, the funding was killed, and the universities dropped the programs, and that whole system has to be started up again. We have to develop a whole new fleet of nuclear engineers, and I think it is very, very important that we have properly trained personnel.

Although I said that the problem with Three Mile Island was that, at that time, there was a surplus of physicists in the country. I said the problem was Three Mile Island was being run by taxicab drivers, and taxicabs were being driven by physicists, which is kind of a backward way to solve a problem.

So, I think we have to set up good training programs, make sure we have an ample supply of nuclear engineers, who can design, build, and operate nuclear reactors safely. The safety record, I think, is phenomenal, for all but the Soviet Union. We have reasons why that happened there, governmental as well as training.

I, Mr. Chairman, all I am saying here is we have to get going. We can't just depend on the industry to get started itself. The investments required are phenomenal. The security that will be provided if we don't step in and provide the assurance that things will work, there is not going to be enough security there for the industry, for the financiers, to put the money in to get it going. So, I think we ought to face up to our responsibility here, as well as making sure that industry assumes their fair share of the responsibility, and that is the only way it is going to happen, but it has to happen. We are literally running out of fossil fuels in the petroleum and natural gas area, got plenty of coal, but frankly, as I said earlier, I would much rather have nuclear power than coal-fired plants, in terms of the environment, not just the greenhouse gases, but the mercury, and all the other factors.

Pardon? And the nuclear, that is right. So, at any rate, that is the end of my sermon, and I hope we can unite on some positive action here.

Thank you.

Mr. LIPINSKI. Thank you, Dr. Ehlers. I, we always are very much enlightened by your sermons here, so if we just all followed, then we would solve a lot of problems.

But we will now, the Chair will now recognize Mr. Chandler for five minutes.

LOW PUBLIC CONFIDENCE IN NUCLEAR ENERGY

Mr. CHANDLER. Thank you, Mr. Chairman. It seems to me, in listening to all of this, and following what I have been following over the years, in regard to this issue, that we have, as much as anything, a public confidence problem, a significant public confidence problem which, of course, impacts the willingness of investors to be involved significantly.

Do you all have any ideas about how the industry can assist in building public confidence. The storage issue, of course, disposal issue is, I am sure, one that has to be addressed in particular in that regard, but could you give me some ideas about what could be done to bring the public into a position where they feel more confident about moving forward with nuclear energy?

Ms. KRAY. Mr. Vice Chairman, I will volunteer a response to that. The industry admits that we do not do a good job, and we are not boastful, and that comes to our detriment when you look at public confidence. I think in the investor community, and Mr. Asselstine will correct me if I am wrong, those who explore it, I think yield a more positive view.

Through the Nuclear Energy Institute, we do conduct surveys, and for those surveyed around the plants themselves, we have a very high support rate for nuclear power. What we do see, however, when we survey the more broader population, is that there is a misunderstanding, in particular, in the environmental area, and most people do not equate nuclear power with being carbon-free, with respect to greenhouse gas emissions. So, we have taken that on as one of the issues that we do need to do.

Also, there are a number of other organizations. One of our more successful one is the Young Generation Nuclear Group, which is some of the new students coming out of the universities, working into the industry, to help communicate that. I would also say that, in addition to the industry, the NRC has integrated public interaction very much into the licensing process. And even before any of the applications were submitted, the NRC, by process, would conduct a number of town meetings, so as to educate people about that. So, that is an opportunity, at that point, also, for the industry to share the safety record, to share the process going forward.

But—so I do acknowledge that the advertising and self promotion is probably something that, as an industry, we have not made a priority, but need to, going forward.

Mr. CHANDLER. Maybe Mr. Asselstine and possibly, Dr. Cochran, too, on this, if you don't mind, if you have any ideas.

Mr. ASSELSTINE. First, I would say, from the perspective of somebody in the financial community, I think the industry has actually done a fairly effective job over the past couple of years, in beginning to lay the groundwork to build support for new plant commitments, and obviously, this process is going to be ongoing over the next several years. And I start with the performance of the existing plants. That has been consistently strong over the past decade, and that was a very important foundation, because without that, then the prospect of new commitments just wouldn't happen. So, continued strong performance in the existing plants, from a safety standpoint, from a regulatory standpoint, and economically, is a critical initial ingredient.

But what the industry has done fairly effectively, I think, over the past couple of years, is begin to talk about the cost, potential cost of a new nuclear plant, the approach that they will use in making a decision whether to go forward or not, in order to really educate the financial community and investors, about how that process will unfold, well in advance of when they come to investors and say, now, we want to borrow several billions of dollars to build this. I think they need to continue to follow that approach going forward.

Dr. COCHRAN. Well, in my view, the best way to get public support is to be truthful and transparent about all the risks and benefits of the technology. And looking at the industry's potential public relations problems going forward, a concern I would have is that if you look at the safety of plants, nuclear plants in the United States are safer today than they were two decades ago.

But if you are going forward, most of the plants, new plants that are going to be introduced in the world, are going into countries that do not have good safety cultures, and when one of these plants runs into a problem, as it has in the past, the good plants will suffer along with the bad ones, and so, I think some attention needs to be given, by the United States Government, to the development of an improved safety culture in other countries that are getting into this business.

It is the safety culture at the plant that is the most significant, most important factor that affects the overall safety. It is the culture at the plant, and we have improved the culture at U.S. plants, but we have not addressed that problem on a global basis going forward.

Mr. CHANDLER. All right. Mr. Fri, do you have something quickly to add?

Mr. FRI. One thing that might be worth looking into is the legislative and regulatory structure we have for spent fuel. Dr. Ehlers is exactly right, it seems to me—the structure we have requires you to prove that this stuff is going to be safe for a million years. I have chaired the committee for the National Academies that came up with that brilliant suggestion, and it is really hard to do, and it is very hard to convince the public that you can do it. And so, it might not be a bad idea to take another look at that structure.

Mr. LIPINSKI. Thank you, Mr. Chandler. The Chair will now recognize, for five minutes, Ms. Biggert.

REPROCESSING SPENT NUCLEAR FUEL

Ms. BIGGERT. Thank you, Mr. Chairman. I have to say that, maybe I am going to start venting, too. I hope not. But I, when I came to Congress almost 10 years ago, the first thing that happened, and I—Argonne National Laboratory is in my district—was that the President cut the EMT, the Electro-Metallurgical Program, by $20 million, and I was hysterical. This was in the first month that I was here, and I needed to get that funding back, because I really do believe in, and have long been an advocate in the recycling and reprocessing of spent nuclear fuel. Well, I did get the money back, and the program continued to conclusion, and I know that there are different processes, the PUREX, the UREX, the UREX+, some have mixed actinides, and so the—to cut down on the proliferation, but I think the three issues, or the two really, that—pure plutonium and the, and what to do with the waste, are key issues.

But to me, I think we should be moving much, much quicker than we are, and as—when I was the Chairman of this, of the Energy Subcommittee in the 108th and the 109th Congress, we really worked on GNEP, and trying to develop that. There was one sticking point, and that was that we asked the Department of Energy to do a comprehensive systems analysis, rather than move right to what we thought was commercialization. And there was a disconnect there, and I think that that really, it slowed down the process, but I think we would be a lot further along right now, if we really had turned to the systems analysis, rather than the construction of a commercial scale facility.

And the problem was, then, that the funding was cut until that systems analysis, or trying to get that. Of which I was not an appropriator, so I was not involved in that, but the Appropriations Committee felt the same way.

So, I would like to know from Admiral Grossman, where are we now, as far as moving ahead. You know, Congress, the GAO, and the National Academies, I think, would be more accepting of the, what you are trying to do to close the fuel cycle, and I think this is the most important issue that we are facing is, you know, finding alternative energies, and it has to be nuclear. I guess I come from a state that 50 percent of our electricity is nuclear, so we are used to it, and I really wanted to see what goes on, but I just think that we are spinning our wheels again. We are just sitting around waiting to say we will do it in the future. The costs only go up. The lack of nuclear energy is only going to hurt our country. We see all over the world all this building of nuclear plants, and we are sitting. And reprocessing plants, and—we have one in Illinois that was built and then shut down by Jimmy Carter. There is at least five others that were built at that time.

Vice Admiral GROSSENBACHER. Well, Congresswoman, I take your points, and I think they are very good ones. The reasons to reprocess are, in my opinion, twofold. One is to get additional energy out of the uranium that you dug out of the ground. I mean, uranium and the other fissionable natural materials, thorium, are limited resources. So, if we look ahead, if we say nuclear energy is going to be an important element of our energy portfolio for the next 100, 200 years, then I think if you put it in that context, then, resource utilization, not just the current market price of uranium, is an important consideration.

In addition to that, the technologies involved, in reprocessing at industrial scale, are difficult. You take highly radioactive material, and the first thing you do is dissolve it in hot nitric acid. That being said, resource utilization, the other is with increased resource utilization comes a waste disposal problem at the end of the cycle that is easier to manage. The waste is less toxic, less radioactive for a long period of time, so those are really the goals of reprocessing and then recycling. And GNEP, of course, has proposed a separation of used fuel into its components, and burning the particularly difficult ones, the long lasting, highly radioactive ones, in a fast reactor kind of technology.

The systems analysis that you talk about to support that is ongoing. It is, I think, frankly, limited by the number of uncertainties in what does it look like at a commercial scale. What are the economics going to be, so to move forward, what we have to do is both the research and development, and involve the industry along the way.

Ms. BIGGERT. If I might, though, if we are going to have to deal with the waste, if we put what, the waste that we have now, that has already accumulated, we would actually fill Yucca Mountain.

If we were to, be able to do the reprocessing, and if we would be able to burn and re-burn that waste, we could have a facility that would last for over a century, and I think we just have to make that, you know, we can go ahead and build these plants, and have more waste, but at some point, we are going to have to decide when we can't use Yucca Mountain.

Vice Admiral GROSSENBACHER. Yes, ma'am. Those are the gains, that we can reduce the need for a geological repository, reduce the waste burden, and the costs of the development of the industrial scale reprocessing technology, the resolution of the uncertainties. The principal uncertainty is you know, we know, at a laboratory scale, we can do the kinds of separations we want. We can parse the fuel. Can you do that at an industrial scale, because it really does change?

And then, the other uncertainty is can you make fuel that you want to burn the particularly, what I will call the bad actors, can you make the fuel, and can you recycle it efficiently? And there are just a lot of, you know, technology unknowns in that, but the only way to resolve them is to do the research and development, involve the industrial components at the right pace, at the right level, because this is not just the business of laboratory scientists. It is the business of industrial operators.

And then we will know. Then we will know whether or not we want to do it.

Chairman GORDON. Thank you, Admiral, and thank you, Ms. Biggert. I am having to deal with an issue collateral to this. I am sorry to be coming and going. Mr. Baird is recognized both to question and to chair.

THE ROLE OF FEDERAL SUBSIDIES

Mr. BAIRD. [Presiding] I thank the Chairman. I will move to the chair, and ask a couple of questions.

I appreciate the testimony of the witnesses, and very much in line with some of the points made by Mr. Ehlers, and however, I should also say that I come from a state, the State of Washington. I am down-river from the Hanford Nuclear Reservation, which is not clean by a darn sight. Obviously, it was not a nuclear power issue initially, but nevertheless, there is a substantial nuclear waste issue today. And we are also from the state that had the WPPSS, the Washington Public Power Supply System debacle, the largest bond default, I think, in the history of the country up to that point.

And it is not, just, seems to be, I have two questions. One, can somebody give us a handle of the total net federal subsidies, thus far, that have gone into nuclear energy, and that would include development, design, indemnification, et cetera, et cetera.

And then, the second question is, what can we do if we spent it on not coal, not nuclear, but something else, and take, for example, more fuel efficient heat sources, et cetera, et cetera. What are the returns on investment, and the relative risks and costs of those, more efficient heat pumps, in-ground heat pumps, in line with Mr. Bilbray's question, don't require any new generation, or any new generation or transmission capacity.

So, two questions. What about subsidies, and what about alternatives? And the final one would be, if any of you want to volunteer whether or not you have asked the Administration to increase funding to clean up Hanford. We would certainly welcome that, if you are asking for new money for new power plants, to clean up your mess beforehand would be great.

So, anybody want to take any three of those? Dr. Cochran.

Dr. COCHRAN. I think it is difficult getting a handle on the total federal subsidies to nuclear power in the United States. I have seen numbers on the order of $150 billion, which probably includes direct and indirect subsidies.

Mr. BAIRD. A total over the lifespan of the industry?

Dr. COCHRAN. Total, yes. I mean, you know, the industry was built on the back of the submarine program—the naval nuclear propulsion program. It had enormous subsidies in its early career. We spent tens of billions on the fast breeder reactor and other nuclear technologies that didn't come to fruition.

It is a mature industry now. It is a 50-year-old industry in the United States, and the subsidies that are being provided today are not going to change the underlying economics between fossil fuels and nuclear baseload energy generation.

Mr. BAIRD. And yet——

Dr. COCHRAN. They are basically subsidies to build a few new nuclear plants, and the only way you can change the really underlying economic differential is to internalize the true cost to society of emitting carbon. Regarding federal subsidies, I would look to where the Wall Street money is going, in terms of these energy technologies, where is the high risk money going out in the Palo Alto area, and it is going towards solar, new solar technologies. And a number of other renewable energy areas.

Mr. BAIRD. Mr. Asselstine.

Mr. ASSELSTINE. I would agree with Tom. I think it is very difficult to quantify past support.

Mr. BAIRD. Some costs anyway——

Mr. ASSELSTINE. That is right. But it is much easier to look at the financial support that is now being provided for the next generation of plants, and if you look at the Energy Policy Act, you can work through the numbers fairly easily.

There is a production tax credit of $0.018 per kilowatt-hour for up to 6,000 megawatts of new generation, very similar to the production tax credit that is provided for renewable energy resources, as well. So, if you took that 6,000 megawatts over eight years, with the cap of $125 million per 1,000 megawatts per year for nuclear, that is $6 billion over the eight-year time period.

Mr. BAIRD. But is that not somewhat specious, because there is not waste disposal problems of the same magnitude? I mean, so you have got a production tax credit, which is a direct subsidy, but what about waste disposal issues, transportation——

Mr. ASSELSTINE. Well, waste disposal, the Nuclear Waste Policy Act did impose a mandatory charge for utilities for nuclear generation that has been in effect since the mid-1980s, where the utilities have paid one mill per kilowatt-hour for every kilowatt-hour of electricity generated by nuclear power plants in the country. That money has gone to the Treasury to fund the waste disposal program, and if anything, what we have seen over that time period is the Federal Government failed to meet its obligation to take the waste, and if anything, courts have now been returning some of that money, or compensating utilities for their ongoing storage costs.

So, I would argue, on the waste side, the utilities were pay-as-you-go from the mid-1980s, and continue that way today, and the assumption is, if you have new nuclear power plants going forward, those plants will also be assessed for their waste disposal costs down the road.

You can also look at the stand-by risk insurance, which provides protection against licensing and litigation delays for six units, if that risk insurance is actually needed and used, that would be about $2 billion, and the Congress has appropriated about $18.5 billion in funding for loan guarantees for the nuclear plants.

Add all of those up, it is about $26 billion, and as the Chairman pointed out in his opening comments, we now have applications or statements from the utilities that they intend to apply for licenses for 25 to 30 new units. So, the tradeoff would be about $26 billion in federal support to help ensure that we might get 25 to 30 new nuclear power plants over, say, the next 20 years or so. Those 25 to 30 new plants would mean that nuclear, taking into account the Energy Information Agency's projection about growth in electricity demand, would keep nuclear at about 20 percent of our generating mix going forward.

My own personal view is that is a reasonable, the Congress made a reasonable decision to provide that support to get about 25 to 30 new plants, to keep nuclear at 20 percent of our generating mix. And why is that beneficial? It makes the challenges of dealing with carbon, with the coal-fired generation, easier to deal with. It makes dealing with price volatility for natural gas somewhat easier to deal with, and it keeps nuclear in the balance of its current contributions to our generating mix.

My own view is that is a reasonable tradeoff, and reasonable value for the federal support going forward.

Mr. BAIRD. Appreciate it. I would like to let others testify, or speak, but I have exceeded my own time, and I try not to abuse that as the Chair.

No one offered that they want to increase funding for clean-up, and we have answered, but we would sure welcome that at some point.

Dr. Gingrey is recognized.

YUCCA MOUNTAIN AND WASTE STORAGE

Mr. GINGREY. Mr. Chairman, thank you. Dr. Cochran, in your testimony, you recommended that Congress should require that the Department of Energy resume a search for a second site to complement Yucca Mountain as a nuclear waste repository.

You went on and criticized the Department of Energy, and I think you said corrupting the site selection for Yucca Mountain. Since the idea of utilizing Yucca Mountain has seen delay after delay, due in, I think, in large part because of one Senate Majority Leader, it has hampered further usage of nuclear power because of the question of what do we do with the waste? So, therefore, until we finally open Yucca Mountain as the national repository for nuclear waste, I think it will inevitably prevent the Federal Government from adequately finding a secondary source.

That being said, if you feel that the site selection of, on Yucca Mountain has been corrupted, what do you believe will occur if any secondary site is selected, and additionally, where do you recommend we look for a secondary location for a nuclear waste repository?

Dr. COCHRAN. Very interesting questions.

Mr. GINGREY. Well, you have had some very interesting comments.

Dr. COCHRAN. I don't know that I have the answers, but let me make the following observations. Beginning in the Carter Administration, there was a genuine, bipartisan effort to solve the waste problem, and set up an interagency review to address this issue. And they came up with, and Congress passed, what looked like a very good proposal. One agency, the Department of Energy, was tasked with going out and systematically finding the best site. A second agency, the Environmental Protection Agency, was tasked with developing criteria for assessing whether that site should be licensed. And a third agency, the Nuclear Regulatory Commission, was tasked with making the judgment as to whether the site would meet those criteria.

Now, in the decades since, that has gotten all botched. I mean, the site selection process was botched, and knowing how the Federal Government works, they would probably botch it again. The development of the criteria was totally corrupted. EPA is not an independent agency, making these decisions. Before decisions come out of EPA, they go into secret meetings at OMB, where EPA and NRC and OMB and Justice all get together and decide what the Administration's position is. So, EPA really isn't independent of DOE. And here we are, 20 years later, and we have no final EPA criteria to begin with.

Mr. GINGREY. So, Dr. Cochran, excuse me for interrupting, because I have a shortage of time here, but some of us on this side feel that maybe the process was corrupted politically more than it was by the Administration or——

Dr. COCHRAN. That also.

Mr. GINGREY. I want to address a question to Mr. Fri. I don't disagree with Dr. Cochran's concerns about the nuclear proliferation potential of spent fuel, and obviously, when you talk to the Germans, you know, that is always their big concern, and you can't ignore it, but where are we in regard to mitigating those concerns, in regard to reprocessing and, indeed, getting some of this spent fuel that is, in these storage pools at the 101 current reactors in our country, into a final depository?

If you could address that for the Committee, I think it would maybe allay some concerns that exist over this nuclear proliferation issue, because I firmly believe that the nuclear power, we need to go forward with it, but I don't—I am taking too much time. You go ahead and respond to that.

Mr. FRI. Let me respond to it this way, Congressman. First of all, it—we are probably on the order of decades away from having a reprocessing and recycling operation on a commercial scale to begin to deal with the nuclear waste in the form that has been proposed, for example, by the energy, in which you separate plutonium, you burn up the actinides, and so forth, a lot of which can go into Yucca Mountain.

But behind the question is, in the intervening time, a proliferation danger—to worry about. And basically, in terms of spent fuel, there are a lot of proliferation issues, but one in spent fuel, as I understand it, is not very high, because spent fuel, sitting at a reactor site, or in an interim storage facility, is not separated plutonium. It is very hot, and it is just not a really good source of material for a weapon.

So, I don't think, and the Nuclear Regulatory Commission has been storing this stuff, first in a pool, and then, in a dry cask, over a period of decades, and it is perfectly safe. So, I don't think that there is the large proliferation risk in taking our time to get the job done right on recycling and reprocessing.

Mr. BAIRD. Mr. Melancon was next, but he is absent right now. Ms. Richardson. Mr. Smith is next.

MAKING NUCLEAR COST-COMPETITIVE

Mr. SMITH. Thank you, Mr. Chairman and witnesses.

Dr. Cochran, I appreciate your testimony. Would you generally give a thumbs-up or thumbs-down to nuclear power?

Dr. COCHRAN. Excuse me. Nuclear power is in the mix. It is a mature industry, and when it can compete with the other technologies on a level playing field, it ought to be, you know, we should permit it to compete. Setting aside the separate issue of whether you should reprocess the fuel. I think that is a terrible mistake.

But the problem today is, new nuclear plants are not economical. These guys are coming up to the Hill to get subsidies for a few new nuclear plants. It won't change the underlying economic problem they have. You need to cap carbon if you want to change the underlying economics. It is also the right thing to do, and then, if nuclear can compete, let it compete, but it is going to have to compete with a lot of new technologies that are going to be coming down the line, and it is going to be a difficult road for them.

Mr. SMITH. So, you mention capping carbon. Is that through cap and trade policies?

Dr. COCHRAN. Yes.

Mr. SMITH. And what do you think the impact would be to electricity rate payers, as an example, on cap and trade?

Dr. COCHRAN. I think it would increase the cost of fossil fuels by, initially, a few cents (¢), and then, further out, more, but I think that could be offset by a higher investment in improved energy efficiency in the near-term, particularly, which has a benefit in lowering the cost of electricity.

And so, the net effect, over the long-term, I don't think would effect the economy—I don't think it would, should be significant.

Mr. SMITH. Okay. Thank you.

DOMESTIC URANIUM SUPPLIES

Ms. Kray, if you wouldn't mind responding, how much of our current electricity use in the United States could be generated by nuclear power, using only domestic uranium?

Ms. KRAY. Only domestic uranium? I might have to actually defer that to my USEC friend here.

Mr. VAN NAMEN. Given the rise in the prices that we have seen over the last several years, I think you are seeing resurgence in siting uranium mines, and licensing new uranium mines. I don't think, again, you would ever have a substantial portion funded, or fueled by domestic mines. I think you would still look to partners such as Canada and Australia to supply much of the uranium, but our ability to do, maybe in 20, 15 to 20 percent, is very reasonable.

Mr. SMITH. Okay. Thank you very much. Thank you, Mr. Chairman.

Chairman GORDON. Thank you. Mr. Rohrabacher is recognized for five minutes.

Mr. ROHRABACHER. Thank you very much.

Chairman GORDON. Excuse me, Mr. Rohrabacher. I didn't—is Mr. Matheson—if you are teed up, and Mr. Matheson——

Mr. MATHESON. I am teed up.

Chairman GORDON.—is recognized for five minutes. And then, we will follow by Mr. Rohrabacher.

ON-SITE WASTE STORAGE

Mr. MATHESON. Thanks, Mr. Chairman. I had a few questions I wanted to ask the panel, relative to the waste issues. I think the waste issue really is one that we need to move to some point of resolution if nuclear power is going to have a better opportunity.

During the debate in Congress over the last few years, on moving waste to Yucca Mountain, a number of Members of Congress would get up during the debate, and they would say, gee, I have got all these nuclear power plants right in my backyard, and I want to give this waste away. We have got millions of people living next door to this.

Is it not true that as long as there is an operating power plant, there will be waste on-site, even if you had an off-site storage disposal site someplace else, and there would be a reasonable amount of waste there, that has to stay there for a few years before it can be moved?

Is that a fair statement?

Ms. KRAY. I can answer that, Mr. Chairman.

By design, once the reactor fuel is removed from the core itself, it is placed into wet storage, and that is to accommodate the heat load that is still present then. But ideally, the original design of the plants was that once that time had expired, that it would be moved to dry cask storage, not for on-site storage, but rather, to the ultimate repository. So, if the repository were available, there would be a very short period of time while the fuel is in wet storage.

But I would also add that, while it was not the plan, having the dry cask storage on these facilities does not pose an undue risk. It is just outside of what the original mission was.

Mr. MATHESON. I am glad to hear that, because that leads to my next line of questioning. But I wanted to, first of all, address what I think a number of Members of Congress have inappropriately assumed: that they wouldn't have nuclear waste in their backyard with an operating power plant. They will. They will, whether Yucca Mountain happens or not. It may not be the same amount or volume, but it will be there.

Secondly, you mentioned that the benefit of going to dry cask storage, back in 1982, I think, when Congress passed the *Nuclear Waste Policy Act,* I don't think dry cask storage was necessarily on the table at that point. That is where technology has taken us now.

What do people think about the opportunity, in terms of trying to resolve this complicated issue, of looking at interim on-site storage, where we put the waste in dry cask storage, we leave it on-site, the government takes title to the waste. That may address some of the concerns of the power plant owners.

And from a cost basis, and from an effort at trying to bring some medium-term resolution to this issue, it is not the million year resolution, but maybe it is a 100-year resolution. How does the panel react to that type of proposal, to try to move beyond the dynamic we are in now, in terms of waste storage? I would ask anyone on the panel.

Ms. KRAY. Yeah, and I would offer right now, the industry, as well as with the Department of Energy, is considering a number of alternatives. Included, I believe what you are suggesting, is interim storage, not necessarily at the site at which it was generated, but perhaps, multiple but more centralized dry cask storage facilities.

Also, revisiting the idea of closing the fuel cycle, and I think, contrary to Dr. Cochran, what the intent of it is, is to develop the process by which you would not increase proliferation risks, so this interim storage would, therefore, avail the fuel for future reprocessing, just as was said earlier, to extract from it the energy that still remains in it.

So, I think all of those, whether it be the interim on-site storage, the more centralized dry cask storage, the reprocessing, but ultimately, there will be a byproduct that is needed for Yucca Mountain, but in much lower volume, and also, a much, significantly lower heat load.

Mr. MATHESON. Well, this line of questioning is motivated, and I want to hear from some other folks on the panel, but this line of questioning is motivated, I have introduced legislation that calls for interim on-site storage, and the Federal Government taking title to the waste. And I think it represents at least some level of looking at a practical step forward on this issue, as opposed to where we have been with substantial amounts of money being spent on Yucca, questions about the scientific analysis. Time is dragging on. We haven't met deadlines. We have spent a lot of money, and I think that there may very well be both an economic argument and a practical argument, in terms of making progress on this issue, as a medium-term solution, that we look at interim, on-site storage, with the Federal Government taking title to the dry casks. What other people have reactions to that?

Mr. VAN NAMEN. Congressman, what you are doing is asking what I think is a very good question, and that is, let us ask ourselves what is the safest and smartest thing to do with this stuff for the next 100 years, while we figure out what the safest and smartest thing is in the very long-term.

Mr. ASSELSTINE. I would just add from my perspective within the financial community, I think from investors, particularly as I have talked to them about potential commitments for new nuclear power plants, the waste issue virtually always comes up.

The NRC has always been able to determine that on-site storage or extended dry cask storage does not pose a safety hazard or a safety risk. There is a cost associated with it that would need to be dealt with, but I suspect that from an investor perspective, and probably from the perspective of the companies themselves within the industry, some movement or progress toward an extended storage solution will be necessary before you see large scale new plant commitments, because people will want to know what is going to be done with the waste. That is also probably true from the standpoint of state rate regulators, economic regulators, as well. They are probably just as upset about the delays and the problems in waste disposal as the utilities are, as well.

So, if Yucca Mountain is not going to move forward, some alternative to provide an extended storage solution for the waste, probably is necessary, before we see substantial new plant commitment.

Mr. MATHESON. Thanks, Mr. Chairman. I would just offer again, I think it may be a more cost effective method, too, and if I can just add one point. A lot of people are still questioning the transportation risk of moving all this waste to Yucca Mountain. The Interim On-site Storage Bill would address that problem as well.

Mr. Chairman, I will yield back.

Chairman GORDON. Thank you, Mr. Matheson. I think that we could have a very interesting hearing just on this topic, and thanks for raising it. And the patient Mr. Rohrabacher is now recognized for five minutes.

HIGH TEMPERATURE GAS-COOLED REACTORS

Mr. ROHRABACHER. Thank you very much, Mr. Chairman. Let me just note, and this is a side issue, but just again, Mr. Cochran or Dr. Cochran, global warming is not the basis for making decisions like this. Even in your testimony, it has gone from climate change to global warming, and the fact that it has been—in fact it is getting colder for these last seven years has now taken the global warming people, so now, they are saying it is global climate change, and that is so, that is such a mishmash, I think that reasonable people have got to frankly look at other issues, rather than climate change for such incredible decisions as we are making today.

However, with that said, I think you made some very good points about nuclear energy that need to be addressed, other than whether it is going to change the climate of the planet or not. I asked, I made sure my staff asked the panel beforehand, and gave them some indication that I would be asking them about the High Temperature Gas-Cooled Reactor. Have any of you been to Japan, and seen the High Temperature Gas-Cooled Reactor that they have in operation there? I went to Japan a month ago, and went to that reactor.

This reactor, from what I understand, after questioning the scientists there, as well as questioned various scientists, is lower in construction costs, lower in operation costs, has no risk of meltdown, has no risk of radioactive discharge, has no proliferation danger, and the, and a major reduction in leftover nuclear waste. Now, what I want to know, with—first of all, that is what I understand. I am not a scientist, you know, there are protons, neutrons, electrons, and morons in this universe. And I would have to say that I am closer to the latter than the former.

Maybe, am I wrong in seeing that there is a great potential in the High Temperature Gas-Cooled Reactor that is just being ignored? Go right ahead.

Ms. KRAY. I can offer a perspective on that. The High Temperature Gas-Cooled Reactor design, sometimes referred to as Generation IV, they offer a promising option in the future, primarily because of the potential to divert that high process heat, whether it be for enhanced oil recovery in tar sands, or even hydrogen production.

However, I would differ from your perspective when you say, about the costs. There are a number of issues right now, as far as implementing them in the U.S., where they are significantly behind what is referred to as the Generation III plus, looking at what we want to implement next. It is, primarily, it is the licensing piece of it. They are not yet design certified by the NRC or the other——

Mr. ROHRABACHER. So, in other words, it is the bureaucratic costs, not the technology costs.

Ms. KRAY. Not yet. I would also add the size of them.

Mr. ROHRABACHER. Yes.

Ms. KRAY. And there is, in order for them to be commercially deployed, there is the licensing aspect of it, and along with that, some safety implications, the NRC has indicated the need for advanced fuel performance and characterization, as well as the selection of materials, again, because they operate at such a high temperature, which is to their benefit, but also, a challenge.

So, with the cost, I would say any estimates of implementing them in the U.S. right now would be aspirational at best, and that is because of the lack of the maturity of them at this time. Intuitively, I would think that they will be more costly than the light water reactors, only because of their per-kilowatt output, or their size, and they don't have the economies of scale.

Mr. ROHRABACHER. Well, actually, you can, if you have got smaller reactors, you can actually place them in different places, maybe closer to the consumers, perhaps.

Ms. KRAY. We have looked at that, I know, with the Pebble Bed Modular Reactor, and in the U.S. grid system, it still suggests that from an economic perspective, you would actually want to bundle at least four or six of those together. However, in——

Mr. ROHRABACHER. Which you could do.

Ms. KRAY. You could do, but then, again, so that deployment, or that distributed generation, which that is, doesn't necessarily win so much over here. But again, there is a strong future and outlook for those.

Mr. ROHRABACHER. Why is it, I guess what you are telling me, of all over, what we have got now, this water-based reactors that we have now, this is 56-year-old technology. These were things somebody designed 60 years ago, that now, there have been incremental improvements on, but it is the fundamental concept of, frankly, people who were raised and educated before World War II, and what I don't understand is, that why there doesn't seem to be, I mean, listen, I went over and talked to those engineers. The Japanese engineers were not just Japanese engineers that had made their life on the High Temperature Gas-Cooled Reactor. These were engineers that had a long history, a long history of their involvement in the nuclear energy field, all of them suggested that just the technology of it had all of these great benefits that I just suggested, especially the fact that there is no plutonium left over, which as I say, Dr. Cochran's concern for that is very well—I disagree with him on global warming, but I totally agree with him on some of the points he raised that have to be concerns, like proliferation and the leftover waste material, as well as potential accidents.

Were they lying to me when they said that there is no possibility of a melt-down or a radioactive discharge, as compared to light water reactors?

Ms. KRAY. There is definitely a benefit with the High Temperature Gas-Cooled Reactors, because the fuel type is ceramic in nature, it can withstand higher temperature, and there is less likely to melt. However, I would say as far as the technology looking to be deployed next, that is being designed as we speak, so it is not archaic technology, but rather, we see it from an operational perspective, as the optimum balance between the innovation, using the path of approach to technology, but at the same time, the wealth of experience that we do have on light water reactors. Because again, as we go through, while the financial issues have dominated a lot of the discussions, at the end of the day, for us investing and operating, it is the safety aspect of it.

Mr. ROHRABACHER. Well, the safety operation, you are trying to tell me that light water reactors are going to be, just a safety comparison to what this High Temperature Gas-Cooled Reactor offers, that there is a better safety potential for the water reactor, with all of the leftover plutonium?

Ms. KRAY. I think it is unknown at this point—well, I don't think that the plutonium issue is as much of a differentiator.

Mr. ROHRABACHER. Okay. Okay, what about the melt-down issue? What about the discharge of radioactivity issue? I mean, these Japanese scientists are, were very specific with me about this. They had all worked on the light water reactors before, and said there is just no comparison as to the actual safety of these two operations.

Ms. KRAY. I would, again, argue that there is a potential, and there are safety benefits associated with the High Temperature Gas Reactors, but at the same time, there are unknowns, again, in the area of fuel, and also, with the materials, which have implications, obviously, to the safety.

But, so I think that the High Temperature Gas Reactors need to be on the horizon, but I think the bridging technology, to get from where we are to that is to implement the next evolution, not revolution, of technology, to sustain the infrastructure, to allow us to implement the Gen IV reactors.

Mr. ROHRABACHER. Well, it sounds like——

Chairman GORDON. The gentleman's time has expired, but Admiral, it looks like you—are you trying to get into this? Do you want to say something quickly?

Vice Admiral GROSSENBACHER. Yes, sir, I just wanted to add, and you know, we are, certainly my laboratory believes that, yes, High Temperature Gas Reactor technology has a lot of potential. I don't think the Japanese engineers lied to you. I think they implied a degree of maturity in the technology that is not there yet. It holds a lot of promise. The issue is, you got to finish developing the technology. You got to show that you can make this fuel, and make it reliably, and billions and billions of times. The other is the market for these machines, these reactors. They, big, light water reactors are very good at generating electricity, and they are very inexpensive in the U.S. context. These reactors, the High Temperature Gas Reactors, are really focused in a different market, which is the high temperature process heat applications, including how you make hydrogen.

In point of fact, a market that doesn't exist yet. So, you know, we are committed, and the Department of Energy is committed to developing that technology, and resolving those issues, and this is what we call reactor after next technology. It is not as mature, I guess.

Chairman GORDON. Thank you. We will have a second round. And Mr. Rohrabacher, for your information, Mr. Bilbray had asked unanimous consent that your self-commission be concurred, but I would not consent to that, so—but I will recognize him for a second round.

THE FUTURE OF NUCLEAR TECHNOLOGY

Mr. BILBRAY. Always willing to support my fellow surfer down there, whatever his motion is.

Admiral, you know, do you believe that there is going to be a resurgence of the nuclear use and technology in the world?

Vice Admiral GROSSENBACHER. Yes, sir, I do, and if I can just make one point. When we discuss other choices for energy, you have to consider the density of the source, and if you are providing energy for a large, industrial activity over a large population center, certainly, we want to do everything we can with efficiency, because the cleanest megawatt is the one that is never used. We certainly want to do everything we can with renewables and distributed sources, but as I mentioned in my opening remarks, we have chosen a very energy dense path. Today, we satisfy the high concentration needs with hydro, with fossil fuel, and nuclear, and there are challenges associated with all those, all three, when I add up the pluses and minuses, I think there is an important future for nuclear energy.

Mr. BILBRAY. Do you agree that it is important, and in fact, it is almost echoing what Dr. Cochran said about the fact that other countries getting into nuke without the kind of oversight we have in this country, do you believe it is not only essential for us as Americans to be involved in this, but also, in the issue of being involved in what technology and how this technology is being used around the world?

Vice Admiral GROSSENBACHER. Yes, I do. We need to be leaders in those processes.

Dr. COCHRAN. I will speak to that. I agree with that conclusion. However, our leadership is misdirected towards closing the fuel cycle, and developing a technology that simply has been demonstrated to be unreliable, and far more costly than even the light water reactors.

Mr. BILBRAY. Well, I understand that, Dr. Cochran. Admiral, there was discussion about the Federal Government's involvement in this industry. In the last 20 years, who has been the major purchaser of reactors within the United States?

Vice Admiral GROSSENBACHER. In the last 20 years? No one.

Mr. BILBRAY. Except the United States Navy, right?

Vice Admiral GROSSENBACHER. Yes, sir.

Mr. BILBRAY. Okay. I just want to say that while we have sort of pointed fingers over at industry on one side, we have been the major consumer of reactors, as the United States Government, and then, we wonder why is the Federal Government getting involved in this issue, when we have been the biggest consumer, the consumer for domestic sources.

That being said, is, when we—you know, and one of the things, I guess, that we need to point out, that I think there is sort of a, this concentration of energy being needed to be sited at a certain location, with the zero emission potential, is not just an issue for electricity. Hydrogen production, if we are ever going to go there, either has to depend on using natural gas, which is, in my opinion, it is going to be an essential transition fuel for global sources, or we are going to need to go to some way we can concentrate the energy for hydrogen and, for those of us in California, desalinization, which we are already seeing.

I don't know what other technology not only provides that option, but I think the one bum rap that I keep hearing is that when you look at the life cycle, the true costs, not the regulatory or legal costs, but the true costs, hydro where you can do it, wind generation where God has put it, and then nuclear. Overall, you compare that to the other costs life cycle, they, I don't think this is one of those issues where we have got to choose between the economy and the environment.

But my concern is this. We need to start shutting down major emitters of greenhouse gases now. We can't wait 20 years, 30 years. How do we shut down coal plants across this country without going to some kind of technology that is able to concentrate it down the line? So, let me just say this. We were looking at the cost.

Ms. Kray, what percent, you know, how much effect does government regulation and litigation and tort exposure have to do with the overall costs, and I would only, and then, I would turn around and say, Dr. Cochran, one of my concerns is my state has outlawed one of the options that has been pointed out by the UN Council on Climate Change, has outlawed that technology. At the same time in California, we are talking about taking a lead on.

REGULATION AND INVESTMENT

So, let us talk about the regulatory, and I guess let me go back and say from the investment point of view, is it the regulatory and the tort issues that are the dark clouds on the horizon when you are talking to investors?

Ms. KRAY. And I, so the NuStart consortium was formed to address that. The, I mean, you can use the word—and recognize the failure of that investment process. So, that is what is on the minds of investors going forward.

And part of the changes in the licensing process that the NRC invoked was to address that, and to essentially pull forward all of that litigation risk before the tremendous capital investments are made, and that was not the case when the current fleet was built, where, in effect, you were pouring in your capital investment at the same time you were at the mercy of the regulatory process. So, that huge uncertainty still is in the minds of investors, whether it is from the utilities side, or from the financial community itself.

So, our belief is that with the revised Part 52 process, that that will improve that, but nevertheless, our objective is to demonstrate that by getting a license in hand, again, prior to making those huge investments, and to avoid the situation you are referring to.

Mr. ASSELSTINE. You are exactly right, Congressman. That concern is foremost in the minds of the investment community. We have a new process. I personally believe that process will work effectively. If you have essentially completed designs that the NRC has reviewed and signed off on at the outset, if you have an opportunity to go through, literally, all of the environmental and safety issues around the plant before you start construction, then the risk of a problem or a surprise down the road, particularly after the capital investment in the plant has been made, ought to be relatively low.

The problem is that we have got the new process, and it hasn't been tested, and until we get several plants through that process, and it performs as everyone intends, the financial community will look at that, and say there is a risk and an uncertainty here. What sets nuclear apart from every other alternative form of generation, is the requirement to go through the NRC licensing process. And so, that is the difference, and until we have a track record of successful performance from the new system, that uncertainty will be there.

Mr. BILBRAY. Now, I served on two environmental regulatory agencies, some of the best in the world, I think we would agree, and I have been proud to serve on those groups, California Coastal Commission and the Air Resources Board for California.

But getting back to the Admiral's statement about, we are talking about a concentration of energy generation, what we have seen here is also a concentration of capital and deep pockets that attracts the type of vultures who swoop down and are looking to take their pound of flesh, and becomes a huge target to be able to generate great revenue through regulatory obstructionism and legal proceedings. And we need to address that thing, Mr. Chairman. I guess what it really comes down to, is this attitude of just back off and let the system work, is the fact that we basically have, you know, tied this industry down, and then, based on the fact that they can't move, and then say why haven't they done more.

And I think there is a real challenge, that we have got to be more proactive on this, and as I stated before, don't think the other industries right now, or the fair-haired groups, aren't going to have litigation, and come to San Diego County, and take a look at the litigation against the links that are going to solar, wind, and geothermal. It is a huge uproar in a community that is very environmentally sensitive, so all of these things, in the long run, you are going to have a lot of baggage, and we need to be proactive, rather than reactive on it.

Thank you very much, Mr. Chairman.

Chairman GORDON. Thank you, Mr. Bilbray, and Mr. Rohrabacher is recognized for our final question.

MORE ON HIGH TEMPERATURE GAS-COOLED REACTORS

Mr. ROHRABACHER. Well, thank you very much. You know, I have been listening very closely here, and I just, it seems to me that what we have got here in the United States is a corporate mentality that is only interested in trying to make more money off the current status quo, and only a very short-term vision, and any vision that they have for the future is based, it is not being based on something new being in the picture. It is all based on status quo technology, and again, nuclear energy isn't all that new. We are talking about something, the fundamentals that were set down by what we are talking about, something that was designed by people who were educated before World War II. And it is basically 50-year-old technology that has been incrementally improved.

I think the idea of having, focusing our research on reprocessing plants that can help solve part of the problem is a good idea, but I would like to know, if we can't rely on corporate America to come, for innovations, on the other hand, rely on government policy, how much money has been going into research and development, federal dollars, in terms of developing this High Temperature Gas-Cooled Reactor concept, as compared to just incrementally improving this, the light water reactor concept?

Vice Admiral GROSSENBACHER. I can speak to, from the standpoint of the improvement of light water reactor technologies, there has been very little Federal Government investment in research and development. There is an ongoing effort for a cost-shared program with, between government and industry, so that the research tools of government can do what industry can't do, or doesn't have the capabilities to do to ensure the extension of that technology.

In terms of the High Temperature Gas Reactor, in the United States, the project that needs to deliver that capability is the Next Generation Nuclear Plant. There is an ongoing program to develop and demonstrate that technology, at a scale that will, then, convince commercial interests that this is something that they want to buy.

Mr. ROHRABACHER. Well, why is it that the Japanese have one of these working, and we don't?

Vice Admiral GROSSENBACHER. Well, they have a test reactor.

Mr. ROHRABACHER. That is correct.

Vice Admiral GROSSENBACHER. It is not industrial scale.

Mr. ROHRABACHER. It is a big reactor. I went there, and I went through the reactor myself.

Vice Admiral GROSSENBACHER. South Africa has an aggressive developmental program in this area, and again, we think, and I speak just from the standpoint of reactor technology, and our perspective at the Idaho National Lab, this is a very important future technology. It is also complicated. You have got to prove the fuel performance. You have got to prove that you can manufacture the fuel, and the fact that you can do it once in a test reactor, and not stress it, or demonstrate it at industrial scale, there is lots of uncertainties that have to be resolved. So, that refers to my comment, is perhaps the folks you talked to were a little bit aggressive in terms of their estimates of the maturity of the technology.

Having said that, Congressman, I am with you. I think this is an important technology, but reactors are not simple things.

Mr. ROHRABACHER. I believe, first of all, that the, as I say, the criticisms of the current system is justified. We have plutonium left over, and we have got waste problems, and we have got risks associated with it. I am dismayed that we have a situation where we have a potential alternative nuclear option that is not being fully looked at, that the Japanese and the Russians, of all people, are engaged in actually moving forward on this technology at a much faster pace than we are, and that we will be left behind, because of corporations' inability to basically, to look forward and have long-term strategies, and our government, which seems to be unfortunately, too tied to the hip to major U.S. corporations, that we are being dragged back, and not being able to make these investments in future technologies.

So, I think this is a great risk. I think we could wake up, look, I am the benefit, Mr. Chairman, we are the benefit of that World War II generation. My father helped develop the things that right now, and his generation, that are now solving the problems that we face today. But there are future problems, and unless we are the ones that are open to new ideas, rather than totally focused only on incremental improvements in the status quo, we will be left behind a generation from now, and our kids will not be the leaders of the future, as Americans have been for the last 30 and 40 years, based on the work of our parents.

So, I would hope that we live up to the Great Generation's challenge to us, and remain the world's leader, and energy is so important, and I believe that the High Temperature Gas-Cooled Reactor is an example of something that we should be putting maximum attention on, and instead, it is being pushed to the side and out of the picture. So, thank you——

Ms. KRAY. If I could comment on that.

Mr. ROHRABACHER. Sure.

Ms. KRAY. I would agree that the U.S. has fallen behind in its leadership of the nuclear industry.

Mr. ROHRABACHER. Right.

Ms. KRAY. But at the same time, I think we have a very similar view of the High Temperature Gas-Cooled Reactor, as does the

Asian market, particularly Japan. I think we both see it as prototype, somewhat developmental in nature, through Admiral Grossenbacher's theory is we need to look at the fuel characterization and the materials issues, but if you look at what Japan is building and purchasing now, it is not High Temperature Gas Reactors. They are building the light water advanced reactors.

Mr. ROHRABACHER. Yeah, they have got the same problems with their corporations that we do.

Ms. KRAY. Well, and I think, and again, when we put out a request for proposal for additional baseload power, we are, we do not limit it to anything. We will get coal, any renewable and nuclear, and within the nuclear family, whoever responds, the answer is there was no response of the High Temperature Gas-Cooled Reactor, and that is because it is not yet ready for the commercial deployment. But we are hopeful that, as we sustain this infrastructure, there will be deployment of HTGRs, whether it is for electricity production, or some of the other benefits that it can provide.

Mr. ROHRABACHER. Well, I will be going to Russia to look at their operation, and some of the issues that you have brought up, and I think this really deserves the attention of the Committee, and I thank you very much for giving me this time.

Chairman GORDON. The gentleman's time has expired. I know, Dr. Cochran, you would like to continue, but let me say this. You have been an excellent panel. We have not closed the record. This is not the extent of this dialogue. This is one that we want to continue. It needs to, we need to continue. There are not easy answers here. We are all going to have to talk about it in a collaborative way. And we will continue on this committee to do that.

So, under the rules of the Committee, the record will be held open for two weeks for Members to submit additional statements and any additional questions they might have for the witnesses.

And the hearing, but not the subject, is adjourned.

[Whereupon, at 12:25 p.m., the Committee was adjourned.]

Appendix:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Marilyn C. Kray, Vice President, Exelon Nuclear; President, NuStart Energy Development

Questions submitted by Representative Ralph M. Hall

Q1. Ms. Kray, have NuStart's members seen any NIMBY opposition or environmental opposition to their proposed nuclear plants?

A1. While some opposition has emerged, it has not been significant. In fact, NuStart members have uniformly seen strong support from State and local stakeholders surrounding potential new plant sites.

Positive relations with the community surrounding a nuclear plant is a primary goal of Exelon as well as of other NuStart member utilities. For Exelon, we strive to be a valued member of the community through our charitable contributions as well as through the contributions of our employees who serve on boards, coach sports teams and are active in other service areas.

The nuclear industry routinely polls the public regarding its opinion on nuclear energy. The April 2008 survey conducted by Bisconti Research, Inc. reported that 63 percent of those polled favor the use of nuclear energy, while 33 percent oppose. This percentage is approximately the same as a survey conducted in October 2007 but down from a peak of 70 percent favorable in 2005.

In selecting a site for a potential new plant, community support is one of many factors that are considered. When NuStart selected its sites for the DOE Nuclear Power 2010 Program, we received positive feedback from the communities of all six of the finalist sites. Similarly, Exelon has been welcomed by the local community of its selected site in Victoria County, TX. To date, resolutions in favor of a new plant have been passed by the City of Victoria, the Guadalupe-Blanco River Authority, the Victoria Chamber of Commerce, the African American Chamber of Commerce of Victoria, the Victoria Economic Development Corporation and the Victoria County Commissioners' Court.

Support for a new plant is clearly not unanimous. The "not in my backyard" (NIMBY) sentiment is expected in each of the planned licensing proceedings. The NRC licensing process, however, is keenly focused on soliciting public opinion and offering ample opportunities for public involvement. These opportunities include public meetings that are held at various stages of the licensing process, starting even before an actual application for a new plant has been submitted. The NRC licensing process also includes the opportunity for formal intervention in the hearing proceedings. To date, the two lead Combined Construction and Operating License Applications (COLAs), TVA's Bellefonte COLA and Dominion's North Anna COLA, have each received petitions to intervene.

Q2. Ms. Kray, how long has the industry been engaged in programs to attract a skilled workforce? Has it been a success?

A2. Since the industry's inception, nuclear utilities have been conducting programs to attract and retain a skilled workforce. These efforts have been accelerated recently in anticipation of the potential addition of new nuclear plants to the U.S. fleet and have led to an increased focus on identifying, recruiting, and training workers to meet a variety of needs related to plant design, construction, engineering, and operations.

The issue of workforce development is of particular interest to the nuclear utility industry given that the median worker age in the nuclear utility industry is over 48 years which is higher than that of the national average. Further, as much as 35 percent of the incumbent nuclear utility workforce may be eligible to retire within five years.

Today, the typical nuclear plant employs 400 to 700 people, and jobs at these plants pay substantially more than average salaries in the local area. For example, the median salary for an electrical technician at a nuclear power plant is $67,517; for a mechanical technician, $66,581; and for a reactor operator, $77,782.

Utilities have been working together through the Nuclear Energy Institute (NEI) and have sponsored individual initiatives and programs in their local areas of interest. Through NEI, the industry is working with organized labor, government, educational institutions and nonprofit organizations.

On a company level, Exelon has taken a number of actions to address the workforce issue. These range from direct financial contributions to targeted engineering institutions to working with a local community college to develop a two-year program to prepare students for employment opportunities in power generating facilities. To address our potential need in Texas, the site of our proposed new plant, Exelon is involved in outreach efforts at the local high schools to encourage students to pursue careers in the nuclear power industry.

While the challenge remains, preliminary results are positive. An industry survey conducted in 2007 found a 34 percent increase in the number of young engineers 18 to 27 years of age working in the utility workforce from 2005 to 2007. During the same period, operations personnel 18 to 27 year of age increased 33 percent.

Question submitted by Representative Adrian Smith

Q1. Could you please address challenges associated with nuclear waste transport and any reform needed to streamline the process or improve its safety?

A1. Allow me to address the question of safety first. While accidents can and do happen, the safety record of transport of used nuclear fuel in the United States and throughout the world is excellent. Nearly 3,000 shipments of used fuel have been transported in the United States since the early 1960s. Overseas, more than 650 shipments are made each year in Britain and France alone. Several minor vehicle accidents have occurred involving these shipments, but *none has resulted in the release of radioactivity to the environment.*

The Nuclear Regulatory Commission (NRC) is responsible for licensing the shipping packages used in the United States and for the security of used fuel transport. The Department of Transportation (DOT) oversees package labeling, manifest and content. State and local authorities provide escort and inspection services as required. Coordination of these entities is generally performed at the state level with the involvement of state police troops and state governmental agencies.

From a safety standpoint, Exelon believes satisfactory controls are in place at the federal, state and local levels to ensure that transport of used nuclear fuel can be accomplished safely. Continuing dialogue between the states—under the auspices of the Council of State Governments and the Department of Energy (DOE)—is helping to communicate the State and local responsibilities and to prepare emergency response organizations.

Regarding streamlining the process, Exelon believes there are a number of issues presenting bottlenecks to used fuel transport. One simple logistics example is that individual states have the option of designating "preferred routes" and entrance/egress inspection requirements for the transport of used nuclear fuel. Unfortunately, "preferred routes" may not be contiguous between bordering states, and State/local inspection requirements may unnecessarily delay transport and potentially create security risks. Reforms at the federal level may be able to reduce this bottleneck and potential security risk.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Robert Van Namen, Senior Vice President, Uranium Enrichment, United States Enrichment Corporation Inc.

Questions submitted by Representative Ralph M. Hall

Q1. Mr. Van Namen, in Dr. Cochran's testimony he said that one of the negatives of nuclear power is that it "has significant unresolved health and environmental problems associated with uranium mining." Do you have any thoughts on that statement?

A1. As with any conventional energy source, the feedstock for nuclear fuel must be obtained by extracting it from a country's natural resources. During the past several decades, U.S. uranium miners have progressed substantially in their responsible stewardship of the mines while decreasing the negative effects of their operations on local communities.

Today's mines are highly regulated by the U.S. Environmental Protection Agency, the U.S. Nuclear Regulatory Commission (or the equivalent state agency in Agreement States), the U.S. Department of the Interior's Bureau of Land Management, and the U.S. Department of Labor's Mine Safety and Health Administration. Mining of uranium and other natural resources in the United States is also regulated at the State level.

The benefits gained by extracting this powerful natural resource through conventional and leach mining techniques greatly outweigh the minimal health and environmental effects caused by today's uranium mining practices. In fact, most mines in operation today, or that will come online in the future, will be required to return the mine site as close as possible to its original condition and to remove or remediate any remaining byproduct material.

What Dr. Cochran is probably referring to are the effects of the legacy wastes left over from U.S. Government mining operations during World War II and the Cold War at abandoned mines in the western part of the United States, when national security needs were a high priority. Today, the highest priority of our nation's commercial uranium industry is safety, as well as environmental and health protection that has reduced concerns in these areas.

Q2. Mr. Van Namen, will you tell us about the supply of uranium and if there are any foreseen supply problems for the projected worldwide nuclear plants? Do you think reprocessing is necessary from a uranium supply standpoint?

A2. The increase in price for natural uranium has spurred the rapid prospecting for and development of new uranium mines around the world. Mining companies in the United States, Australia, Canada, Kazakhstan and several African nations have begun preparing for new production to meet an anticipated need for additional natural uranium. Most market participants expect that existing mines, new mines and legacy supplies, such as those held by the U.S. Department of Energy, will be able to meet any growth in demand for the foreseeable future.

The majority of the new uranium production expected to come on line in the next several years will come from expansions to existing operations or re-opening mines that were put into standby mode during a period of low prices. The permitting and development process for a new mine can take as much as 10 years to bring a deposit into production.

Uranium reprocessing is not necessary to meet the needs of the existing or planned nuclear plants over their lifetimes based on known available resources of uranium. However, given the potential long-term economic and environmental benefits of recycling nuclear fuel once it has gone through the reactor, reprocessing nuclear fuel is clearly a technology that should be pursued. Reprocessing allows for the recapture of approximately 90 percent of the original energy content in the nuclear fuel that has been used in a nuclear reactor. Clearly, the opportunity to capture that energy potential with a corresponding reduction in the quantity of spent fuel is attractive. The key is that we must invest now to develop the best possible reprocessing technologies that meet non-proliferation, environmental and economic objectives.

Q3. Mr. Van Namen, how many mines are there in the U.S.? You mentioned in your testimony that domestic mines supply 18 percent of the natural uranium purchased by U.S. reactor operators. Are there more uranium supplies that could be mined? Are there any barriers towards mining in new locations? What is our country's uranium supply in terms of years of use?

A3. As the accompanying chart indicates, the Energy Information Agency of the Department of Energy reports that there are currently 12 sources of uranium currently in operation in the United States producing about 4.5 million pounds of U^{308}. Other sources of U.S. produced uranium include government stockpiles, industry inventories, and processing of uranium tails at the enrichment plants.

There are many known sources of uranium in the U.S. that can be mined, and there has also been a sharp increase in exploration activity in search of new resources. Known domestic reserves of uranium, as reported by the EIA, are estimated at 890 million pounds U^{308}, enough to supply the current reactor fleet for 18 years. The OECD/IAEA "red book" reports prognosticated resources for the U.S. at about four times the estimated reserve level (note that reserves are estimated at $50/lb cost for U^{308}, and would be higher at higher market prices).

The primary barrier to uranium production is obtaining the numerous permits required to bring a discovery to production. There is at least one State, Virginia, which currently does not allow uranium mining. One of the largest high quality uranium deposits in the North America is located in South-Central Virginia, North of Danville. At present, development of this project is on hold pending efforts to change Virginia's statues to allow this project to proceed to the regulatory phase.

U.S. Uranium Mine Production and Number of Mines and Sources

Data for 2007
Report Date: May 13, 2008
Next Release Date: May 13, 2009

Table 2. U.S. Uranium Mine Production and Number of Mines and Sources, 2003 - 2007

Production / Mining Method	2003	2004	2005	2006	2007
Underground					
(estimated contained thousand pounds U_3O_8)	W	W	W	W	W
Open Pit					
(estimated contained thousand pounds U_3O_8)	0	0	0	0	0
In Situ Leaching					
(thousand pounds U_3O_8)	W	W	2,681	4,259	W
Other[1]					
(thousand pounds U_3O_8)	W	W	W	W	W
Total Mine Production					
(thousand pounds U_3O_8)	**E2,200**	**2,452**	**3,045**	**4,692**	**4,541**
Number of Mines Operated					
Underground	1	2	4	5	6
Open Pit	0	0	0	0	0
In Situ Leaching	2	3	4	5	5
Other Sources[1]	1	1	2	1	1
Total Mines and Sources	**4**	**6**	**10**	**11**	**12**

[1] Other includes, in various years, mine water, mill site cleanup and mill tailings, and well field restoration as sources of uranium.
E = Estimated data.
W = Data withheld to avoid disclosure of individual company data.
Notes: Totals may not equal sum of components because of independent rounding. Table does not include byproduct production and sources. The 2003 annual production amount was estimated by rounding to the nearest 200,000 pounds to avoid disclosure of individual company data.
Source: Energy Information Administration: Form EIA-851A, "Domestic Uranium Production Report" (2003-2007)

http://www.eia.doe.gov/cneaf/nuclear/dupr/umine.html

Q4. Mr. Van Namen, what step of the fuel cycle needs the most help or the most protection from the U.S. Government?

A4. Two parts of the fuel cycle need U.S. Government assistance.

First, a comprehensive solution for managing the long-term storage of existing and future used fuel from commercial reactors needs to be implemented. The U.S. Government, specifically Congress, needs to come to agreement and take action about the best way forward towards achieving a responsible, sustainable storage solution. The lack of a viable solution may eventually prevent the expansion of nuclear power in the country as utilities may be reluctant to increase their use of nuclear power until they know that the used fuel generated by their current and future plants will have a disposition path.

Second, the domestic uranium enrichment industry needs protection from unfairly priced enriched uranium supplies that could be dumped onto the U.S. market by the government-backed Russian nuclear fuel conglomerate. In addition, the U.S. Government's Title XVII loan guarantee initiative for innovative technologies includes a provision for $2 billion in guarantees for U.S. fuel cycle facilities. Timely implementation of this initiative is a critical action to support deployment of advanced uranium enrichment technologies to meet the fuel needs of the current reactor fleet over their remaining lifetimes and the new reactors currently in development.

Questions submitted by Representative Daniel Lipinksi

Q1. You mention in your testimony that the U.S. gave up our industry leading position on nuclear technology long ago. Can you elaborate on this and explain in what ways other countries have taken the lead? As leaders in the field, what advantages have these countries gained?

A1. While the United States brought the commercial use of nuclear energy to the world, our leadership role has slowly eroded since the 1980s. This decline reflects a complicated interplay of several factors including economics, politics, activist positions of environmentalists and the industry's own lack of assertiveness in correcting many of the misconceptions that grew from the accident at Three Mile Island and the subsequent cancellation of orders for nuclear reactors in the following decade.

With little domestic industry growth to support U.S. nuclear companies, many closed, shifted focus from development and construction to maintenance services, or were sold to foreign firms who utilized American expertise and technologies to capture a dominant role in the world market as other countries continued their expansion of the technology. This decline was accompanied by a loss of jobs spanning a range of skills.

As America plans to build new reactors, U.S. utilities must turn to foreign vendors for a majority of the necessary components, manufacturing and project expertise because no American company has built a reactor in almost three decades. This reliance adds costs and risks to our attempt to increase our sole emissions-free baseload electricity source at a time when our economy is increasingly driven by information technology and service industries.

Without the indigenous capacity to build a nuclear plant, we can no longer direct our own path to a reduced-carbon future. It is time for the United States to take back its leadership role by promoting the use of nuclear energy through the actual construction of new plants and fuel cycle facilities, by advancing the use of U.S. technologies around the world and by continuing to innovate and commercialize advanced nuclear technologies such as advanced reactor designs and reprocessing technologies.

Our American Centrifuge uranium enrichment plant is a perfect example of this new path. Based on U.S. gas centrifuge technology that USEC has substantially improved during the past six years, the American Centrifuge machine will be almost five times more productive than the next best machine commercially deployed in the world today. The last U.S. enrichment plant was constructed more than 50 years ago and today we pay the price of relying on an outdated, energy-intensive process that most of the world abandoned decades ago. By utilizing U.S. technology, manufacturers, and the labor force, USEC's project has taken the first steps towards reasserting America's leadership role in the worldwide nuclear industry.

Similar efforts should be championed at other American companies if we are to again be the world's leader in this vital sector that will power the low-carbon world of the future.

Q2. You mention that the Converdyn plant in Illinois recently expanded to allow it to meet about 80 percent of annual U.S. demand. Where does the other 20 percent come from? And are any plans underway to meet this remaining demand domestically?

A2. U.S. demand for conversion is currently met by sources from around the world, primarily the Metropolis, Illinois plant whose product is marketed by Converdyn and by a plant in Canada operated by Cameco. While it would probably be feasible for the Illinois facility to be expanded again (it was recently expanded to its current capacity), it is unlikely that this will be the case until more demand develops in the United States.

The President of Converdyn has indicated publicly in recent months that the company may instead consider building a new facility in Europe or Australia in order to balance conversion supply geographically with enrichment or in large uranium production centers such as Australia. However, any number of nuclear companies could also consider building a new conversion facility in the United States using similar technology if the demand, typically aligned with enrichment capacity, is present. Conversion capacity, as well as centrifuge based enrichment capacity, can be built in a shorter timeframe than the nuclear power plants that they would support which significantly reduces the risk of a supply shortfall resulting from expanding the nuclear fleet.

ANSWERS TO POST-HEARING QUESTIONS

Responses by James K. Asselstine, Managing Director (Retired), Lehman Brothers; Former Commissioner, Nuclear Regulatory Commission

Questions submitted by Chairman Bart Gordon

Q1. In your testimony, you describe current federal incentives for nuclear power as essential to enabling utilities to build new plants in the U.S. If you were still with Lehman Brothers today, would you recommend that the company use its resources to finance a new nuclear plant which takes advantage of the current incentives over a standard natural gas or coal plant? If similar applicable incentives were offered to comparable-scale renewable projects, such as large-scale wind farms in the Northeast or solar thermal plants in the Southwest, what recommendation would you make? If all incentives were removed and a strong carbon cap-and-trade system were implemented, would your recommendation change?

A1. I believe that the package of incentives for nuclear power contained in the *Energy Policy Act of 2005,* if properly implemented, effectively offsets the risks and uncertainties associated with building an initial group of new nuclear power plants in the United States. Taken together, these incentives, along with appropriate contractual arrangements between the plant's owners and the plant vendors, should help to make a new nuclear power plant competitive economically with other forms of generation, including coal and gas-fired power plants and renewable energy resources. Accordingly, were I still with Lehman Brothers, I would recommend that the firm support the financing of a new nuclear plant. As a full service investment bank, Lehman Brothers works with its corporate clients to execute their equity and debt financing needs in the capital markets, advises its institutional investor clients as they consider alternatives for their equity and debt investments, and uses the firm's own capital to make direct investments where the firm sees attractive opportunities. I would recommend that the firm consider supporting a new nuclear plant investment in this country through some or all of these financing roles.

In my view, the growing consensus on the effects of greenhouse gas emissions dictates that in the electricity sector we aggressively pursue a strategy of energy conservation and enhanced diversity in our electric generation mix. Conservation measures offer the promise of reducing the growth in electricity demand, and may provide the lowest cost alternative for reducing greenhouse gas emissions. Several states are providing or developing incentives through the rate-setting process for utilities to reduce electricity demand, and these initiatives should be encouraged. Nevertheless, although added conservation measures can reduce the growth in electricity demand, I doubt that they can eliminate the need for additional generation resources, at least for the foreseeable future.

Nuclear power and renewable energy resources both provide the opportunity to add new generating capacity to the system without adding to greenhouse gas emissions. As I discussed above, I believe that the existing federal incentives, if properly implemented, will make a new nuclear plant economically competitive with other available generating alternatives. Like gas and coal-fired power plants, nuclear plants are baseload generating facilities, and therefore are available to operate essentially all the time except for relatively brief refueling outage periods. In general, the U.S. generating mix is becoming short of baseload generating capacity, and there is a need to add more baseload facilities. The principal drawback of nuclear is the large initial capital cost of the plant and the long lead time for planning, licensing, building, and commissioning the plant. Given the size of the U.S. utility industry and the relative size of the individual companies, I believe that a target of adding 25–30 new nuclear plants over about the next 20 years is realistic and achievable. This would effectively maintain nuclear power's share of our generating mix at about the current level of 20 percent and provide some additional greenhouse gas-free baseload generating capacity. In my view, new renewable energy resources such as wind, solar, and geothermal, should also be encouraged and supported. More than half of the states now require that the utilities obtain a growing percentage of their electricity requirements from renewable energy resources, and these requirements will lead to further renewable energy resource development. Like the initial new nuclear units, renewables tend to have somewhat higher economic costs than fossil-fired generation. Accordingly, renewables may require continued economic incentives such as production tax credits and federal loan guarantees to remain competitive at least for the near-term. This is particularly true for wind and solar plants, which operate at lower capacity factors than baseload plants, and therefore are not available to operate all of the time. A strong carbon cap-and-trade system will likely have a positive effect on the economics of nuclear power and renewable energy resources. Depending upon how the system is structured and how emissions credits are allocated, the economic benefits of a carbon cap-and-trade system could reduce the need for financial incentives for nuclear and renewables at some point in the future, but until the detailed elements of a cap-and-trade system are adopted, in my view, it is too soon to tell whether such a system can replace the economic incentives for nuclear power and renewables.

Like nuclear, coal provides a reliable and low cost (in terms of fuel and operating costs) source of baseload generation, and this country benefits from abundant coal resources. But, conventional coal plants are a major contributor to greenhouse gas emissions. I believe that plants using clean coal technology to reduce greenhouse gas emissions should be encouraged, as should research and development of carbon sequestration technologies. Because of differences in views within the industry concerning the reliability of commercial scale clean coal technology, and because initial plant costs are likely to be comparable to the initial nuclear units, financial incentives will likely be needed for the first group of clean coal plant projects as well. These incentives were provided in the *Energy Policy Act of 2005* and, if properly implemented, should encourage the development of clean coal technology. These plants, together with a group of new nuclear units, can provide needed new baseload generating capacity and help replace some of the older coal units in this country that are among the largest current emitters of greenhouse gases. Like nuclear and renewables, clean coal technology could also benefit from a strong carbon cap-and-trade system.

Finally, natural gas is likely to provide a growing contribution to our electric generating mix in the future, and the more efficient combined cycle plants can function as baseload generating facilities. Although gas-fired plants contribute to greenhouse gas emissions, their emissions are considerably lower than those from conventional coal-fired plants. Further, due to their low initial capital cost and short construction periods, new gas plants can be financed using conventional means without the need for federal incentives. But, as we have seen in recent years, actual production costs for gas-fired generation can vary widely due to severe price fluctuations in natural gas prices brought about by supply and demand considerations. Because new gas-fired plants can be built relatively quickly and cheaply, they are likely to become the utilities' primary choice to fill the short-term gap between electricity supply and demand after taking into consideration the benefits of conservation, and the contributions from renewables, new nuclear and clean coal baseload units.

Questions submitted by Representative Ralph M. Hall

Q1. Mr. Asselstine, in Dr. Cochran's testimony he quotes a report by the Union of Concerned Scientists that says "the NRC is not adequately enforcing the existing standards." He goes on to state in his testimony that "the biggest barrier to significant improvement of U.S. nuclear plant safety is the poor safety culture of the NRC." As a former NRC Commissioner, do you agree with those statements?

A1. No, I do not. In general, I believe that the NRC is appropriately focused on ensuring the adequate protection of the public health and safety, and security. I believe that the NRC's safety culture is sound, and that the agency does an effective job in enforcing its existing safety standards. In my view, the steady and significant improvement in the regulatory and reliability performance of our 104 operating nuclear units over the past decade is evidence of the effectiveness both of the industry's operation of the plants and the NRC's regulatory performance. From time to time, operating experience at the plants has disclosed the need for additional operating initiatives by the industry and additional regulatory oversight by the NRC. This was the case a few years ago with the reactor vessel head inspection and material condition issues identified at the Davis-Besse plant. In this and other cases, I believe that the industry and the NRC have responded effectively to the need for additional safety and regulatory improvements.

Q2. Mr. Asselstine, in your testimony you mention the loan guarantee program established under Title XVII of the EPAct 2005. In your opinion do DOE's implementing regulations for the loan guarantee program provide lenders the assurance they need to offer loans for the first wave of plants?

A2. Yes, I believe that in general, DOE's implementing regulations provide an adequate basis for lenders to participate in the loan guarantee program for a new nuclear plant. Nevertheless, a number of significant additional actions by DOE are needed to implement the new loan guarantee regulations, and the outcome of these actions will determine the workability and attractiveness of the loan guarantee component of the federal incentives for new nuclear plant development. In my view, the review by the DOE Loan Guarantee Program Office of individual loan guarantee applications, as well as DOE determinations of the subsidy cost for providing a loan guarantee, should provide us with additional insights on the cost and workability of the loan guarantee program.

Q3. Mr. Asselstine, in your testimony you point out that continued successful implementation of all three financial support components in EPAct 2005 is essential for firm orders for new plants. It is my understanding the applications for new plants must be filed before the close of 2008 for qualification of the production tax credits. Due to this deadline are additional tax credits or incentives needed for continued participation by the investing and lending communities?

A3. I do not believe that additional tax credits or incentives are needed at this time for continued participation by the investing and lending communities. Your understanding is correct that in order to be eligible to receive a production tax credit for a new nuclear plant, the sponsor of the proposed plant must have submitted an application for a combined construction and operating license (COL) for the plant with the NRC by the end of 2008. A number of companies have either already submitted their COL license applications or stated their intention to submit their applications by the end of this year. Thus, by the end of this year, I suspect that a substantial number, and perhaps most, of the new proposed nuclear units will have established their initial eligibility to receive the production tax credit, and it will be possible to calculate the minimum amount of the production tax credit that each plant would be eligible to receive. (The plant's sponsor will need to achieve certain other milestones over time to maintain the plant's eligibility for the production tax credit.) A sponsor for a new nuclear plant need not have placed a firm order—that is, entered into a contract to purchase the plant—at the time that the NRC license application is filed. These orders for new plants in most cases, will probably be placed at some point during the NRC licensing process when the project sponsors and their investors have gained some experience with the licensing process and as developments progress on the other financial incentives.

Q4. Mr. Asselstine, in EPAct 2005 we provided what you refer to as three complimentary financial support provisions (tax credit, stand by support, and loan guarantees). Are there improvements to these provisions or additional provisions that would improve the likelihood of success?

A4. I continue to believe that the package of financial incentives provided in the EPAct 2005, if properly implemented, are sufficient to bring about the development of a new group of nuclear power plants in this country. Accordingly, I do not see the need for additional statutory provisions or improvements to the existing provisions at this time. If the development of new nuclear plants is to be successful, it will depend upon the industry's performance in negotiating reasonable contracts for the plants, the NRC's performance in executing the licensing process for the new plant applications, and DOE's performance in implementing the financial incentive provisions. This is especially the case with the loan guarantee program, where key steps and actions are yet to be completed by DOE. Additionally, as we gain some experience with DOE's implementation of the loan guarantee program over the next one to two years, it should be possible to determine whether there is a need for additional funding authorizations and appropriations beyond those now in place for loan guarantees for renewables, clean coal technology, and new nuclear plants.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Thomas B. Cochran, Senior Scientist, Nuclear Program, National Resources Defense Council, Inc.

Questions submitted by Representative Ralph M. Hall

Q1. Dr. Cochran, you mention MIT's nuclear study in your testimony and that it estimated that the cost of electricity generated by a new merchant nuclear plant would be 60 percent higher than that of a fossil fuel plant. Do you know what the comparison would be if the fossil fuel plants had CCS technology installed?

A1. In December 2006 IEA estimated "typical cost of CCS [carbon capture and storage] in power plants ranges from U.S. \$30 to 90/tCO_2 or even more, depending on technology, CO_2 purity and site . . .. Assuming reasonable technology advances, projected CCS cost by 2030 is around \$25/tCO_2 . . .. CO_2 separation cost from natural gas wells may be as low as \$5–15/tCO_2." (*http://www.iea.org/textbase/techno/essentials1.pdf*). CCS costs can also be reduced when done in conjunction with enhanced oil recovery.

In the MIT study, based on modeling performed in 2003, new nuclear merchant plants were estimated to become competitive with coal and gas (assuming high gas prices) at carbon emission costs of about \$100/tonne of C (\$27/tonne of CO_2). (MIT, *Future of Nuclear Power,* 2003, p. 7.) This would be near the low end of IEA estimates of the cost of CCS. Since 2003 the estimated cost of new nuclear plants has doubled and is still climbing, and the cost of fossil fuels has similarly increased. It is more important to get federal energy policy right than it is to try to predict future winners in a changing energy market. With regard to getting the policy right Congress should: a) internalize the societal cost of greenhouse gas emissions primarily by limiting CO_2 and other greenhouse gas, b) support demonstration of CSS options, and c) cease subsidizing new nuclear power plants. Nuclear power is a mature electricity generating technology. The federal subsidies going to new nuclear plants are not going to bring down their costs and are penalizing alternative technologies that can provide climate change mitigation more quickly, safely, at less cost, and with fewer environmental harms than building new nuclear power plants.

Q2. Dr. Cochran, you state in your testimony that new nuclear plants would not be cost competitive with electricity from wind or solar. Is this comparison done with or without the production tax credit given to renewable forms of energy?

A2. The comparison is without the production tax credit (PTC). Solar thermal is a promising near-term cost competitor to nuclear, following behind energy efficiency, wind, geothermal, biomass, and high-efficiency gas.

There are two kinds of solar cost projections: 1) current costs with and without federal PTCs and State incentives, and 2) solar cell manufacturing cost projections based on bringing the industry to scale. Rooftop photovoltaic (PV) solar in California, including federal and State incentives, is now competitive with grid-delivered peak electricity at 13.5 cents per kWh (this was for a recently completed SunEdison project in Southern California). Thus, with current incentives, rooftop PV solar is competitive now with peak delivered electricity rates in a few parts of the country with supportive policies, such as California and New Jersey.

With respect to unsubsidized future solar costs that would compete with nuclear electricity in the 2015–2020 timeframe, a number of thin film and concentrating PV manufacturers, and independent industry analysts, are projecting solar cell costs of \$1 to \$5 per peak watt, which would clearly make rooftop solar competitive without subsidies with the current delivered retail costs of nuclear electricity. However, getting to these low costs requires scaling up production and installation capacity, and hence a PTC or some other type of investment tax credit (ITC) to help bridge the gap between current and projected costs. Since non-renewable and costly nuclear already has an eight-year PTC for the first 6,000 MWe of new capacity, there is absolutely no logic or merit in denying the same treatment to renewable solar technologies.

For solar thermal plants, which are more directly comparable to nuclear plants, the industry is projecting a decline from 15 cents today to about 10 cents per kilowatt hour at the busbar (including 6–12 hours of energy storage) between now and 2015 if production capacity can be scaled up. Several such plants are now under construction around the world, and most observers feel the technology has immense near-term potential. In the U.S. the concentrating solar thermal power (CSP) industry currently has access to a \$10 billion pool of DOE administered federal loan guarantees for renewable energy and transmission projects—less than half the current

$20.5 billion pool for nuclear reactor and enrichment technology projects—and it can negotiate long-term power supply contracts with utilities and other large customers that make the economics quite transparent and workable. A PTC will make these projects more attractive from an investment perspective and hasten the scale-up of the industry, but this might be needed for only five years or so. Thus, it is reasonable to assume that at 15 cents per kWh CSP plants are competitive now with some of the higher projections of nuclear power busbar costs, and CSP costs are projected to come down as industry manufacturing capacity is increased to around 10 cents per kWh at the busbar within five to seven years. This would make CSP cheaper than most projections of the cost of electricity from new-build nuclear plants.

Of course, since it is centered in the desert Southwest, the CSP resource is a good substitute for nuclear (and coal) in that region, and in neighboring markets where the power can be economically and efficiently transmitted, such as to California, the Rocky Mountain West, and Texas. Obviously, CSP technology, which relies on direct solar radiation, is not an answer for cloudier regions of the country, such as the Northeast, Midwest and Southeast. Photovoltaic technology is appropriate in these regions, along with wind, electrical end-use efficiency, wave and tidal energy, industrial waste-heat cogeneration—a large underutilized resource—and biogas. If the cost of low-carbon electricity using each of these sources is less than new nuclear plants, we should exploit them for carbon mitigation to their fullest extent before turning to new-build nuclear plants. Increased end-use efficiency alone can free-up more additional megawatts than all of the nuclear power plants currently proposed to be in operation by 2020, and at far less cost (less than five cents per kWh), so that is where we should turn first before throwing tens of billions of dollars at new-build nuclear power plants. Under a carbon cap and trade scheme, their time as an economically preferred option may eventually come as fossil-fueled baseload power options increase in cost and the nuclear industry figures out a way to standardize components and major subsystems and apply modern assembly line techniques to reactor production. But renewable energy technologies will also be improving and reducing costs as well. Congress should not seek to dictate a place for new-build nuclear by subsidizing its way back into the marketplace.

Q3. Dr. Cochran, do you think the Federal Government should be spending any money on nuclear programs or nuclear R&D?

A3. Yes. There is an appropriate role for federal funding of energy technologies, including but not limited to: a) R&D on technologies that are in the national interest, but whose development is too risky financially, or where the time to commercialization is too long to interest the private sector in funding the needed R&D, and b) subsidizing deployment of worthy technologies in order to scale up production capacity for the purpose of reducing unit costs, e.g., subsidies discussed in the response to Question 2 above.

I support: a) R&D and qualification of a high-burnup uranium-seed, thorium-blanket fuel for use in light water reactor (LWR) operating on a once-through fuel cycle, b) development of a smaller standardized transportable modular reactor LWR design of around 300–500 MWe that could be flexibly deployed and retrieved, c) construction of the very high-temperature gas-cooled reactor demonstration plant, the so-called New Generation Nuclear Plant (NGNP), and d) R&D on advanced safeguards technologies.

A crude nuclear device constructed with highly enriched uranium (HEU) poses the greatest risk of mass destruction by terrorists. Current Radiation Portal Monitors (RPMs) installed at ports and border crossings and the next generation Advanced Spectroscopic Portals (ASPs) cannot reliably detect HEU. (See, Thomas B. Cochran and Matthew G. McKinzie, "Detecting Nuclear Smuggling," *Scientific American,* April 2008, pp. 98–104.) Thus, the Federal Government should place a much higher policy priority, and in some cases spend more funds, on securing and eliminating HEU sources worldwide. In this regard it should increase greatly the priority given to the development and deployment of alternative low-enriched uranium (LEU) fuel for the few remaining U.S. research reactors and the larger number of foreign research reactors now using HEU fuel. The Federal Government also should support the construction a domestic capability to make medical isotopes with LEU targets. Logically, this capability should be located at the University of Missouri, which currently makes medical isotopes in the University of Missouri Research Reactor (UMRR).

Finally, the Federal Government should support university-based nuclear physics, chemistry and engineering programs, not only to educate and train people going into the field of nuclear power generation, but to meet nuclear-related national and homeland security, nuclear medicine, nuclear waste management and disposal, and nuclear regulatory needs.

This is not an exhaustive list of nuclear energy R&D worth of federal support, but an even more comprehensive list would not include the Department of Energy's proposed research on advanced reprocessing and fast reactors as set forth in its Global Nuclear Energy Partnership (GNEP) vision.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Robert W. Fri, Visiting Scholar, Resources for the Future; Chair, Committee on Review of DOE's Nuclear Energy Research and Development Program, Board on Energy and Environmental Systems, National Research Council

Questions submitted by Chairman Bart Gordon

Q1. Secretary Bodman took issue with the level of urgency the recent National Research Council review placed on closing the fuel cycle. He stated that it is paramount that leaders in this country seek to solve the issues that inhibit the expansion of nuclear power, including providing a durable and credible nuclear waste disposition path.

To what extent does dry-cask storage of spent nuclear fuel—an option the National Research Council report seems to support—represent a credible waste disposition path to support the expansion of nuclear power that the Department of Energy (DOE) seeks?

A1. The report states that "There is general agreement and approval by the USNRC that such a scheme [dry cask storage] would provide safe, secure, storage for at least 100 years." As such, this option is available to support the expansion of nuclear power. Indeed, it is available now, unlike both the Yucca Mountain project and a major recycling program.

Q2. According to DOE, the findings of the recent National Research Council review as they relate to GNEP are based on faulty premises. In particular, Assistant Secretary Spurgeon stated the review incorrectly assumed that DOE had pre-selected technologies and the scale at which to build recycling facilities. He went on to state that fast reactor recycling will take many decades to implement and that any near-term deployment of commercial-scale facilities would likely rely on technologies similar to those that are commercially available for recycling in current generation reactors.

A2. As general background to this question, a letter from Dr. Ralph Cicerone, President of the National Academy of Sciences, to Secretary Bodman is attached. It summarizes the committee's arguments for recommending against a large demonstration or commercial facilities program, only one of which was based on the premature selection of technology.

Q2a. What is your view of the proposal to rely initially on commercially available technologies, presumably MOX, while continuing to develop technologies for fast reactor recycling?

A2a. The committee concluded that the technical risk of skipping the engineering scale facilities was unacceptably high for a broad range of technologies. In addition, the committee concluded that there is neither an economic reason nor domestic policy need to proceed with recycling now. Dr. Cicerone's letter discusses these issues in more detail.

Q2b. Assuming the long-term goal is to close the nuclear fuel cycle, are we more likely to succeed through the phased approach DOE seems to be advocating, or by waiting until R&D on the more advanced technologies is at a point to get directly to the end goal of fast reactor recycling?

A2b. The committee recommended following the general plan of the Advanced Fuel Cycle Initiative, which is a phased approach to the development of fast reactor recycling. In the view of the committee, this plan is the most likely to result in a tested, acceptable technology.

Q3. In your written testimony, you note that the study committee you chaired did "not recommend a large federal research program, because most of this research should be industry-supported."

What would you describe as reasonable goals for a research program and what actions would DOE need to take to help achieve those goals? Would new research and development facilities need to be built? If so, how would you recommend those costs for new facilities are shared between industry and DOE?

A3. This question appears to refer to research associated with the current fleet of nuclear power plants. The federal role in such a program would be to support research that the private sector cannot support. The most obvious example would be for DOE to provide specialized user facilities, such as the Advanced Test Reactor at INL. This facility could be used, for example, to test the design of high burn-up fuels developed in the private sector. Such facilities should be operated along the same lines as user facilities at other national laboratories, importantly including a policy of charging commercial users only incremental costs. For a more complete study of possible collaborative efforts, please contact INL or the Electric Power Research Institute for the results of a study they jointly conducted several years ago.

Questions submitted by Representative Daniel Lipinski

Q1. You mention that DOE should strengthen university capabilities to educate young professionals and scientists to allow for a sizable buildup in nuclear energy production, research, and development. What is currently done at U.S. universities in relation to nuclear energy, and what do you recommend be done to expand and improve upon this work?

A1. Although university-based nuclear science and engineering (NSE) education programs receive financial support from a wide range of federal agencies as well as industry, core NSE research thrusts are generally not funded by the other federal research funding agencies because they are viewed as the exclusive jurisdiction of DOE, as set forth in the *Atomic Energy Act.* Therefore, DOE plays a crucial role in maintaining the core research programs and student support needed to sustain university NSE programs. The past DOE Nuclear Energy University Program was comprehensive in scope, providing fuel services for research reactors, basic research grants, support for industry matching grants (dollar-for-dollar match from industries), infrastructure support for university research infrastructure, as well as scholarships for undergraduate students and fellowships for graduate students, and partnerships to share reactors with other universities and industries and includes minority serving institutions.

To ensure that DOE continues to play this role, the committee recommended that there be a separate line item for university programs in the Energy and Water appropriations for DOE to implement the NSE program outlined in EPAct05. The committee also endorsed the report of the American Nuclear Society, *Nuclear's Human Element: A Report of the ANS Special Committee on Federal Investment in Nuclear Education* (2006), which contains detailed recommendations for the design of the NSE program.

Q2. What is the status of DOE's Nuclear Hydrogen Initiative with regard to the new technologies under development? Is the Program on track to deploying new light water reactor and fuel cycle technologies by 2015, and next-generation advanced reactors and fuel cycles by 2025?

A2. The committee's recommendations on the issues raised in this question are:

- The Nuclear Hydrogen Initiative is well-designed, but its goals and schedule need to be coupled more closely to the goals and schedules for the Next Generation Nuclear Plant (NGNP). As noted below, these schedules may slip.
- The NP 2010 program is on track to support the deployment of new light water technology at the rate determined by private sector investment. This could be as early as 2015.
- The NGNP program is not likely to meet its schedules unless the public/private partnership on which the schedule depends comes into being. DOE should decide whether to pursue a different demonstration program with a smaller industry contribution or a more basic technology development program.
- The committee did not estimate when fuel cycle facilities could be in place, but did suggest that there is little economic or domestic policy reason to accelerate their construction.

Questions submitted by Representative Ralph M. Hall

Q1. Mr. Fri, in your testimony regarding the Nuclear Power 2010 (NP 2010) Program you state that augmenting the program to ensure timely and cost-effective deployment of the first new reactor plants is necessary but that the Committee does not recommend a large federal research program, because most of this research should be industry supported. Could you provide us with examples of the research areas you believe should be industry supported that would augment the NP 2010 Program?

A1. Please see the answer to Question #3 asked by Chairman Gordon.

Q2. Mr. Fri, also in regard to the Nuclear Power 2010 Program (NP 2010) you mention the need for strengthening university capabilities to educate a growing number of young professionals and scientists in relevant areas. Did we assist this strengthening in the America COMPETES Act*?*

A2. Although the committee did not address this question, I understand that Section 5004 of the *America COMPETES Act* was intended to bolster academic infrastructure for nuclear education. A committee members who are familiar with this legislation (and who is speaking for himself, not the committee) believes this program is "perfectly positioned to facilitate the creation and expansion of academic programs, not only in nuclear engineering, but in other fields, such as nuclear chemistry, radiochemistry, health physics, and material sciences, that are critical to the long-term sustainability of nuclear energy."

Q3. Mr. Fri, you mention the Committee believes a research program similar to Advanced Fuel Cycle Initiative (AFCI) is worth pursuing and that DOE obtain more external input such as an independent through peer review of the program. What insights does the Committee expect such a review would provide DOE when crafting such a program?

A3. The committee recommended that DOE establish an outside review capability for all of its nuclear R&D programs. We suggested three criteria for an outside review—that it be strategic, independent, and transparent. In the case of the AFCI program, a strategic review would address the major technical choices to be made over the long duration of the program. It would do so with outside advice that avoids conflict of interest and a collective bias for any one choice. Finally, the work of the advisory committee would be open to comment by the entire nuclear R&D community, both to ensure technical accuracy and to build support in the community for DOE's decisions.

Question submitted by Representative Adrian Smith

Q1. Could you please address challenges associated with nuclear waste transport and any reform needed to streamline the process or improve its safety?

A1. The committee did not address issues of transportation of spent fuel. However, the Nuclear and Radiation Studies Board of the National Research Council has published a report entitled *Going the Distance? The Safe Transportation of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States* (2006) which may be of some help in addressing this question.

NATIONAL ACADEMY OF SCIENCES

Office of the President

November 19, 2007

The Honorable Samuel Bodman
Secretary
U.S. Department of Energy
Washington, DC 20585

Dear Mr. ~~Secretary~~: Sam:

I appreciate your conveying to me in your letter of November 9 your candid concerns regarding the recently released National Research Council (NRC) report, *Review of DOE's Nuclear Energy Research and Development Program*. I regret that you and your colleagues in the department are disappointed with our committee's recommendations regarding the research and development features of Global Nuclear Energy Partnership (GNEP). I have reviewed the issues raised in your letter with the committee chair and staff, and have summarized below what I have learned.

To place your concerns in context, let me first recap the committee's two principal recommendations regarding the GNEP program. First, it recommended against accelerated construction of large demonstration or commercial facilities for reprocessing and recycling of spent nuclear fuel. Second, it recommended that the Department of Energy (DOE) develop and seek independent external review of a robust research and development program for closing the nuclear fuel cycle over time. Your principal concern, I believe, centers on the first of these recommendations.

The committee believes that it has relied on the most current information available from DOE in recommending against building early demonstration or commercial scale facilities. None of the ten outside reviewers of the draft report suggested that the committee had failed to take the most relevant data into account, and no information about the GNEP research and development program released recently by DOE has altered the committee's view. Even had there been new information about the technology to be selected for demonstration or deployment, it is unlikely that the committee would have come to a different conclusion. The chief reason is that the committee did not base its recommendation on any one technology. Rather, it found that that none of the fuel cycle technologies likely to meet the GNEP goals is sufficiently mature technically to warrant accelerated deployment (Finding 4-4). For this reason, the committee's concern was that to skip the engineering step, as proposed by the GNEP Strategic Plan, created unacceptable technical risks over a broad range of technologies. Based on experience with premature demonstration projects in other programs, the committee concluded that these risks could actually result in more delay and higher cost than a more measured development approach.

500 Fifth Street, NW Room Washington, DC 20001

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In addition, the committee based its recommendation against early deployment on two other findings – first, that there is no economic reason to proceed immediately to commercial scale (Finding 4-3); and second, that there is no urgent domestic need for early deployment (Finding 4-1). Thus, even if the technical risks could be mitigated to the point that skipping an engineering stage facility was an acceptable strategy, the committee relied on other important factors in making its recommendation.

I recognize, of course, that you suggested in your letter that the growth of nuclear power creates a sense of urgency. Different judgments about the speed with which nuclear generating capacity will increase in the future are to be expected. The committee has outlined the uncertainties that led it to its conclusion and its rationale for a more measured pace for successful development of reprocessing and recycling technology. I hope that as the debate goes forward the differing judgments on this important issue can be examined in depth.

Finally, let me address your concern about the use of the term "GNEP". Assistant Secretary Spurgeon raised this issue with the committee chair when the report was first made available. While it is unfortunate that some readers may not have appreciated that the report focused on the GNEP research and development program, it should be noted that the title of the report clearly states that it is about the research and development program, and that the report's GNEP chapter was careful to say that the committee was only evaluating that part of GNEP that involved technology. Indeed, the sentence that you quote in your letter refers to a research program.

The extraordinarily qualified committee that carried out this study and the subsequent peer review by an equally qualified collection of reviewers produced a report that had many good things to say about the prospects for a robust and effective research and development program at DOE to help support nuclear "rebirth" in the U.S., as you put it in your letter. That rebirth will likely require a concerted effort by all to build a new nuclear capability in the nation that can withstand the considerable scrutiny that it will certainly receive. The committee concluded that moving quickly toward a commercial scale fuel reprocessing regime, skipping the step of engineering scale facilities, carries too many risks that are unnecessary at this point. Instead, since a steady, dedicated nuclear research, development and commercialization program in the U.S. carries such enormous potential for the nation's energy future, the committee conveyed its views on the prudent steps to build such a program.

I would be happy to meet with you to discuss any of your concerns with this report.

With best regards,

Ralph

Ralph J. Cicerone
President, National Academy of Sciences
Chair, National Research Council

cc: Charles M. Vest

Bcc: Bill Colglazier
✓Peter Blair
Jim Jensen

The Secretary of Energy
Washington, D.C. 20585

November 9, 2007

Dr. Ralph J. Cicerone, Ph.D.
President, National Academy of Sciences
500 Fifth Street, NW
Washington, DC 20001

Dear ~~Dr. Cicerone~~ Ralph:

This letter is to express my great disappointment in the newly released report on the Department of Energy's (DOE) Nuclear Energy Research and Development Program, with regard to its conclusions regarding the Global Nuclear Energy Partnership (GNEP), and in my view, an inadequate consideration of significant program planning information that was available but not considered by the review committee.

The Department appreciates the challenge faced by the review committee and realizes that a review for such an effort does need to be temporarily cut off at some point to give adequate time for final editing, review, and approval of the report. However, given the fact that new funding for the GNEP program was delayed until March 2007 as a result of the year-long continuing resolution, it is most unfortunate that the committee chose to close the review period in July 2007, only four months into the program.

One of the most serious concerns we have about this report is use of the term "GNEP" when the committee truly seeks to comment on the research and development conducted through the Department's Advanced Fuel Cycle Initiative (AFCI) in support of GNEP. By making the blanket statement that "GNEP should not go forward," the committee brings into question the U.S.-led international partnership that currently consists of 16 nations. I recently led a ministerial meeting of representatives from these 16 countries, in addition to 19 other observer countries and three international organizations. At this meeting, it was evident that a growing international consensus exists that supports urgently moving forward to develop the political and technical framework for closing the nuclear fuel cycle. I accept that the committee did not mean to comment on the international partnership as evidenced by the press release issued with the report, but the poorly chosen language in the report and the committee's inflexibility to modify this language during the pre-publication review reflect negatively on the National Academies.

The *de facto* conclusion of the report relating to GNEP is that the program "should not go forward and that it should be replaced by a less aggressive research program." This conclusion is premised on the faulty assumption that

DOE has narrowed the potential technology to be deployed solely to UREX+ (the baseline technology developed at DOE's National Laboratories) and that it is moving too aggressively towards commercial deployment. However, as noted to the committee both via interview and in multiple documents, we have made no technology selection and in accordance with the National Environmental Policy Act are currently evaluating alternative technologies and approaches to closing the nuclear fuel cycle.

The committee's support for closing the fuel cycle is noteworthy. However, we take issue with the level of urgency the committee feels should be placed on this vital task. The projected global demand for electricity is expected to nearly double by 2030. Many nations, including the United States, are witnessing a rebirth of nuclear power to address this coming demand in a way that does not contribute to the concern about climate change. It is paramount that leaders in this country seek to solve the issues that inhibit the expansion of nuclear power, including providing a durable and credible nuclear waste disposition path.

In the coming weeks and months, there will undoubtedly be opportunities for open debate on how the Federal Government should execute its management responsibilities for the Nation's growing inventory of spent nuclear fuel. I hope that the National Academies will participate in these discussions and use its prestige and its reputation for scientific excellence to help guide the scientific and engineering communities in their quest to provide sound solutions to an ever growing challenge.

Sincerely,

Sam

Samuel W. Bodman

ANSWERS TO POST-HEARING QUESTIONS

Responses by Vice Admiral John J. Grossenbacher, Director, Idaho National Laboratory, U.S. Department of Energy

Questions submitted by Representative Ralph M. Hall

LWR SUSTAINABILITY

Q1. Mr. Grossenbacher, with the increased efficiency of the existing fleet resulting in a significant amount of additional baseload power generation, how much longer do you believe the existing fleet can take up the slack to offset other baseload sources? Will new construction be required to continue this offsetting?

A1. Through improvements and up-rates to the current fleet, nuclear generation has increased significantly over the last 20 years. However, by 2030, electricity demand is expected to grow to a level 30 percent higher than today. New plants must be built to meet demand, but it is estimated that the supply chain required for the construction of new nuclear power plants currently limits the construction of nuclear power plants to about four plants per year. With life extension, the current fleet would begin to retire in 2030. However, operating these plants to up to 80 years, with capital investment to upgrade existing components and modernize systems, could emerge as a sound business decision and an effective means to lock in to non-emitting capacity.

Q2. If we are to extend the licenses of the existing fleet beyond 60 years how will, for example, the Nuclear Power Strategic Plan with EPRI, address the gap before new nuclear power plants come online? Will this program for example examine the performance of nuclear plant materials beyond 60 years of service?

A2. The Nuclear Power Strategic Plan is aimed at conducting the research and development necessary to support the extended safe and reliable operation of the Nation's fleet of nuclear power plants. Extending operation of existing plants and building new plants will be necessary to meet growing demand of electricity in the U.S. Based on this strategic plan, the Department of Energy proposes to increase funding in Fiscal Year 2009 to conduct research and development on technical issues related to extended performance of nuclear plant materials, transition to digital instrumentation and control; new techniques for in-service inspection, including diagnostic, maintenance, and repair techniques; enhanced fuel reliability and performance; and new higher burn-up fuels.

AFCI

Q3. Realizing the Advanced Fuel Cycle Initiative (AFCI) will take time, is there something in the interim that could be done prior to the Advanced Fuel Cycle Initiative is completed?

A3. Yes. The U.S. nuclear industry is prepared to make substantial investments in new reactors, but needs consistency from government regarding support for nuclear energy. On the research front this includes funding for operations, maintenance, and needed upgrades of domestic research facilities, as well as support for cooperative agreements with Japan, France and other countries for joint use of unique facilities. The Advanced Fuel Cycle Facility is a much-needed laboratory that will support both laboratory and engineering scale research on advanced nuclear fuel recycling, including advanced separations and transmutation fuel development for consumption of transuranics. Support for accelerating the development of this laboratory is urged. Given the projected need for energy from non-carbon emitting sources, research on extending current reactor life is also needed, as is research on higher burn-up fuels.

On the regulatory front development is also needed. Recycling will result in significantly different waste streams with much lower long-term hazards, but current language in the Nuclear Waste Policy Act does not account for these differences. While most radioactive waste is regulated based on content and the hazard associated with that content, current law regulating "high level waste" is based solely on the source of the material and not the actual hazard present. Continued support for opening of the federal geologic repository is also urged. While the hazard present in waste from advanced recycling will be much lower per unit of energy produced than that from used fuel disposed as waste, there will still be a need for deep geologic isolation of a portion of the waste.

ADVANCED FUEL CYCLE INITIATIVE

Q4. Along with the additional research that will take place as part of AFCI's longer-term goals, are there benefits to developing or redeveloping nuclear fuel reprocessing capabilities now using existing technology?

A4. Yes. Establishing the policy and regulatory framework of nuclear fuel recycling will serve as a catalyst for industry participation domestically and U.S. leadership internationally. The Nuclear Regulatory Commission has already received applications for 15 new reactors and expects that number to rise to 27 by year-end. Returning to a policy of recycling will not only address the waste confidence issue for new reactors, but also encourage industry participation in the development of the fuel recycling infrastructure. Transitioning to advanced recycling technologies will be easier with an operating infrastructure, including an established transportation network. Recovered fissile materials will also reduce the need for additional uranium mining and enrichment. Also, by joining the countries currently recycling used nuclear fuel, the U.S. will be in a better position to move the rest of the world forward in adopting advanced technologies that will end the direct separation of pure plutonium and recycle all the transuranic elements.

Question submitted by Representative Adrian Smith

NUCLEAR WASTE TRANSPORTATION

Q1. Could you please address challenges associated with nuclear waste transport and any reform needed to streamline the process or improve its safety?

A1. The U.S. has safely conducted more than 3,000 spent nuclear fuel (SNF) shipments over the last 40-plus years without any releases harmful to the public or the environment. The National Academy of Sciences concluded in a study of SNF shipments [February 9, 2006] that there are no technical challenges to conducting these shipments safely under the current regulations. There are financial challenges associated with building the infrastructure and addressing the social and institutional concerns associated with shipments to Yucca Mountain. Adequate funding to train emergency responders along transportation corridors and to develop the fleet of transport casks, rail cars and the railroad to Yucca Mountain are the biggest challenges. No legislative reforms are needed to either streamline or improve the safety of these shipments.

Questions submitted by Representative Bob Inglis

U.S. NUCLEAR INFRASTRUCTURE

Q1. Would you give your assessment of the state of the U.S.-owned nuclear technology and supply industries?

A1. The state of the U.S.-owned nuclear technology industries is poor. The supply of adequate equipment, materials, and personnel to support expansion of the nuclear industry in the U.S. will be problematic. As an example, ultra-heavy forged reactor pressure vessels are currently available from only one factory in Japan. It is imperative that the U.S. domestic nuclear infrastructure be expanded to accommodate future needs.

NUCLEAR INFRASTRUCTURE

Q2. How many predominantly U.S.-owned reactor vendors were there in the 1970's? How many are there now? What happened?

A2. Four major U.S.-owned companies served as reactor suppliers in the 1970s: Babcock & Wilcox, Combustion Engineering, General Electric and Westinghouse. Since that time, however, foreign companies have either acquired or bought into each of these U.S. firms.

The French firm Framatome (now Areva) purchased a half interest in Babcock & Wilcox's nuclear services division in 1989. Combustion Engineering became a wholly-owned subsidiary of Asea Brown Boveri, a Swiss-Swedish multi-national conglomerate in 1990. Asea Brown Boveri was subsequently acquired by British Nuclear Fuels in 2000. British Nuclear Fuels acquired Westinghouse Electric Company in 1999. In 2006, Toshiba signed an agreement with British Nuclear Fuels USA Group and Westinghouse Electric UK Limited to acquire 100 percent of Westinghouse. Hitachi and General Electric combined their nuclear power divisions in 2006. GE–

Hitachi is owned 60 percent by GE and 40 percent Hitachi, and is currently the only U.S.-owned reactor vendor.

Q3. Why is the state of the U.S.-owned nuclear technology and supply so poor?

A3. The U.S. pioneered nuclear technology and dominated nuclear energy leadership in the 1970s. Nuclear development in the U.S. suffered a major setback, however, because of delays caused by a cumbersome and lengthy licensing process, the oil embargo of 1973 that led to high interest rates and low economic growth, and with the 1979 Three Mile Island accident. Not a single new nuclear power plant was ordered after 1973, causing a major downturn in supply and business of U.S.-owned nuclear technology.

Historically, the U.S. policy on nuclear energy stands in stark contrast to the policies in France and Japan. France now claims a substantial level of energy independence and almost the lowest electricity cost in Europe. France also has an extremely low level of CO_2 emissions per capita from electricity generation. Japan has also embraced the peaceful use of nuclear technology to provide a substantial portion of its electricity. Today, nuclear energy accounts for about 30 percent of Japan's total electricity production.

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