NATIONAL ENERGY POLICY: THE FUTURE OF NUCLEAR AND COAL POWER IN THE UNITED STATES

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND POWER

OF THE

COMMITTEE ON COMMERCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTH CONGRESS

SECOND SESSION

JUNE 8, 2000

Serial No. 106–131

Printed for the use of the Committee on Commerce

U.S. GOVERNMENT PRINTING OFFICE

66–466CC WASHINGTON : 2000

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NATIONAL ENERGY POLICY: THE FUTURE OF NUCLEAR AND COAL POWER IN THE UNITED STATES

THURSDAY, JUNE 8, 2000

HOUSE OF REPRESENTATIVES,
COMMITTEE ON COMMERCE,
SUBCOMMITTEE ON ENERGY AND POWER,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:07 p.m. in room 2123, Rayburn House Office Building, Hon. Joe Barton (chairman) presiding.

Members present: Representatives Barton, Largent, Burr, Whitfield, Norwood, Shimkus, Wilson, Bryant, Boucher, Sawyer, and Strickland.

Staff present: Kevin Cook, science advisor; Karine Alemian, professional staff member; Elizabeth Brennan, legislative clerk; Sue Sheridan, minority counsel; and Rick Kessler, minority counsel.

Mr. BARTON. The subcommittee will come to order. We are going to go ahead and proceed. A number of members have indicated that they are on their way. Hopefully, if I give an extremely long-winded opening statement, they will be here by the time I conclude.

Today is the second in our series of subcommittee hearings examining our national energy policy. On May 24, the first hearing addressed the supply of oil and natural gas.

Today's hearing will look in detail at nuclear power and coal. These two energy sources form the mainstay of our current electricity generation capacity, with approximately 20 percent of our electricity coming from nuclear reactors, and a little over 50 percent coming from coal-fired power plants.

In the near term, we can not afford to lose the generating capacity represented by coal and nuclear power. There is no ready replacement for 70 percent of our electrical power. Yet, there are pressures from various directions to reduce our present reliance on nuclear and coal.

The most significant impediment to nuclear power in the near term is the lack of a centralized facility for the permanent disposal of spent nuclear fuel. The Federal Government has failed to fulfill its legal obligation to dispose of spent nuclear fuel, beginning in 1998.

The earliest that the Department of Energy says it can open a repository at Yucca Mountain is the year 2010, 12 years late. Yet, the Clinton Administration has blocked every attempt by Congress to accelerate that schedule. This delay in solving the disposal ques-

tion impacts the continued operation of nuclear reactors in this country. It increases the price of electricity generated by nuclear power, and it delays the clean up of decommissioned reactor sites.

Most damaging, perhaps, the government's inaction on the Yucca Mountain repository affects public confidence in nuclear power. It suggests that there is a major technical hurdle yet to be resolved, when the real problem is a lack of political will regarding the siting of the repository.

Looking beyond the next decade, we have to ask what role nuclear power should play in our future energy portfolio. As concerns increase about greenhouse gas emissions causing global climate change, we ought to rethink our assumptions about nuclear power in this country.

Until fusion power becomes real, if ever, we may need to rely on the next generation of advanced reactor technologies for safe and climate friendly electrical power. Such advanced reactor technologies may also represent a significant export market for the U.S. companies.

The near term challenge for coal revolves around air quality, and controlling the emissions of sulphur dioxide, nitrogen oxides and particulates; all pollutants presently regulated under the Clean Air Act.

The long term focus will also be on air quality that may shift, limiting the omission of greenhouse gases, particularly carbon dioxide, from the combustion of coal.

The answer to both the near-term and long-term challenges for coal may lie in advanced coal technologies that will enable a cleaner and more efficient use of coal in electrical power generation. However, we need to be sure that the Department of Energy is making the right policy decisions and technology investments today to support such a future for coal.

The larger question here is how this country goes about establishing and implementing a comprehensive, long-term national energy policy. What is our energy policy today? Where do we go? Where do we want to go in the future, and what long-term policies will enable us to get there? What is the process we use to resolve conflicts and stay on course for our long-term objective?

Some of these questions need to be addressed at the end of our series of hearings on energy policy, but some are very relevant to the particular challenges of nuclear and coal power.

For both energy sources, it seems to me that the short term political and environmental issues dominate over any coherent long-term policy. It is not clear to me that we know, as a country, where we are headed with nuclear energy and coal power, but I am hopeful that our hearing today will shed some light on that question.

I want to welcome our witnesses before us on this panel and the next panel. I look forward to your testimony.

Does the gentleman from Georgia wish to make an opening statement?

Mr. NORWOOD. Mr. Chairman, I will submit it for the record. But I want to thank you for holding this hearing. I think it is very appropriate that you keep our attention on the future, particularly of nuclear, which I am a big supporter of. I think we need to, as you pointed out eloquently, deal with our problem of storage of it.

I hope we will just keep focusing away on this, until we finally wake up and set a policy for our future. With that, I thank you.

Mr. BARTON. Does the gentleman from Kentucky wish to make an opening statement?

Mr. WHITFIELD. Mr. Chairman, I am just delighted that we are having these hearings. As you know, nuclear and coal provides about 72 to 75 percent of the electrical power in America. I think it is vitally important that we have this hearing, listen to these experts, and obtain a better understanding of where we are going and what we can do to maintain a reliable nuclear energy and coal industry in the U.S.

Thank you.

Mr. BARTON. Does the gentleman from Ohio wish to make an opening statement?

Mr. SAWYER. Thank you, Mr. Chairman. I have a longer statement. I would welcome the chance to insert it in the record, as you always make room for.

Mr. BARTON. Without objection.

Mr. SAWYER. Let me just make an observation, and I hope that in the course of our afternoon that we will hear from you regarding this.

With coal, it is a concern. With nuclear, it is of critical importance that among the transitions that we are going through today, both State by State and nationally, is the movement away from universal service territory, rate of return regulation, in which the investment in continuous maintenance and the cautious management of generating capacity is a part of the allowable rates to be charged.

In an arena in which competition and the ability to provide low cost as one dimension of the service that will be a factor in that competition, it seems to me that the safety and security of our generating capacity is very much at stake. I hope that you will speak to that in the course of your testimony today.

With that, I will yield back the balance of my time. Thank you, Mr. Chairman.

Mr. BARTON. The Chair would ask unanimous consent that all members not present have the requisite number of days to insert an opening statement in the record, at this point in the record. Is there any objection to that?

[No response.]

Mr. BARTON. Hearing none, it is so ordered.

[Additional statements submitted for the record follow:]

PREPARED STATEMENT OF HON. JOHN SHIMKUS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Good morning, Mr. Chairman and to all who have shown up this afternoon. I am looking forward to this hearing today. I very much wanted to keep my opening statement rather short, which I'm sure would please the Chairman. Unfortunately for him, this hearing today will focus on the future of two important energy sources to my home state of Illinois.

Coal is a vital part of the growing Illinois economy, it is the state's 3rd largest industry. 27 Illinois mines employ more than 5,000 miners, and generate roughly 25,000 spin-off jobs.

Illinois coal is used for power generation all over the world. The top 7 utility users of Illinois coal are: PSI Energy, Illinois Power, Tennessee Valley Authority, Central Illinois Public Service, Northern Indiana Public Service, Tampa Electric and Union Electric.

There are many concerns across the country about the pollution caused by burning coal. The future of coal hinges on whether clean coal technologies become commercially available to coal-burning utilities. In Illinois, we are continually working to find cleaner ways to burn coal. The Illinois Clean Coal Institute's clean coal research activities focus on the needs of coal users and producers in meeting the standards of the Clean Air Act Amendments of 1990. The ICCI spends over $3 million a year on research designed to make energy-rich Illinois coal environmentally sound. It is the largest state-supported coal research program in the country. The Illinois coal industry has a powerful future, one that's worth fighting for!

Nuclear power also plays on important role in Illinois because my home state generates about 40-45% of its power from nuclear reactors, almost twice the national average. We depend on nuclear power. Almost without a doubt, nuclear energy is and should be here to stay.

However, at a time when the future of nuclear energy looks brighter than it has in many years, there is a dark cloud hanging over our own domestic nuclear fuel capabilities.

My own state hosts the nation's sole remaining uranium conversion facility. Every indication is that this facility is now on the brink of going out of business. To make matters worse, the loss of this facility and capability will be a further serious blow to both the uranium mining and processing industries and to the U.S. enrichment enterprise—all of which are already on the ropes.

I happen to think that our nation should not rely only on just one energy source such as natural gas, coal or wind to generate power, but all of these sources. It is the smart thing to do over the long haul. Just like any good retirement portfolio, our energy industry should be diversified.

Again, thank you for having this hearing today Chairman Barton and focusing on two issues that are extremely important to my home state. I yield back the balance of my time.

PREPARED STATEMENT OF HON. JOHN B. SHADEGG, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ARIZONA

Chairman Barton, thank you for holding this hearing on one of the most vital aspects of our nation's energy policy: the role of nuclear power in electricity generation. This is an issue of special significance to me since Arizona is the home of Palo Verde, the largest, as well as one of the newest, safest and most efficient, nuclear power plant in the United States. It is also an issue which, as today's witnesses are likely to explain, different policies are working at cross purposes to hinder the further development of this important energy source.

This hearing is very timely for a number of reasons. First, the Energy Information Administration (EIA), an independent federal agency, has estimated that nuclear generation capacity in the United States will begin declining in approximately ten years, and will continue to decline with no prospect of a subsequent revival. The EIA estimates that 674 billion kilowatt hours of electricity were produced by nuclear energy in 1998 and projects that, by the year 2020, nuclear generation will have declined to only 427 billion kilowatt hours per year.

Second, the demand for electricity is projected to grow at a rate of between one and two percent per year for the next twenty years. This growth cannot be met solely by increased use of renewable energy sources and conservation. As an illustration, Energy Secretary Bill Richardson announced an initiative on June 21, 1999 that calls for generating *five percent* of electricity from windmills by the year 2020. In fact, the EIA has projected that windmills will only produce *one quarter of one percent* of electricity generation by 2020. The EIA projection is bolstered by the fact that, depending on weather conditions, it would take between 121,309 and 181,963 windmills of some of the largest type (750 kilowatts) currently in active use to produce the five percent of electricity called for by the Administration, *while there are only five of these windmills currently in operation.* This shows that, despite the optimistic hopes of the present Administration, we will continue to rely on non-renewable sources of energy for the vast majority of our electricity supply.

Finally, there is continued worry about air quality issues, including the role that combustible fuels play in emitting air pollutants. I strongly support the continued use of coal and natural gas for electricity production but these energy sources, while more clean burning now than ever before, do emit air pollutants including carbon dioxide, sulfur dioxide, and nitrous oxide. Nuclear power, of course, does not emit any pollutants into the environment.

It is in the environmental arena that there is the greatest disconnect between environmental protection policies and policies towards nuclear power. The current Ad-

ministration expresses tremendous concern about the theory of global warming and the role which emissions of so-called "greenhouse gases" like carbon dioxide may play. The Administration has gone so far as to sign the Kyoto Protocol under which it agreed to hobble the United States economy by reducing emissions of these gases by seven percent from 1990 levels by the year 2012. Despite its professed concerns for air quality and global warming, the Administration continues to discourage the use of the largest non-emitting source of energy, nuclear power, by vetoing legislation which would safely dispose of nuclear waste.

Mr. Chairman, nuclear power is a safe, clean, efficient source of energy production. Countries like France, which produces over three quarters of its electricity from nuclear power, recognize this but this logic escapes the Administration. Nuclear energy is needed now and will become even more necessary as energy consumption increases during the next twenty years. It is more important than ever that a policy be developed that will encourage its continued use and future development.

PREPARED STATEMENT OF HON. TOM BLILEY, CHAIRMAN, COMMITTEE ON COMMERCE

I commend Chairman Barton for convening this second in a series of hearings on national energy policy. The first hearing focussed on oil and gas supply issues. We want to be sure our country has an energy policy that addresses not only the "*crisis du jour*," but positions the United States for a stable and secure energy future.

Today's hearing looks at two more vital energy sources: nuclear power and coal. Combined, nuclear energy and coal account for over seventy percent of the electricity generated in this country. With serious reliability concerns facing us this summer, it is essential that we maintain our existing nuclear and coal generating capacity over the near-term. Looking further down the road, we have to ask what role nuclear and coal power should play in our future energy portfolio.

New technologies will be key, to our energy future. Such technologies will enable this country to use its enormous coal resources in a way that does not harm the environment. Advanced technologies may also bring us a new generation of safer and more efficient nuclear reactors.

Today's hearing, along with the other hearings in this energy policy series, will inform us whether the federal government is taking the right near-term and long-term actions to prepare us for a secure energy future. I look forward to the testimony of our distinguished witnesses today.

Mr. BARTON. We want to welcome our first panel. It is going to focus on nuclear energy. We want to especially welcome Mr. William Magwood, who is the Director of the Office of Nuclear Energy, Science, and Technology, at the U.S. Department of Energy.

It is our normal policy, when we have Administration witnesses to put them on a separate panel. We also have a DOE witness on the second panel, because we have so many people. If I had to go to four panels as opposed to two, it would take a lot longer.

It is not disrespectful that we have asked you to be with the rest of the group, but it expedites the efficiency of the hearing. So I want to let you know that there is absolutely no disrespect meant. Normally, you would be on a panel all by yourself. But because of the number of people and the time we are starting the hearing, we have done this in two panels.

We are going to recognize you first. We would ask that you summarize your written statement, and we thank you for having it in on time. I have been chastising some of my Administration witnesses for being tardy. I want to compliment you for being on time.

We will give you 7 minutes, and then we will go through the rest of the panel. So welcome, Mr. Magwood. You are recognized for 7 minutes.

STATEMENTS OF WILLIAM D. MAGWOOD, IV, DIRECTOR, OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY, U.S. DEPARTMENT OF ENERGY; CORBIN A. MCNEILL, JR., CHAIRMAN, PRESIDENT, AND CEO, PECO ENERGY GENERATION; DALE E. KLEIN, VICE CHANCELLOR FOR SPECIAL ENGINEERING PROGRAMS, UNIVERSITY OF TEXAS SYSTEM; JAMES J. GRAHAM, PRESIDENT AND CEO, CONVERDYN; DAVID LOCHBAUM, NUCLEAR SAFETY ENGINEER, UNION OF CONCERNED SCIENTISTS; AND ROBERT E. EBEL, DIRECTOR, ENERGY AND NATIONAL SECURITY, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

Mr. MAGWOOD. Thank you, Mr. Chairman.

I appreciate your remarks about having our testimony in on time. I would like to thank my staff for working so hard to get that done.

Also, Mr. Chairman, I would like to say that I am actually very proud to serve on a panel with these illustrious gentlemen to my left, and particularly, Mr. McNeill, Dr. Klein, and the others down the row. I know most of them very well, and appreciate the opportunity to testify with them today.

I am William Magwood, Director of the Department's Office of Nuclear Energy, Science and Technology. To begin, let me also thank you and congratulate you for holding this hearing, and for the series of hearings you have held on the subject of energy security. I think that this hearing is a very important opportunity to focus on these issues, and to get a lot of facts on the table.

This is an appropriate time to address the subject of nuclear energy. We, at DOE, are working hard on many aspects of nuclear technology, and believe that the United States has some very important choices to make about the future of nuclear power.

That said, I believe that the approach to energy that our Nation has employed over the last 20 years, reliance on a free market, has served us very well. Unlike many other nations, the United States has a wide range of energy options to choose from. We have been able to apply coal and nuclear and other sources to fuel America's homes and businesses.

Currently, about half of our electric power, as you noted, is derived from coal, the subject of the next panel; and nuclear provides about 20 percent, overall.

Many people are surprised to learn that the United States continues to increase its use of nuclear-generated electricity. Last year, because of the increased efficiency of our 103 nuclear power reactors, the U.S. added the equivalent of seven new nuclear power plants to the grid.

While the amount of U.S. electricity derived from nuclear power is now at an all time high, we have not started construction of any new nuclear power plants for some two decades.

This fact should be seen as a decision by the market; a decision first, based on the fact that the United States has, in recent decades, enjoyed a relative surplus of supply of electricity; and second, on the uncertainly utilities faced in controlling the cost of constructing the last set of nuclear power plants in the late 1970's and 1980's.

The future, I believe, has great potential for resurgence of new market prospects for new U.S. nuclear power plants. This is because of many encouraging and interesting dynamics that are taking place right now.

First, U.S. nuclear utilities are not only producing more electricity than ever before, but they are doing so more economically, as well. The U.S. nuclear power plants are now some of the most cost effective generators of electricity on the market. The average nuclear power plant is producing electricity at 1.9 cents per kilowatt hour, which is quite an achievement.

For this reason, operating nuclear power plants has become a sought-after commodity in today's market. In all, 23 nuclear units are on the market, or have been sold, since last July. Most recently, two plants in New York, representing over 1,700 megawatts of efficient capacity were purchased for approximately $1 billion.

These trends are most interesting in that they demonstrate that the electricity industry can and will make significant investments in nuclear power plant capacity, and highlights the desire of some companies to pursue a supply strategy that specializes in nuclear generation.

Further, the march toward renewing the licenses of U.S. nuclear power plants continues. Just 5 years ago, some analysts were predicting the mass closure of U.S. nuclear power plants in the face of relatively low natural gas prices and electricity competition.

Even our own Energy Information Agency predicts a significant downturn of electricity, coming from nuclear power in the next few decades. Reality, however, is overtaking these projections.

In March, the NRC granted permission for Calvert Cliffs to extend its reactor operation for additional 20 years. Just last week, Duke Power's Oconee Plant followed in Calvert Cliff's footsteps and became the second plant to receive a 20 year extension. These renewals have come at a fraction of the projected costs, and years earlier than many predicted.

Our consultations with utility executives confirm that the overwhelming majority of the Nation's nuclear power plants can be expected to apply for and receive license renewals for continued operation well into the middle of the century.

The operation of our nuclear power plants have helped many states deal with their obligations to meet Clean Air Act targets, while still increasing the electricity supply.

In 1999, operation of the Nation's nuclear power plants has provided the great share of clean energy in the United States. Seventy percent of America's emission-free generation was provided by nuclear power, with most of the rest coming from hydroelectric resources.

This presents a challenge to the future. Even with dramatic improvements in efficiency, the EIA projects that U.S. energy consumption will increase substantially by 2020, with about 300,000 megawatts of new generating capacity required to meet demand and replace retiring capacity.

As a result, if the U.S. is to simply maintain its current proportion of non-emitting capacity, we will have to build about 108,000 megawatts of new capacity from hydroelectric, non-emitting renewable or nuclear power.

It is therefore important that nuclear remain a viable option for the future, and helping assure that this future is possible is part of the role of government.

The NRC, the Nuclear Regulatory Commission, has done its part. They have done an outstanding job, in my opinion, in becoming a very efficient regulatory agency with whose safety oversight, utilities can work to plan for the future.

The negative experiences of the past have not been replayed by NRC's successful implementation of license renewal. Many in industry now believe that NRC could also be a good partner in the construction of new nuclear power plants under the new, but untested, "one step licensing" rules possible for the three certified advanced light water reactors.

We, at DOE, are doing our part, as well. We are reasserting U.S. leadership in international exploration of nuclear power technologies. We have successfully reinvigorated the U.S. nuclear R&D with our peer reviewed Nuclear Energy Research Initiative, and our new industry cost-shared Nuclear Energy Plant Optimization Program, where we receive about 60 percent of the funding for the program through the Electric Power Research Institute.

We are also planning with our international partners for the long-term future by engaging in discussions in what have become known as Generation IV nuclear power systems. Generation IV systems are next-generation advanced technologies that will be economically competitive with the most efficient natural gas system, and will be deployed over the next 20 years.

DOE initiated this consideration in January, when we sponsored a workshop with representatives of the Governments of Argentina, Brazil, Canada, France, Japan, South Africa, South Korea, and the United Kingdom, to begin discussing the interests of other countries in the future of nuclear power. We have provided a copy of a joint statement issued by that meeting for your use.

Our advisory committee, the Nuclear Energy Research Advisory Committee, or NERAC, is helping us shape the future, as well. Interacting with the broad resource community, NERAC has made recommendations to shape the future of R&D activities.

Like the President's Committee of Advisors on Science and Technology before it, NERAC calls for significant increases in the Federal investment in nuclear R&D. Its recommendations are modest and carefully targeted.

There are many other challenges to be dealt with. We must move forward with dealing effectively with the disposition of spent nuclear fuel, as you stated in your opening statement, Mr. Chairman. While we would all like to see things move faster, they are moving, and this forward momentum is an essential element in the long term future of nuclear energy.

We must preserve and enhance our education system, as well. The decline in numbers of students graduating with nuclear engineering degrees has been startling, down two-thirds over the last decade or so. But we have also seen positive signs in this area.

DOE's increased focus on our university programs has paid some dividends by reversing the precipitous decline in the numbers of students graduating with nuclear engineering degree. Clearly, this is just a start, but it is movement in the right direction.

In this, as in other areas, we have been making considerable progress. but there is a lot of work to do. With your support and guidance, we hope to do more.

With that, I look forward to the other witnesses' statements, and to your questions.

[The prepared statement of William D. Magwood IV follows:]

PREPARED STATEMENT OF WILLIAM D. MAGWOOD, IV, DIRECTOR OF THE OFFICE ON NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY, U.S. DEPARTMENT OF ENERGY

Mr. Chairman and members of the Subcommittee, I am William D. Magwood, IV, Director of the Department of Energy's Office of Nuclear Energy, Science and Technology. I am pleased to be here today to discuss the important role of nuclear energy for over forty years in helping deliver reliable and competitive energy to the Nation—energy that meets our national interests and values for *energy security, diversity of supply, and environmentally sustainable energy*. I will also address what we see as the need for nuclear energy, the challenges, the opportunities ahead, and what the Administration is doing to advance nuclear energy technology to meet today and tomorrow's energy needs.

Over the last decade, the United States has experienced unprecedented economic growth and prosperity. To a large extent, the prosperity we see today is made possible because of access to reliable, diverse, and affordable energy supply options. The country's energy strategy over the last twenty years, has been one of market reliance—that is, of reliance on a competitive market to meet supply and demand—it is a strategy that has worked. The fact that new nuclear energy plants have not been built in the U.S. in recent years should be seen as a decision by the market. This decision is based first on the fact that the United States in recent decades has enjoyed a considerable surplus in electric supply options and second, on the uncertainties utilities faced in controlling the costs of constructing the last set of nuclear plants in the 1980's. I will comment further on both of these factors later.

We believe that Government's role in the energy sector is primarily to assure that the Nation has at its disposal for the future, a range of energy technology options to provide diverse, economic, and environmentally responsible energy choices to fuel our economy in the twenty-first century. As reflected in detail in our DOE Research and Development Portfolio (February 2000), the Administration supports a wide range of energy production options, each with unique strengths and challenges. It is our job to make these options available. We leave their final selection and implementation to the market.

IMPORTANCE OF NUCLEAR ENERGY TO TODAY AND TOMORROW'S ENERGY SECURITY

By all indicators, 1999 was a banner year for nuclear power in the United States. Nuclear power plants surpassed the peak operating performance records last set in the 1970's, increasing plant capacity utilization to 85.5 percent. Despite the closure of some inefficient nuclear units, nuclear energy delivered 20 percent of the Nation's electricity, second behind coal, which provided 51 percent of electricity.

Nuclear's share of the electricity market continues to increase as plants increase availability and achieve greater operating efficiencies, in 1999 adding the equivalent of seven 1,000 megawatt plants to the grid. Contrasting this to 1990, when plant capacity averaged 66 percent, nuclear plants have made dramatic progress in improving efficiency and economic competitiveness, while at the same time reducing the amount of waste generated and worker exposures. U.S. nuclear power plants now produce electricity at an average of 1.9 cents per kilowatt-hour and represent some of the most cost-effective generation of electricity on the grid today.

In fact, operating nuclear power plants have become a sought-after commodity in today's market. In all, 14 nuclear plants are on the market or have been sold since last July, representing 23 reactor units. Most recently, two plants in New York representing over 1,700 megawatts of efficient capacity were purchased for approximately $1 billion. We expect vibrant bidding for the Nine Mile Point reactors, which are also located in New York. These trends are most interesting in that they demonstrate the willingness of U.S. utilities and independent power operators to make significant investments in nuclear plant capacity, and the willingness of some companies to pursue a supply strategy that specializes in nuclear generation.

Further, the march toward renewing the licenses of U.S. plants continues. Just five years ago, some analysts were predicting the mass closure of U.S. nuclear plants in the face of relatively low natural gas prices and electric utility competition. Even our own Energy Information Agency predicts a significant downturn in the

electricity coming from nuclear power in the next few decades. Reality is overtaking these projections. In March, the Nuclear Regulatory Commission (NRC) granted permission for Calvert Cliffs to extend reactor operations another twenty years. Just last week, Duke Power's Oconee plant followed in Calvert Cliff's footsteps to become the second plant to receive a license extension. These license renewals have come at a fraction of projected costs and years earlier than many predicted. Our consultations with utility executives confirm that the overwhelming majority of the Nation's 103 operating plants can be expected to apply for and receive license renewals and continue operating safely, reliably and economically well past 2030.

Finally, the operation of the Nation's existing nuclear power plants have helped States meet the Clean Air Act while increasing electricity supply to meet demand. In 1999, operation of the Nation's existing nuclear power plants provided the greatest share of clean energy in the United States—70 percent of America's emission-free electricity generation (with most of the rest coming from hydroelectric resources). Between 1973 and 1998, the use of nuclear energy avoided 87.2 million tons of sulfur dioxide and 40 million tons of nitrogen oxides (pollutants under the Clean Air Act). Without nuclear power plants, the states covered by Title IV of the Clean Air Act, located in the Eastern and Midwest United States, would be hard-pressed to meet the targets required by the law.

U.S. nuclear plants also avoid the release of 165 million metric tons of carbon annually which plants. Cumulatively, more than two billion metric tons of carbon has been avoided in the years since 1973. In the future, without the avoided carbon from nuclear energy, the United States would have to reduce greenhouse gas emissions by over 325 million tons annually—double the current, already ambitious target—in order to reach the 1990 baseline under the United Nations Framework Convention on Climate Change. In the decades ahead, nuclear power will remain an essential part of the Nation's diverse energy resource portfolio, fueling our economy with a secure, domestic source of electricity. The safe, long term operation of these plants serves our national interest by providing for energy security and diversity and providing for reliable and affordable energy—a fundamental underpinning of our economic prosperity.

The Energy Information Agency projects U.S. energy consumption will increase substantially by 2020, with about 300,000 megawatts of new generating capacity required to meet demand and replace retiring generating capacity. As a result, if the U.S. is to maintain its current proportion of roughly 30 percent non-emitting electricity supply, about 108,000 megawatts of this new capacity must be renewable, hydroelectric, and/or nuclear power capacity.

Clearly, the recognized benefits of nuclear energy are prompting new discussions about the future of nuclear power in the United States as attention focuses on the nexus between reliable competitive electricity, clean air and preserving the earth's climate. Market decisions on whether to deploy new nuclear capacity, will be decided in large part based on the economics. We believe that nuclear power can play an important role in meeting future U.S. energy needs. We have seen the success industry has had in reducing operating costs. While work continues to be needed to reduce construction costs, we have great cause to be optimistic.

First, the Nuclear Regulatory Commission has done an outstanding job in becoming an efficient regulatory agency under whose safety oversight, utilities can successfully plan for the future. The negative experiences of the past have not been replayed in NRC's successful implementation of license renewal. Many in industry now believe that NRC could also be a good partner in the construction of new nuclear plants under the new but untested "one-step licensing" rules possible for the three certified advanced light water reactor designs. The Department looks forward to working with NRC to bring advanced, performance-based, risk-informed regulation into reality, with promises of additional improvements in oversight.

Second, much of the new advanced light water reactor technology has been implemented and proven overseas. The successful construction and operation of Advanced Boiling Water Reactors in Japan is the salient example. This experience demonstrates that these technologies can be built in a timely, cost-effective manner and result in power plants of high quality, reliability, and economic competitiveness.

In order for nuclear energy to be competitive in the U.S. in the twenty-first century, however, challenges to its expanded use much be satisfactorily resolved. The high construction costs seen in the late 1970s and early 1980s must be avoided, concerns about generation and disposal of nuclear waste must be finally resolved, remaining public concern about safety must be addressed, and issues associated with proliferation must be dealt with. In great part, focusing on the technical aspects of these issues has become a primary mission of my office.

NUCLEAR ENERGY RESEARCH—50 YEARS OF INNOVATION

Beginning in the 1950's, DOE's predecessor agency, the Atomic Energy Commission (AEC), with its scientific infrastructure, sponsored development of prototypes for reactor technologies that are in commercial use today. This activity continued through the 1960's as the AEC assisted in the design and construction of several more civilian nuclear power plants. However, as less and less startup support was required from the Federal government, the AEC began to focus more sharply on other potential applications for nuclear technology, including space reactors, radioisotope production, nuclear medicine and different types of advanced power reactors that offered theoretical advantages over established light water reactor technology.

Today, as a result of this early partnership between government and industry, 103 light water reactors are operating in this country—a technology which operates safely, and predictably, providing almost 23 percent of the Nation's electricity. This is an impressive success story. With a Government R&D investment of about $2 billion (roughly $7.6 billion in FY 2000 dollars) over the last forty years, utilities have put in place a $200 billion nuclear plant infrastructure which is economic, reliable, and safe. More recent investments the Government has made in this technology, after the commercial nuclear plant business was launched (75% of the U.S. Government investment in commercial light water reactor technology was made prior to 1980), have successfully increased efficiency of nuclear fuel by 50 percent, reduced generation of spent fuel by a third, reduced plant worker exposure by 67 percent, and made a whole new generation of certified, advance light water reactors available to the world. These follow-up investments not only improve the environmental performance of nuclear plants and enhance worker safety, but will save billions of dollars for the U.S. economy over the life of our operating plants.

Despite, or perhaps because of this success, the Government's investment in nuclear technology declined substantially in the 1980's and 1990's. With completion of the Advanced Light Water Reactor (ALWR) program in 1997, the funding for nuclear energy R&D declined to zero in 1998 and the Department took this time to reshape our approach to fission research to realign research with the key challenges to the use of nuclear energy and to goal of preserving the Nation's nuclear science and engineering education and facility infrastructure. This shift was based on the Administration's Comprehensive National Energy Strategy (1998), the DOE Research and Development Portfolio (February 2000), and by the recommendations of the President's Committee of Advisors on Science and Technology (PCAST).

External Advice in DOE's Nuclear Power Program

PCAST identified nuclear energy as among the technologies that could address a number of energy challenges, including reducing dependence on foreign oil, diversifying the U.S. domestic electricity supply system, expanding exports of U.S. energy technologies, and reducing air and water pollution, including greenhouse gas emissions. PCAST recommended that the Department reinvigorate its nuclear energy R&D program; this was followed by a second report last summer, in which PCAST recommended additional investments in the Department's nuclear R&D program to enable the program to expand its cooperation with the international community.

Using the PCAST recommendations as a roadmap, we have begun the recovery of the Federal nuclear technology program. In 1998, Secretary Richardson, took additional steps to guide the future direction of the Department's nuclear energy research, to ensure successful implementation of the PCAST recommendations, including identifying promising research that warrants additional investment. He did this primarily by establishing the Nuclear Energy Research Advisory Committee, or NERAC.

NERAC, chaired by Dr. James Duderstadt, former President of the University of Michigan, is comprised of independent policy, science and technology experts from universities, national laboratories and industry, with expertise ranging from reactor operations and nuclear engineering to biological sciences, nuclear medicine, environmental sciences, economics and strategic planning. I am pleased to note that one of NERAC's most active members, Dr. Dale Klein, is seated here with us today.

PCAST and NERAC have helped us reinvent the Federal role in nuclear energy research and development. Recognizing the realities of today's constrained budgetary environment, we have reorganized how we conduct research, how best to accelerate innovation and how to assure the best return on the investment for the Nation. We have returned to a more focused Federal role in conducting R&D—that is, investing most of our research portfolio on long term, higher risk basic research aimed at reducing or eliminating significant barriers to future use of nuclear energy. This is research that typically is not within the shorter-term planning horizon of industry.

Current Nuclear Energy R&D Activities

NE's largest research activity, the *Nuclear Energy Research Initiative* (NERI), reflects this fundamental shift in the way in which research projects are selected, funded, conducted, and evaluated. Focused on obstacles to long-term use of nuclear energy, NERI promotes investigator-initiated, peer reviewed research, enabling us to consider a broad range of innovative ideas brought forth from universities, industry, and our national laboratories to address issues such as plant economics, waste, and proliferation. Last year, 46 research projects were launched under NERI, involving 21 universities, eight national laboratories, 16 private sector organizations, and one federal agency. This year, 10 new projects will begin, involving seven universities, five national laboratories, and one government agency. Many of these projects also include significant collaboration by international research organizations.

Another major area of focus for the NERI program this year, and an area of growing interest in the U.S. and with the international research community, are *Generation IV* nuclear power systems. Generation IV systems are next generation advanced technologies that will be economically competitive with combined cycle gas fired systems and deployed over the next 20 years. In January, the Department sponsored a workshop with representatives of the governments of Argentina, Brazil, Canada, France, Japan, South Africa, South Korea, and the United Kingdom to begin discussing the attributes of Generation IV reactor systems. The workshop included observers from the International Atomic Energy Agency, the OECD Nuclear Energy Agency, the U.S. Department of State, American Nuclear Society, and DOE's Nuclear Energy Research Advisory Committee. Following the conclusion of the workshop the participants issued a joint statement agreeing to pursue Generation IV nuclear power systems as a potential next generation energy option. There have been other meetings since January, refining concepts for effecting multilateral cooperation and setting general technology targets for next-generation nuclear power systems.

In fiscal year (FY) 2000, another major shift in our research priorities occurred with the initiation of the *Nuclear Energy Plant Optimization* (NEPO) program. Recognizing the important role that the nation's existing nuclear power plants continue to serve over the next several decades in meeting demand for electricity in an environmentally sound manner, $5 million was provided in FY 2000 for NEPO research conducted in cost-shared cooperation with the Electric Power Research Institute, the research arm of the electric power industry, for the purpose of improving existing plant operations, safety, and reliability.

This $5 million represents a Federal investment in intermediate term, higher risk research that is needed to increase the pace of innovation for developing new technologies for today's nuclear power plants. While industry's $85 million annual investment is focused on a short term horizon, funding "just-in-time" solutions to problems for existing plants, our investment serves to leverage Federal research dollars with industry's matching funds in order to expedite and conduct intermediate term generic research needed by all of the nuclear utility industry to continue safe, economic, and reliable operation of the Nation's nuclear plants.

All of the work conducted in this program is reviewed by independent experts, including the NERAC, the Nuclear Regulatory Commission, and U.S. universities and is guided by a detailed *DOE/EPRI Joint Strategic R&D Plan for Operating Nuclear Power Plants.* Further, this program is cost-shared with the private sector; about 60% of the work planned for this year will be funded by industry.

University Programs—Preparing for the Future

Government, industry, and academia alike face similar challenges in sustaining our critical nuclear science and technology infrastructures—our research facilities and human resources. Like much of the industrial base that emerged during and after World War II, the nuclear industry is a mature industry that is challenged by an aging workforce and research facility infrastructure. This is echoed by the Nation's universities, which are challenged by declining enrollments and aging facilities.

Nuclear engineering programs and departments with an initial emphasis on fission were formed in the late 1950's and 1960's from interdisciplinary efforts in many of the top research universities, providing the manpower for this technical discipline. In the same time period, for many programs, university research reactors were constructed and began their operation, providing facilities for research and training of students. Over the last decade, U.S. nuclear science and educational infrastructure has stagnated, and started to decline. The number of independent nuclear engineering programs and number of operating research reactors have fallen by about half since the mid 1980's. In contrast, demand for nuclear-trained per-

sonnel is increasing to meet the needs of operating nuclear power plants and new initiatives in radiation science in collaboration with industrial and medical researchers as well as new bio-technologists. Finally, nuclear science and engineering continues to be needed in national security as well as providing the U.S. Navy with effective, safe nuclear propulsion.

In order to meet the increasing demand for nuclear scientists and engineers in this century to support advancements in all of these areas—medicine, management of nuclear waste, nuclear technologies—in 1997, the Department re-instituted a university and reactor assistance program, and now provides about $12 million of direct support each year to 47 educational institutions in 28 states. With scholarships and fellowships to outstanding students, research and infrastructure grants, and other programs, the Department has become the sole Federal agency to address the challenges in this vital sector of our education system.

We have seen some success. With the modest federal investment, we have been able to help reverse the precipitous decline in the number of students earning nuclear science and engineering degrees at the Nation's universities. However, we recognize that more needs to be done if we are to preserve this irreplaceable, world-leading education infrastructure for the future needs of the United States.

Future Directions

NERAC has several very active subcommittees examining various aspects of nuclear technology. Relevant to this discussion, the Committee has recently issued two reports that address the future of nuclear energy, the *Long-Term Nuclear Technology Research and Development Plan,* to guide nuclear energy research out to the year 2020 and a report from a Blue Ribbon Panel on *The Future Direction of University Nuclear Engineering Programs.*

The Long-Term R&D Plan, developed by NERAC with significant interaction from the wider research community, recommends that R&D budget levels be increased in order to enable the Nation to gain further advantages and value from our currently operating nuclear plants; provide for economic technologies and approaches to build enhanced advanced light water reactors in the U.S.; complete a prototype design for a Generation IV nuclear power system, and support a range of enduring missions within the Department. Although motivated in part by the need for new nuclear reactor system designs, clearly, such an investment would have a far-reaching impact elsewhere in engineering and technology. NERAC sets a goal of conducting $240 million in nuclear energy research by 2005.

Both the Long Term R&D Plan and the Blue Ribbon Panel report recognize that the ability to advance nuclear innovation in the future is not only tied to research but to the health of the education and scientific research infrastructure in the U.S. Without a continued supply of new graduates in nuclear energy-related areas, we will not be able to provide society with the benefits associated with the many applications of nuclear technology and U.S. leadership in this essential area of science and technology will slip away. Recognizing the vital nature of this issue, and the fact that the U.S. nuclear education infrastructure is in serious trouble, the NERAC recommends the Federal investment in nuclear science and technology programs at U.S. universities be increased to approximately $45 million, including a new program to fund improvements in university research reactors through peer-reviewed awards for research, training and other educational activities. With this increase, the Committee believes, the United States will be able to maintain a strong and vibrant nuclear science and engineering infrastructure well into the twenty-first century, providing the Nation with a realistic nuclear power option and well-trained engineers and scientists who can address important technical challenges in areas such as nuclear medicine, nuclear waste treatment and cleanup, and enhancing international nonproliferation.

CONCLUSIONS

Deployment of nuclear technology which occurred largely in the 1970's, paved the way for expanded use of nuclear power in lieu of oil-fired electricity supply, thus enabling oil to be concentrated in the transportation sector. Nuclear power was also deployed at a time of considerable debate about deteriorating air quality in the Nation's cities leading to enactment of the Clean Air Act. This strategy, increasing energy security and diversity, while supporting environmental objectives, prevails today and demonstrates the important role that nuclear energy can serve in meeting our Nation's need for electricity in a manner that is consistent with our environmental values and objectives—that energy use, economic growth and environmental protection need not be mutually exclusive.

Today, we are at a time of tremendous opportunity where the research and policies we engage in now will define the technologies that are deployed over the next

20 years when demand for energy is expected to increase substantially. The decisions we collectively make today can significantly influence energy supply options and environmental control outcomes over the next fifty years. It is my hope that support for advancing nuclear energy technologies will grow as the Nation recognizes the important role that nuclear energy can serve in safely, reliably, and cost-effectively meeting demand for electricity in the future in a manner that is consistent with the nation's environmental values and objectives.

I look forward to discussing the benefits on nuclear energy and the important role that nuclear energy continues to serve in providing for energy diversity, security, and reliability and in securing our Nation's environmental future. I would be happy to answer any questions you have.

Mr. BARTON. Thank you, Mr. Magwood.

We now want to hear from Mr. Corbin McNeill, Jr., who is the Chairman, President, and Chief Executive Officer of PECO Energy Generation in Philadelphia, Pennsylvania. He is a graduate of the U.S. Naval Academy, and had a distinguished career in the United States Navy before going into the private sector. His company is making major moves into generating power by nuclear means.

Welcome to the committee.

STATEMENT OF CORBIN A. MCNEILL, JR.

Mr. MCNEILL. Thank you very much, Mr. Chairman. As you said, I am Corbin A. McNeill, Jr., the Chairman, President, and Chief Executive Officer of PECO Energy Company of Philadelphia.

PECO Energy currently owns or operates six nuclear reactors at three sites in Pennsylvania and New Jersey. Additionally, PECO's AmerGen partnership with British Energy, the nuclear generating company in Great Britain, owns and operates two reactors, and has agreements in place to acquire two additional reactors.

Finally, PECO and the Chicago-based corporation, Unicom, the parent company of Commonwealth Edison, are intending to merge later this year, and once the final regulatory approval is received, our combined company, which will be known as Exelon Corporation, will own and/or operate 20 of the Nation's 103 commercial nuclear reactors.

I am here today to provide the perspective of the nuclear energy industry, representing all 103 nuclear power plants, which safely produce 22 percent of our Nation's energy, electricity.

As the electricity industry is deregulated in Pennsylvania, and my experience is that Pennsylvania was one of the first to deregulate, it will be essential to have a comprehensive, updated nuclear energy policy. Only such a plan will guarantee that policymakers have the basis to make sound decisions for assuring a safe, clean, reliable, and economic supply of electricity for the future, and one that ensures energy through fuel diversity.

Unfortunately, the existing Federal policy toward nuclear, as you expressed earlier, can best be described today as one of neglect. This is distressing, given that nuclear energy is our largest source of emission-free electricity, and the second largest generator of electricity, overall.

Despite a cumbersome approach to a national energy policy, there has been progress in policies that will position the industry, as well, as we enter the new century.

As Mr. Magwood mentioned, the Nuclear Regulatory Commission's regulatory reform efforts, paired with consolidation of ownership of nuclear power plants, will help ensure the continued safe,

reliable, and economic operation of the vast majority of today's nuclear plants.

While the continued operation of these plants and the development of advanced reactor designs rely on nuclear powers' economic viability in a deregulated electricity market, the Federal Government has a responsibility to provide a stable and predictable regulatory environment; to avoid artificial distinctions that may disadvantage nuclear energy in the market place; to uphold its contractual commitment to manage used nuclear fuel, and to help dispel what I believe are unwarranted public concerns about the perceived risks related to nuclear energy.

Three other policy changes are appropriate to ensure that otherwise economical plant consolidations are not necessarily burdened. For instance, revision of Section 468A of the Internal Revenue Code, which addresses the tax treatment of nuclear decommissioning trust funds; the repeal of the Public Utility Holding Company Act; and the elimination of the statutory requirement that the Nuclear Regulatory Commission conduct an anti-trust review, when conducting a license transfer proceeding, would be helpful.

The most important of these is the decommissioning issue, which relates to the need to update the current tax code, to recognize that in a deregulated environment, nuclear plants may be owned and operated by an entity that is unregulated in a historic cost of service sense.

Section 468A currently provides for the tax-free transfer of qualified nuclear decommissioning funds, as a part of a plant sale or license transfer, when a plant is transferred from one regulated entity to another.

While the IRS has used its discretionary authority to permit a tax-free transfer of these funds in Private Letter Rulings, related to the three plant sales which have been completed to date, Congress should amend Section 468A to make it clear that plant sales to unregulated entities should not trigger a taxable event when decommissioning trust funds are transferred.

I believe that the future is very bright for nuclear energy in the United States, but that future will be realized only if industry and government, working together, can meet the long term challenges facing the industry. These challenges can be successfully addressed if Congress and the Administration have the political will to act.

Let me be clear that the industry's future should not be based on government subsidies. It is the ultimate responsibility of the industry to ensure that a new generation of nuclear plants be safe, reliable, efficient, and acceptable to the public.

Nevertheless, there is an important role for the Federal Government to play, if we are to benefit from the extended operation of today's nuclear plants in a new generation of emission-free plants.

First, the Federal Government must continue to move toward a safety-focused regulatory system. In addition, Congress should eliminate the duplicative regulation that has allowed the Environmental Protection Agency to become involved in issues that are more appropriately a subject of NRC authority.

Second, the Federal Government must treat nuclear power like any other electric technology, and should not make arbitrary distinctions that disadvantage nuclear energy in competitive markets.

Nuclear energy must be treated consistent with other fuel sources, whether it be in regulation of radiation at all electric production facilities, or to the disclosure of benefits and adverse impacts in consumer labeling of electricity sources.

This means that the Federal Government should also recognize in its environmental policies, the clean air benefits of nuclear energy. Nuclear energy is a source of electric generation that emits no air or water pollution, and should benefit from any Federal incentives awarded to other generation sources, because of their clean air and clean water characteristics.

Third, the Federal Government, as you had mentioned, Mr. Chairman, must meet its statutory commitment to develop a repository for permanent disposal of used nuclear fuel.

Finally, the Federal Government should strive in its public education programs to emphasize the reality that the risk for nuclear energy is small, compared to other risks in society.

In that regard, I would like to respond to Mr. Sawyer's request to address the issue of deregulation, and its impact on safety.

While conventional thought might relate cost pressure to declining safety, in fact, the reverse is true. In a deregulated environment, my company bears the risk of a poor safety record, much more so than it did in a regulated environment. If equipment failures or regulatory shutdowns were to occur, my shareholders will bear all of the cost of that shutdown, and that is unacceptable.

Therefore, as the Chief Executive Officer, I must ensure that the highest levels of safe, reliable operation are maintained.

In my personal experience, and that of the industry, we have found that safety and economic costs are not mutually exclusive. Over the last decade, we have demonstrated that the lowest cost plants in terms of operation, in fact, have the best safety records. This has been the promise of nuclear energy since its inception, and one that is now proving to, in fact, be the reality.

To condense the rest of my statement, Mr. Chairman, to stay on time, I just would tell you that we do have a bright future. Mr. Magwood has mentioned that the Department of Energy has supported the Nuclear Plant Optimization Program and the Nuclear Energy Research Initiative. In fact, we see the promise of potential new reactors in the next 5 years, whether they be the currently licensed new generation or whether they be small modular designs.

In closing, as you prepare, in the next several years, to address the Price-Anderson Act renewal, one of the things that I would suggest to you is that with small modular designs, they need to be treated differently than the large reactors, and that, in fact, we might look for ways to fund Price-Anderson liabilities in a different manner than we do today on a pro-reactor basis; but maybe on a capacity basis.

That concludes my remarks, and I thank you very much, Mr. Chairman.

[The prepared statement of Corbin A. McNeill, Jr. follows:]

PREPARED STATEMENT OF CORBIN A. MCNEILL, JR., CHAIRMAN, PRESIDENT AND CHIEF EXECUTIVE OFFICER, PECO ENERGY COMPANY

Mr. Chairman and Members of the Committee: I am Corbin A. McNeill, Jr., and I am the Chairman, President, and Chief Executive Officer of PECO Energy Company of Philadelphia. PECO Energy currently owns and/or operates 6 nuclear reac-

tors at three sites in Pennsylvania and New Jersey. PECO's AmerGen partnership with British Energy owns and operates two reactors and has agreements in place to acquire two additional units. Finally, PECO and Unicom Corporation, the parent company of Commonwealth Edison Company, have announced our intention to merge later this year. Once final regulatory approval is received from a myriad of federal and state agencies, our combined company—to be called Exelon Corporation—will own and/or operate 20 of the nation's 103 operating nuclear reactors.

Thank you for the opportunity to appear before you today to discuss the current challenges facing nuclear energy and the role nuclear energy can play as part of the nation's long-term National Energy Policy.

As the electric utility industry is deregulated, it will be critically important to have a comprehensive and up to date National Energy Policy in place. Only such a plan will guarantee that policy makers will have the information necessary to make sound decisions for assuring a safe, clean, reliable and economic supply of energy for the future.

Electricity growth over the last 25 years has largely paralleled economic growth in the United States. Thus, assuring an adequate supply of electricity is vital both for our nation's economic growth and for the quality of life of all Americans. Nuclear energy can and, I believe, will continue to play an important role in providing that electricity.

My comments today will focus on three themes:

First, existing Federal policy towards nuclear energy can best be described as one of neglect. This is distressing since nuclear energy is the second leading source of electric generation.

Second, the NRC's current regulatory reform efforts, paired with the consolidation of companies owning nuclear plants, will help ensure the continued safe, clean, reliable and economic operation of the vast majority of the nation's existing reactors.

Third, while the continued operation of existing plants and the development of a new generation of plants will depend upon nuclear power's ability to compete in a deregulated electric market, the Federal government has a responsibility to provide a stable regulatory environment, to avoid artificial distinctions which disadvantage nuclear energy, to uphold its commitments to manage used nuclear fuel, and to provide honest and objective information to the public to dispel public unwarranted concerns about risks related to nuclear power.

CURRENT FEDERAL POLICY

The Federal government's existing policy toward nuclear energy can best be described as one of neglect, bordering at times on open hostility. While this assessment may seem harsh, the facts speak for themselves:

- With few exceptions, Federal policy makers completely disregard the role of nuclear energy in meeting the nation's energy needs. It is a constant source of amazement and frustration to read or listen to speeches by the nation's leading energy policy makers—both within the Administration and within Congress—which address energy and electricity policy without once mentioning the word "nuclear." As recently as May 24, during this Subcommittee's first hearing on National Energy Policy, the Department of Energy's written statement, which was 20 pages long, mentioned nuclear energy only once, and then only as part of a laundry list of research and development initiatives.
- In nuclear power, we have a mature baseload technology that generates billions of kilowatts of electricity annually without emitting any of the pollutants associated with acid rain, smog, haze, ozone, or global climate change. Yet, nuclear power is rarely credited with its role in emissions avoidance or cited as a source of future avoided emissions. To put the role of nuclear power in perspective, if the U.S. closed all 103 nuclear plants and replaced them with fossil fired plants, we would have to remove 90 million cars from America's highways just to maintain the air quality at its current level.
- Just two years ago, funding for the Department of Energy's research and development program for improving commercial nuclear power plants was completely eliminated. In fiscal year 1998, not a single Federal dollar was spent on research and development for an energy source that provides over 20 percent of the electricity generated in the U.S. Funding for this important program was begun again, at a modest level, in 1999 and continues today. But increased funding is necessary to avoid significant negative impacts on efforts to recruit and sustain an educated workforce to design and operate nuclear plants in the future.
- The nation's management program for used nuclear fuel is at least 12 years behind schedule. The Federal government's failure to meet its contractual and

statutory deadline to begin accepting used fuel by 1998 threatens the continued operation of some of the nation's best run nuclear power plants. The Clinton Administration has failed to offer a concrete plan for addressing the crisis faced by these plants, while Congress has failed to reform a flawed funding process that will lead to even more delays if the problem is not resolved soon. President Clinton's veto of recently-passed used fuel legislation ignored what has traditionally been broad, bipartisan support for addressing this issue.

Given these facts, it is hard to argue that Federal policy toward nuclear energy can be characterized as anything but neglectful at best.

Nuclear power, as with all energy sources, is not without its challenges, but those challenges can be addressed successfully and should not overshadow the significant positive contribution of nuclear energy in meeting America's energy needs.

CONTINUED OPERATION OF EXISTING PLANTS

Contrary to conventional wisdom just a few years ago, the future for the existing fleet of nuclear reactors in the United States is bright. While some forecasters predicted that dozens of current plants would shut down prematurely and that dozens more would shut down at the end of their current licenses, many of those same analysts are today predicting that only a handful of plants will close prior to the expiration of their licenses and that the vast majority of plants will seek 20 year renewal of their current licenses. In fact, some studies now are predicting that total electric output from nuclear plants will increase, even without new reactors coming on line, as a result of productivity gains by current reactors.

What has sparked such a dramatic reassessment of the industry? In addition to tremendous strides in operational efficiency, outage reduction, and plant improvements, regulatory reform and the movement towards consolidation of nuclear power plant ownership have presented the nuclear energy industry with new and exciting opportunities to compete in the electric marketplace.

From 1990 to 1999, increases in output as a result of plant upgrades, increased capacity factors, and shorter maintenance outages were the equivalent of adding 16 new 1,000 megawatt plants. These dramatic improvements in plant performance have made nuclear plants increasingly competitive economically.

Two other factors are key to maintaining the current nuclear capacity in the U.S.: the Nuclear Regulatory Commission's transition to a stable, safety-focused regulatory regime and the trend toward plant consolidation in the industry.

The NRC in recent years has served as a model of regulatory reform, adopting a new oversight process that relies on performance-based, objective indicators to judge acceptable levels of plant operations. The new process is more transparent and open than the old system and uses quantitative performance indicators. Revised inspection and enforcement programs have been integrated into this process as well.

This new approach enhances safety by focusing management and regulatory attention on areas with the greatest safety significance. The NRC is to be commended for implementing this new system.

Consolidation of nuclear plants will also have a significant impact on efforts to retain the current capacity of nuclear plants by allowing many plants that may be marginally economic on a standalone basis to continue to operate as part of a much larger nuclear organization.

Consolidation achieves savings by having one organization handle operations, maintenance, outage planning and administration for a number of plants. These costs can be spread over a number of plants instead of being borne by a single unit.

This consolidation is occurring through plant purchases, mergers, and operational arrangements. PECO's AmerGen partnership with British Energy has completed the purchase of two plants and has agreements in place for the purchase of two additional units. Entergy Corporation has completed one purchase and has an agreement to purchase two other plants. Other companies have expressed serious interest in purchasing nuclear plants in the U.S., and seven plants in the Midwest, belonging to five different utilities, are now being operated by a newly formed nuclear operating company. The number of plant transfers is expected to increase as states deregulate their electric generation markets.

Three policy changes are important to remove potential barriers to permitting otherwise economical plant consolidations: revision of Section 468A of the Internal Revenue Code which addresses the tax treatment of nuclear decommissioning trust funds, repeal of the Public Utility Holding Company Act (PUHCA), and elimination of the statutory requirement that the Nuclear Regulatory Commission conduct an anti-trust review when conducting a license transfer proceeding.

The decommissioning trust fund issue involves the updating of the current tax code to recognize that—in a deregulated environment—nuclear plants may be owned

and operated by an entity that is unregulated in a historic cost of service sense. The tax code currently provides for the tax-free transfer of Qualified Nuclear Decommissioning Funds as part of a plant sale or license transfer when a plant is transferred from one regulated entity to another. These provisions were written in 1984, a time when Congress did not envision the possibility of a nuclear plant being sold to an unregulated entity. While the IRS has used its discretionary authority to permit a tax free transfer of these fund in Private Letter Rulings related to the three plant sales completed to date, Congress should amend Section 468A to make it clear that plant sales to unregulated entities should not trigger a taxable event when decommissioning trust funds are transferred.

Legislation has been introduced in the House by Congressmen Jerry Weller and Ben Cardin (H.R. 2038) and in the Senate by Senators Frank Murkowski and John Breaux (S. 1308) to address this issue. The provisions of the Weller-Cardin bill are also included in H.R. 2944, Congressman Barton's Electricity Competition and Reliability Act. Some of the provisions of H.R. 2038 were included in H.R. 2488, the Financial Freedom Act of 1999, and some provisions were included in President Clinton's FY 2000 budget proposal.

Repeal of PUHCA, as you know, is a primary feature of nearly every bill pending before Congress to address the restructuring of the electric utility industry. PUHCA is an outdated law that has outlived its usefulness, as evidenced by even the Securities and Exchange Commission's report a few years ago advocating its repeal. To the extent that PUHCA concerns prevent utility mergers, consolidation of nuclear plants will be less likely.

Finally, the NRC has recommended as part of a package of proposed amendment to the Atomic Energy Act that Congress repeal the statutory requirement that the Commission conduct an anti-trust review when conducting a license transfer proceeding. Such an analysis is duplicative of reviews conducted by other Federal agencies.

LONG-TERM PROSPECTS FOR NUCLEAR ENERGY

Though the future is bright for nuclear energy in the United States, that future will only be realized if industry and government, working together, can meet the long-term challenges facing nuclear power. These challenges, while significant, can be successfully addressed if Congress and the Administration have the political will to act.

Let me be clear that the nuclear energy industry's future in the United States should not be based on inappropriate government subsidies. It will be the ultimate responsibility of the industry to ensure that a new generation of nuclear plants will be safe, clean, economic, reliable, efficient, and acceptable to the public.

Nevertheless, there is an important role for the Federal government to play if the United States is to benefit from extended operation of our current nuclear plants and a new generation of nuclear power plants:

- first, the Federal government must continue to move towards safety-focused regulation;
- second, the Federal government must treat nuclear power like any other electric generating technology and should not make arbitrary distinctions that disadvantage nuclear energy (this includes the recognition in Federal environmental policies the non-emitting benefits of nuclear energy);
- third, the Federal government should meet is statutory commitment to develop and operate a repository for the permanent disposal of used nuclear fuel; and
- the Federal government should strive in its public education programs to emphasize the reality that the risk from nuclear energy is small compared to other risks in society.

Safety-Focused Regulation

The Federal government must continue to move toward true safety-focused regulation that provides objective and transparent standards for assessing the performance of nuclear power plants. As I stated earlier, the Nuclear Regulatory Commission's efforts in this regard deserve particular recognition as a model of regulatory reform

The NRC must continue to adapt to a maturing industry and to develop an effective, safety-focused regulatory framework. The NRC has made substantial efforts to reform its regulatory approach by implementing an innovative regulatory oversight process that is more safety-focused and performance-based and, more broadly, by developing risk informed, performance-based regulations.

While the industry supports the NRC's ongoing efforts to develop a more effective regulatory regime, Congress should continue its oversight of the NRC to ensure that

the agency's actions recognize outstanding industry safety levels and that the NRC implements sound budgeting practices and long-term strategic planning.

Consistent Regulatory Treatment

Retaining nuclear energy as part of a sound national energy policy requires that nuclear energy be treated in a manner consistent with other fuel sources, whether it be in regulation of radiation at all electricity production facilities or disclosure of benefits and adverse impacts in consumer labeling of electricity sources. Nuclear energy can compete today and in the future, but policy makers must treat nuclear energy as they would any other energy source and apply the same rules to all competitors in the newly deregulated electricity market.

In the coming years, the federal government and its administrative agencies must pursue policy initiatives to address issues that will have a significant impact on the industry's future. Those issues include recognizing the value of nuclear energy as an emission-free source of electricity and eliminating duplicative and conflicting regulation.

Policy makers must explicitly recognize the intrinsic economic value of nuclear power as a greenhouse gas emission-free energy source. Maintaining nuclear power's emission free capacity is necessary to prevent increases in the emission-reduction requirements imposed on emitting power sources, such as natural gas or coal. Policy makers should (1) consider ways to allow nuclear energy to capture the clean air compliance value produced by emission-free sources of generation, (2) ensure that nuclear energy is fairly labeled, and (3) ensure that nuclear energy is treated equally with other non-emitting grid capable electric generating sources if an emission-free portfolio standard is adopted.

The Energy Information Agency reported in *Utility Fossil Fuel Receipts and Costs—The Year 1999 in Review,* that "a 1-percent increase in the annual nuclear plant capacity factor . . . translates into a reduction in annual consumption of either approximately 4.3 million short tons of coal, 14 million barrels of petroleum, or 89 billion cubic feet of gas. Most likely, it would be a combination of each."

According to EIA data, the capacity factor for nuclear plants in 1999 was 86 percent, compared to 78 percent in 1998. Clearly, nuclear energy offers a tremendous value in helping make our air cleaner. In fact, it would be difficult, if not impossible, to meet Clean Air Act emissions standards in some parts of the country without nuclear power.

Nuclear energy, as a source of electric generation that emits no air or water pollution, should benefit from any Federal incentives awarded to other generation sources because of their clean air and clean water characteristics.

Congress must eliminate duplicative regulation that has allowed the Environmental Protection Agency to become involved in issues that are more appropriately subject of NRC authority. (For example, EPA has threatened to overturn NRC's regulatory decisions by seeking remediation under Superfund for sites decommissioned in accordance with NRC requirements. Another example of unnecessary and unproductive dual regulation is the application of the Resource Conservation and Recovery Act to commercial mixed wastes.)

Meeting Commitments on Used Fuel Management

The federal government must fulfill its longstanding obligation to provide for central storage of used nuclear fuel. The national policy for management of used fuel was codified in the Nuclear Waste Policy Act of 1982 and in 1987 amendments to the Act. Although DOE currently is evaluating the suitability of a repository at Yucca Mountain, Nevada, the program will not yield timely results without additional legislation, forcing many plants to build temporary onsite storage at a cost of millions to consumers at each plant. The government's breach of its contractual obligation is creating a taxpayer liability that could eventually cost taxpayers billions of dollars.

In addition to programmatic changes, it is imperative that Congress address the budgetary mechanism for funding the Department of Energy's used fuel program. If Yucca Mountain is designated as the site of the permanent repository, the program budget will need to increase tremendously to keep the project on its revised schedule. It is difficult to imagine Congress appropriating the necessary funds given the current budgetary constraints on the program. Congress should take steps to place program spending on the mandatory side of the budget so that it is not subject to the budget caps. (Money collected from the Nuclear Waste Fund is scored as mandatory receipts.)

Energy Secretary Bill Richardson should be applauded for his efforts to address, at least partially, the financial burden placed on utilities due to DOE's failure to meet its contractual obligations by offering to enter into settlement agreements as

directed by the Federal courts. Under such agreements, utilities could be compensated for costs incurred as a result of DOE's delay in accepting used fuel from reactor sites beginning in 1998. Nevertheless, compensating utilities for the costs of on-site storage is not a long-term substitute to centralized storage of used fuel. Congress and the Administration should work together to put this program—which is already 12 years behind schedule—back on track.

Developing an integrated solution to managing used fuel is a political, not a technical, problem. The issue is not how to manage used fuel, but where to manage it.

Public Education

The federal government can and should play an important role in educating the public about the very low and manageable risks related to commercial nuclear power as compared other endeavors in society. DOE's public education efforts should clearly convey the relative risks associated with all energy forms and uses.

Similarly, DOE should respond aggressively to correct misinformation regarding the risks and safety record of the commercial nuclear energy industry. Whether it is a television network developing a made-for-TV movie featuring a runaway train with atomic fuel on board that "explodes," or an irresponsible allegation that nuclear fuel shipments are the equivalent of "mobile Chernobyls," the Department of Energy should publicly denounce such misinformation.

The public looks to the federal government for guidance on complex issues, and while DOE should not be an advocate for nuclear energy, it should be responsible for challenging characterizations that deliberately mislead the public.

NEW TECHNOLOGIES TO IMPROVE EFFICIENCY AND REDUCE ENVIRONMENTAL IMPACTS

Mr. Chairman, one of the issues the committee asked witnesses to address was the potential for new technologies that would improve efficiency and reduce environmental impacts.

The good news is that such technology already exists in the form of today's commercial nuclear reactors. Efficiency improvements have increased dramatically over the last decade, and I have cited in detail the environmental benefits to be gained from continued reliance on nuclear energy. Nuclear energy accounts for nearly two-thirds of all the emission-free electricity generation available to the U.S. electric grid today.

In terms of the long-term outlook, the next generation of nuclear reactors has already been designed and is being built in overseas markets. The Nuclear Regulatory Commission has certified three advanced reactor designs—the Westinghouse AP600, the GE Advanced Boiling Water Reactor, and the ABB System 80+. While I personally believe that the future of current advanced light-water designs in the emerging competitive U.S. marketplace is uncertain, I would note that these advanced plants are being built today in Asia.

My personal view is that the next generation of plants to be built in the United States will be modular reactors as small as 100 megawatts in size. These "Generation IV" plants, as they have been called by some, may offer great opportunities for both increased safety—in that such reactors could remove the risk of severe fuel damage—and appropriate cost and market risk features that would make such plants attractive to investors. These plants could be technically and economically feasible within the next five years.

In anticipation of the development of a small, modular reactor design, Congress should consider changes to the Price-Anderson Act when it is renewed to reflect these design advances. Specifically, Price-Anderson's annual premium should be based on plant size ("per megawatt") rather than levied as a flat "per reactor" fee. As you know, Price-Anderson is scheduled to be reauthorized during the next Congress. I would urge the Committee to begin its review of Price-Anderson soon to ensure timely reauthorization of this important legislation.

CONCLUSION

Mr. Chairman, this is not an exhaustive list of the Federal changes needed to ensure nuclear energy's continued role as part of the nation's diverse and secure energy supply, but it addresses some of the major concerns facing the industry.

The nuclear energy industry fully recognizes that in a competitive marketplace, it will have the primary responsibility for ensuring the viability of nuclear technology. The industry must be responsible for making sure that nuclear plants are operated safely, cleanly, reliably, and economically. At the same time, the Federal government has a vital role to play, a role that industry cannot. These government responsibilities include: providing a stable regulatory environment, avoiding artificial distinctions in its environmental and other policies which arbitrarily disadvan-

tage nuclear energy, upholding its commitments to manage used nuclear fuel, and providing honest and objective information to the public to dispel public unwarranted concerns about risks related to nuclear power.

Mr. Chairman, thank you again for the opportunity to appear before you today. I will be happy to answer any questions that you may have.

Mr. BARTON. Thank you, Mr. McNeill.

We now want to hear from Dr. Dale Klein, who is Vice Chancellor for Special Engineering Programs at the University of Texas. He is on the Department of Energy's Nuclear Research Advisory Committee, and is the Subcommittee Chair. He is very active with the Pantex facility up in Amerillo, and is an expert in nuclear in nuclear issues.

You are recognized for 7 minutes, and your entire statement is in the record in its entirety.

STATEMENT OF DALE E. KLEIN

Mr. KLEIN. Thank you, Chairman Barton, and thank you, members of the subcommittee.

I would like to acknowledge and thank you also for holding these hearings. I appreciate the opportunity to comment on a national energy policy that has to do with both coal and nuclear power.

As Chairman Barton indicated, I am a professor of mechanical engineering, and have been at the University of Texas since 1977. Even though I have tenure, I should make comments that while I am giving an academic perspective, they do not reflect any position by the University of Texas or the University of Texas system.

One of the things that we should certainly recognize is that we have one of the best electrical generation systems in the world, and we need to certainly take positive steps to maintain that activity.

As you know, the current base load generation of electricity comes from primarily three fossil fuel sources and two non-fossil fuel sources. The fossil fuel sources are coal, natural gas, oil, the non-fossil or nuclear and hydroelectric.

As Chairman Barton indicated in his opening comments, nuclear accounts for about 20 percent; coal, about 52 percent. These numbers will not change significantly over the next few years, simply because it takes too long to get significant plants in operation today.

There are five areas that I would like to address briefly today, and just first talk about the importance of nuclear and coal in our electrical generation; briefly, about regulatory reform; talk about the spent nuclear fuel program; the low level waste; and the need to maintain a nuclear power infrastructure.

As we indicated earlier, nuclear and coal account for over 70 percent of our electrical generation. Both of these sources are extremely important for our national security and our economic viability. It is not a question of which one of these sources do we need for the future. We need both.

It does not take long for all of us to realize the importance that electricity plays in our lives today. I grew up on a farm in Central Missouri. I have seen firsthand what the importance of electrical supply has done for the average farm family.

When we look around in our daily lives, and we see the use of stereos, air conditioners, robotics, computers, just the very mention of high tech implies an increased electrical utilization. Therefore,

it is important that we maintain that supply, so that we do have a robust and strong economy.

In terms of nuclear issues, there is certainly a lot of mis-information on this involving radiation. There is a House bill before you during this time, House Bill 4566, that deals with issues of radiation, in terms of the metals industry. I would encourage you to look at regulation standards, and as you address some of these issues, to base nuclear issues on fact, rather than fears, so that we can move forward in a positive way.

Another positive way that we have been moving forward, certainly in the nuclear arena, is with initiatives undertaken by Bill Magwood, at the Office of Nuclear Energy, Science and Technology.

The Generation IV concept that he is proposing has certainly captured the interest of a lot our students. It is an area in which we can address and hopefully move forward in a very positive manner.

On the front of regulatory reform, I think the NRC should be complimented in moving toward a safety-based form of regulation environment. We do not want to spend all of our time counting paperclips. We need to look at the issues that make a difference, do them right, and do them carefully.

I think the NRC is moving forward in a positive way. One activity that I believe Congress could examine, as they look at the NRC budget, is currently the Nuclear Regulatory Commission is required to do 100 percent cost recovery. These fees put the burden on all the licensees.

There is a significant fraction of the NRC's budget that is not directly attributable to the licensees' activities, that involve international programs and others. I think it would be helpful if the Congress would take a look at the NRC's budget, and fund those parts that really are the responsibility of the Federal Government, rather than put the burden on the current licensees.

I will just briefly comment on the spent nuclear fuel disposal. As Chairman Barton indicated, we have not moved forward on a centralized storage facility. I was one of three Commissioners that served on a central storage review committee in 1988/1989.

Our commission recommended that a centralized storage facility be constructed, and that the importance of a centralized facility enhanced as the repository was delayed, and as reactors shut down prematurely, both of which have occurred. Therefore, I think the Federal Government does need to move forward in an expeditious manner to solve the high level waste program.

One activity I believe this committee could pursue is in its oversight responsibility to hold DOE accountable for the schedule in making the decision on Yucca Mountain.

In terms of low level waste disposal, this is an area in which work began in 1980 with the Low Level Waste Authority Act. Several compacts were created to address the low level waste issue. That issue has not moved forward in a positive manner. No new sites have been selected.

Again, it is a very complicated issue, from the standpoint of citing. But unless we make some positive decision on moving forward with low level disposal, it has a very negative impact on our re-

search universities and on medical facilities that are users of isotopes.

I would now like to comment on one of the most important issues. That is, maintaining a strong nuclear infrastructure within the United States. There is an overwhelming majority among the scientific community, government regulators, industrial individuals, that believe that nuclear power should remain one of our options as we proceed forward.

Therefore, the United States needs to have a strong nuclear infrastructure in order to speak on global issues, and to have an influence worldwide, as well as in the United States arena.

It is very important that the facilities at the universities and at the national laboratories are maintained and expanded, so that we can make decisions from a scientific and strong position, rather than one of weakness and intimidation.

There are several recommendations that I would like to make in terms of maintaining a viable nuclear power option, the first of which is to maintain that current infrastructure and expand it. The second is to increase the nuclear R&D budget, primarily through the offices of Bill Magwood at NE, so that we are funding research and development on the order of $200 million to $300 million per year.

We need to increase our engineering educational support to over $20 million a year, and we need to support our university reactors at a level of over $20 million a year.

We also need to fund research and development programs in isotope production, both with accelerators and new reactors. We need to enhance graduate student support, so that our best and brightest continue to pursue these exciting fields, rather than just go into area where they get stock options.

In summary, I would like to commend Congress for taking a lot of positive actions in the past. I know Chairman Barton and others on the committee have been very supportive of long range issues. We need to make some very positive aspects and include regulatory reform, solve the high level and low level waste that is used, and maintain a strong nuclear environment.

I would like to thank you for these comments. I look forward to your questions. Thank you.

[The prepared statement of Dale E. Klein follows:]

PREPARED STATEMENT OF DALE E. KLEIN, VICE CHANCELLOR OF SPECIAL ENGINEERING PROGRAMS, THE UNIVERSITY OF TEXAS SYSTEM

Chairman Barton and members of the subcommittee. I thank you for the opportunity to present comments on National Energy Policy: The Future of Nuclear and Coal Power in the United States. My name is Dale Klein. I am currently a Professor of Mechanical Engineering (Nuclear Program) at The University of Texas at Austin and Vice Chancellor of Special Engineering Programs at The University of Texas System. I have been a faculty member at The University of Texas at Austin since 1977. While my comments are from an academic perspective, they do not represent any official position by either The University of Texas at Austin or The University of Texas System. I have been involved in energy issues for over 25 years and welcome the opportunity to comment on how we can continue to maintain one of the best electrical generation systems in the world.

As you know, our current base load electrical generation system consists of three (3) fossil fuel sources (coal, natural gas, and oil) and two (2) non-fossil sources (hydroelectric and nuclear). Renewable sources, primarily photovoltaics, geothermal, and wind, are not currently major sources of electrical generation and are not likely

to be major sources for several decades unless there are some major technological advances.

During 1999, the electrical generation for the U.S. consisted of the following:

	%
Coal	52
Nuclear	20
Natural gas	15
Oil	3
Hydro electric	8
Renewable	2

These numbers will not significantly change for the next several years because of the time it takes to add incremental supplies.

There are 5 (five) areas that I would like to address today: importance of nuclear and coal electrical generation, regulatory reform, spent nuclear fuel disposal, low level waste disposal, and the need to maintain a nuclear power infrastructure.

Importance of Nuclear and Coal Generation

Nuclear and coal provide over 70% of our electrical generation. Both of these sources are extremely important for our national security and economic stability. It is not a question of which of the sources are needed for future power plants—both are needed.

It does not take long for each of us to realize the importance of electricity in our daily lives. I grew up on a farm in Central Missouri and observed first hand the positive aspects that electricity makes on the lives of farmers. We can all look at our use of electricity and see that our dependence on electricity grows each year. Today it is difficult to imagine life without electric lights, television, stereo's, washing machines, dishwashers, microwaves, robotics and computers. The mere mention of—high tech—implies the expanded utilization of electricity—from manufacturing, to the use by individuals. Therefore, it is extremely important to our national security and economic competitiveness that we have a safe, reliable, and economic electrical generation and distribution system. It would be helpful if the U.S. Department of Energy would develop a public education program, to explain our current electrical generation methods and what the major sources will be for the next decade. Others testifying today, will address the issues related to electrical generation and the use of coal. My comments are primarily directed towards actions we should take to enhance the safe, reliable electrical generation by nuclear power.

Regulatory Reform

The U.S. Nuclear Regulatory Commission (NRC) has made significant progress in moving to a "risk informed" regulatory process. I was part of a study, conducted by the Center for Strategic and International Studies, entitled "Nuclear Regulatory Processes." The study provided several specific recommendations where enhancements to the regulatory process can be made, with no compromise on safety, so that the consumer can benefit from these positive changes. The electrical generation by nuclear power has several decades of experience and it is appropriate to re-examine the regulatory process that was developed when the industry was just beginning.

One specific action that Congress should address is the current 100% cost recovery for the NRC. Currently, the nuclear licensees pay for part of the NRC budget that is the responsibility of the federal government

Spent Nuclear Fuel Disposal

When I speak to various groups on nuclear power, the dominant question is "What is the solution to the disposal of the spent nuclear fuel?" Many members of the general public are not familiar with the spent nuclear fuel program in the U.S. Most of these individuals are not concerned about the technical details of spent nuclear fuel disposal, they simply want to know that there is a plan and that it is safe. In 1988-1989, I served on a Congressional Commission to examine the central storage for spent nuclear fuel. This commission concluded that there was no single discriminator for a central facility, but when considering all the factors, a central storage facility was recommended. The advantages of a central storage facility increased if the permanent repository was delayed and if some nuclear plants were shut down early—both of which have occurred. The alternative to a central storage facility was for each reactor site to develop additional "at reactor dry storage." This results in the consumers of nuclear generated electricity paying twice—once for the permanent disposal site and again for additional facilities at the power plants. There is a need for continued, timely progress the permanent site and for the development of a cen-

tral storage facility. Regardless of where the permanent disposal site is located, there will need to be a central storage and processing facility. In addition, there is a need to ensure that the funds paid by the consumers of nuclear generated electricity be allocated to the disposal of spent nuclear fuel.

A specific activity for this committee is to exercise oversight responsibility and hold DOE accountable for the schedule to make a decision on Yucca Mountain.

Low Level Waste

The 1980 Low Level Radioactive Waste Disposal Act has not been successful in achieving the goal of adding new sites for low level radioactive waste (LLW) disposal. Most states have been successful in joining a compact with other states or have established procedures for licensing a LLW facility in their own state. However, no compact or individual state has been successful in obtaining a license for a new LLW facility. To further complicate this issue, the Barnwell, LLW facility in South Carolina will likely reduce the ability for non-compact members disposal states to use this facility. The uncertainty regarding availability and the high cost of LLW disposal has had a negative impact on university researchers and medical isotope users.

Nuclear Infrastructure

There is an overwhelming majority among individuals in the scientific community, government officials, and elected officials that believe the U.S. should maintain a nuclear power option. In addition, there is a strong belief that the U.S. needs to have a significant nuclear program in order to influence global nuclear policy. It is difficult for the U.S. to promote nuclear policy issues globally, if the U. S. is not a world leader in nuclear technology.

A major area of concern for the national laboratories, government agencies and industry in the supply of nuclear trained individuals. Many highly skilled nuclear workers are reaching retirement age and there is not a coordinated plan to replace these individuals. It is important that the United States retain core scientific, engineering, and technical skills to maintain a viable nuclear power option. Several nuclear programs at the university level have been closed as well as shutting down many university nuclear research reactors. Since the early 1970's, about half the nuclear programs have been terminated and half the university research reactors have shut down. Students today are focusing on careers in computer science/engineering and micro-electronics. A major program needs to be developed to attract students to pursue careers in the nuclear services and nuclear engineering.

The following are specific recommendations for maintaining a viable nuclear power infrastructure. This includes consideration for a new research reactor and an accelerator designed to meet the expected long-term research needs. These two facilities should be designed to include the production of research isotopes and medical isotopes.

1. Maintain the existing nuclear research infrastructure at the national laboratories and universities
2. Increase nuclear R&D to a yearly level of over $200-300 million by 2005
3. Increase the nuclear engineering educational research to $20 million per year and university research reactor support to $20 million per year
4. Increase the R&D program in research for both fundamental research and isotope production using accelerators and nuclear research reactors
5. Enhance graduate student support for advanced degrees in nuclear science and engineering

Summary

The generation of electricity using nuclear power is an option the United States should vigorously maintain and expand. There are many specific actions can be taken by Congress to help maintain the nuclear option without compromising safety. These include regulatory improvements, positive action for the safe disposal of both HLW and LLW, and maintaining a robust nuclear power infrastructure at the national laboratories and at universities.

With these positive actions by Congress, future generations will have a better life similar to the improvement we are seeing today from past investments in nuclear technology.

Thank you for the opportunity to present these comments.

Mr. BARTON. Thank you, Doctor.

We now want to hear from Mr. James Graham, who is President of ConverDyn. Is that how you say it?

Mr. GRAHAM. Yes, sir.

Mr. BARTON. That is a joint venture between Honeywell and General Atomics. Mr. Graham currently serves on the Board of Governors of the World Nuclear Fuel Market, and is the past Chairman of the Nuclear Energy Institute's Nuclear Fuel Supply Forum.

We welcome you to the committee. We would ask you to summarize your written statement in 7 minutes.

STATEMENT OF JAMES J. GRAHAM

Mr. GRAHAM. Thank you, Mr. Chairman and members of the subcommittee.

As stated, my name is Jim Graham. I am, indeed, the President and CEO of ConverDyn, the Nation's sole remaining uranium converter. I would like to thank you for the opportunity today to speak on behalf of the U.S. domestic nuclear fuel supply industry. As stated for the sake of time, I will summarize my key points that can be found in my written testimony.

The conditions and outlook of our business have never been worse in the United States. In fact, market conditions are so serious that uranium mining, uranium conversion, and even enrichment are on the brink of disappearing in this country. If this situation were merely a normal business cycle, I would not be here today, giving this testimony.

Sadly, it is beyond any reasonable doubt that several key decisions and actions by the Federal Government over the past several years have created this precarious position.

We have heard today that nuclear power accounts for over 20 percent of the U.S. electrical power production, and makes a substantial contribution to U.S. energy and national security. This is because at this present time, we have within our own borders the capability to mine, convert, enrich, and fabricate uranium into nuclear fuel.

But the in U.S, capabilities in the entire fuel cycle are presently under extremely duress, because of recent actions taken by the U.S. Government. Two of these major actions would be the 1998 privatization of the U.S. enrichment corporation, and USEC's aggressive sales of large volumes of uranium and conversion, transferred at privatization by DOE, at zero cost, which has been clearly documented to have helped drive the market price for uranium and conversion to near record lows.

In 1993, the U.S. and Russian governments signed an agreement calling for the U.S. to purchase up to 500 metric tons of HEU from Russian weapons over a 20 year period of time. This HEU, which has been blended down to LEU, contains enrichment, conversion, and uranium.

This large source of additional material in the U.S. has also greatly depressed the market price for the components. Taken together, these actions have resulted in overwhelming amounts of the three materials, uranium, conversion, and enrichment entering the U.S. market, with devastating impacts on the domestic fuel supply capabilities.

As examples, for mining we see that since 1998, expenditures for uranium exploration and mine development has declined by almost 59 percent. In 1999, three uranium processing facilities closed, two

in Texas, one in Louisiana. Employment in the U.S. uranium exploration mining and milling has decreased by almost 30 percent.

In conversion, we see that in 1999, production at the ConverDyn facility in Metropolis, Illinois was cut back by 25 percent, and employment reduced by over 12 percent.

Sales are expected to decline by another 10 percent in 2000, while at the same time, the price of new contracts moving forward has dropped well below production costs. Short of timely government intervention, it is very doubtful that the ConverDyn facility will remain in business much longer.

With enrichment, we have seen employment at Paducah and Portsmouth enrichment facilities substantially reduced. Profitability is declined by hundreds of millions of dollars annually. The value of USEC stock has plummeted since privatization.

Needed upgrades to existing plants can no longer go forward, due to lack of capital, and USEC is rumored to be shutting down one, if not both, of their existing plants in the near future.

The end result of the actions taken to implement various U.S. Government policies has been to force the domestic nuclear fuel cycle to the brink of collapse.

The issue of maintaining complete nuclear fuel cycle capability in our country is very, very important, both for U.S. energy and national security reasons. If the Federal Government agrees with this statement, then it must act immediately to ensure that this capability is preserved.

We would like to table several proposed recommendations for the action by the government. Firstly, we should level the playing field for domestic uranium and conversion supplies by enforcing the provisions of the USEC Privatization Act that calls for the maintenance of a viable domestic nuclear fuel supply industry.

Second, it is clear that the privatization of USEC has been a massive failure. Absent any viable alternative, the enrichment industry should be re-Federalized.

Third, to ensure continuation, and I stress continuation, of the HEU agreement, the government should consider purchasing all of the HEU fee component to prevent further deterioration of the domestic uranium conversion industry.

Mr. Chairman, in the past decade, our Nation has gone to war in the Middle East over energy. We invest billions of dollars annually to ensure secure oil supply from the Middle East and elsewhere.

Ironically, at home, the Federal Government has unwittingly been taking actions that have seriously undercut the ability of key domestic industry to do its part in support of our national energy security.

Given the importance of a secure energy supply to our economy and to national security, it is very important that the Federal Government take timely action and steps to reverse the damage that has been done, and to ensure a viable domestic industry.

Mr. Chairman, thank you for the opportunity to address this subcommittee today on behalf of the domestic nuclear fuel supply industry.

[The prepared statement of James J. Graham follows:]

PREPARED STATEMENT OF JAMES J. GRAHAM, PRESIDENT AND CEO OF CONVERDYN

Mr. Chairman and Members of the Subcommittee, my name is Jim Graham and I am the President and CEO of ConverDyn—the nation's sole remaining uranium converter. For the record, I am also the President and CEO of Nuclear Fuels Corporation, a US uranium marketing company. I would like to thank you for the opportunity to speak before you today on behalf of the U.S. domestic nuclear fuel supply industry.

The people and businesses at the front end of the nation's nuclear fuel cycle very much appreciate the Subcommittee's holding a hearing on the future of nuclear energy at this time. The conditions and outlook for our business have never been worse in the U.S. In fact, market conditions are so serious that uranium mining, uranium conversion and perhaps even enrichment are on the brink of disappearing in this country.

If this situation were merely the normal course of business cycles, I would not be here today giving the testimony that I am about to give. But sadly, it is beyond any reasonable doubt that several decisions and actions by the federal government over the past few years have created this precarious situation. My testimony will focus on these actions and I will also make some suggestions as to how the federal government could begin to reverse this situation.

The facts about the importance of nuclear power are probably quite familiar to most Members of the Subcommittee: it represents 23% of the nation's electrical production; it has become extremely economically competitive with other sources of power; and it produces no atmospheric emissions. Further, given the staggering projections for energy demand world wide, nuclear energy's superior environmental characteristics almost by necessity make it the source of choice for the future.

But there is another important fact about nuclear energy: at the present time, we in this nation are not subject to foreign cartels on nuclear energy or price fixing because we have the ability to mine and process the fuel within our borders. It is this element of national and energy security that is endangered today.

At this time, I would like to describe three main actions by the U.S. federal government that have had a devastating impact on U.S. suppliers:

1. The privatization of the U.S. Enrichment Corporation;
2. The Russian HEU agreement; and
3. The lifting of the Kazak Suspension Agreement.

1. USEC PRIVATIZATION

The Energy Policy Act of October 1992 created the United States Enrichment Corporation (USEC), which took over all uranium enrichment activities of the government. On April 26, 1996 the USEC Privatization Act was passed which resulted in the privatization of USEC on July 28, 1998 by an initial public offering (IPO). The IPO is a misnomer here since USEC had to borrow $500 million to match the higher industry bidder. Therefore, the privatization should be called an LBO. I believe this committee has copies of the various testimonies, including mine, given on April 13, 2000 during the hearing conducted by the Subcommittee on Oversight and Investigations of the Committee on Commerce. The evidence presented at that hearing documents in full measure the concerns with, among other things, how USEC was privatized. However, this committee should consider the continuing problems stemming from the privatization of USEC which are:

Aggressive sales of natural uranium inventories owned by USEC. Upon privatization, USEC was granted control of 28,609 metric tons of natural uranium in the form of uranium hexaflouride (UF_6), an intermediate product in the production of nuclear fuel. UF_6, as a commercial product, has two components: natural uranium concentrates (U_3O_8) produced from the mining and milling of uranium ore and the conversion services necessary to chemically transform those concentrates into UF_6. All of this material was transferred to USEC from the U.S. Department of Energy (DOE) at no cost. DOE had accumulated most of this material as a result of purchases by its forerunner, the U.S. Atomic Energy Commission, during the "Cold War" era.

Transfers to USEC were made for several purposes, but mainly to capitalize the to-be-privatized company without having to commit hundreds of millions of scarce budget dollars. At the time of privatization, USEC's uranium endowment was valued by USEC at $745.5 million. Many industry observers and analysts were somewhat surprised at the magnitude of the endowment since they had focused on transfers of 12,000 metric tons of uranium as UF_6 made pursuant to the privatization agreement and publicized in that agreement. What was less visible to the industry prior to privatization, was an existing inventory of 12,145 metric tons of UF6 which

was carried over from USEC's predecessor, the Uranium Enrichment Enterprise of the U.S. DOE.

USEC released details of its uranium inventory and its plans to sell most of that inventory by 2005 in its June 29, 1998 S-1 filing with the U. S. Securities and Exchange Commission. Information appearing in the industry press at the time indicated that USEC planned to sell a total of 33,562 metric tons of UF_6 by 2005 with maximum sales of 8,100 metric tons of UF_6 in 2002. The difference between its original endowment of 28,609 metric tons of UF_6 and its ultimate sales of 33,562 metric tons of UF_6 was to have been created by a process of "underfeeding" its enrichment plants.

In July 1998, USEC assured the U.S. government that it would "sell its uranium gradually in a flexible manner that first and foremost supports a healthy, stable market, and with a view towards fulfilling its commitment to the HEU agreement." USEC's President & CEO further stated several months later that its inventories would be disposed of "in a gradual market-sensitive manner." USEC's scheduled sales of uranium dwarf current and projected U.S. uranium production as illustrated in Figure 1. USEC's scheduled sales cut the market in half for ConverDyn, the sole private provider of conversion services in the U.S. as set forth in Figure 2. Figures 3 and 4 provide a perspective on uranium and conversion prices. Each of these figures show clearly the devastation wreaked upon the U.S. industry by sales of USEC's inventories. USEC's inventories were accumulated without cost to USEC. On this basis it's quite easy to undercut bids made by legitimate producers with real costs for labor, materials, and electricity.

Lack of a new enrichment technology. Prior to privatization USEC management touted the fact that a government-backed laser enrichment program, called AVLIS, would be the future of enrichment technology since it would drastically reduce the power required and therefore the cost of enrichment services. This was essential for the future to compete with European and Russian competitors who had more cost effective centrifuge technology compared to USEC's gaseous diffusion plants. However, within one year after privatization, the same management at USEC said that AVLIS technology would not be commercially viable and killed the program after almost two billion dollars had been spent on it. It is interesting to note that the two private consortia, who also made bids to take over USEC during the dual-track privatization process via the M&A route, stated that they did not feel AVLIS was ready for commercialization in the time frame projected by USEC's management. At the present time USEC does not have any viable alternative to the aging and high cost gaseous diffusion plants for enrichment. This is a serious setback to U.S. interests in keeping a viable and reliable domestic enrichment capability.

2. RUSSIAN HEU AGREEMENT

In February 1993 the United States and the Russian Federation signed a government-to-government agreement concerning the disposition of and purchase of 500 metric tons of highly enriched uranium (HEU) extracted from Russian nuclear weapons. First shipment of low enriched uranium (LEU) obtained from the blending down of HEU was received in June 1995. Through March 1, 2000 a total of 2,385 metric tons of LEU, blended down from 81 metric tons of HEU have been delivered to the U.S. This is equivalent of 24,000 metric tons of natural UF_6 or 62 million pounds of U_3O_8 and over 14 million SWU.

The domestic nuclear fuel cycle industry has consistently supported the foreign policy and non-proliferation initiatives of the U.S. government. However, the time has now come for us to jointly and cooperatively ensure that the cost of such laudable objectives, which benefit all Americans, are not disproportionately borne by the handful of U.S. companies still active in providing a domestic source of goods and services to the U.S. nuclear fuel cycle.

The sale of the U_3O_8 in the natural feed component from the delivery of LEU under the HEU agreement is constrained by the USEC Privatization Act, as shown in Table 1. However, this material is primarily meant for sales to U.S. utilities and as such the physical stockpile of Russian-owned UF_6 that is building up in the U.S. is having a severe impact on the market for U_3O_8 and conversion. Further, it is important for this committee to note that at the current rate of yearly deliveries, Russian HEU feed material is equal to ConverDyn's current and projected annual production of 9 million kgs. Also, there are no restrictions on the sale of the conversion component. Nevertheless, it is worth noting that in 2000 the quota for sales of Russian HEU-derived U_3O_8 into the U.S. market at 6 million pounds is already 30% higher than U.S. production of 4.6 million pounds in 1999.

3. KAZAK SUSPENSION AGREEMENT LIFTED

In July 1999 the Department of Commerce's International Trade Commission voted to end the antidumping investigation against Kazakstan, with the result that Kazak uranium is free to be imported directly into the U.S. market without duties or other obstacles. While Kazak uranium production is considered to be small, at about 2.4 million pounds annually, it does represent another source of material that can add to the oversupplied U.S. market, since our market is the largest for spot sales by determined sellers. Furthermore, an unresolved question is the fate of Kazak enriched uranium product containing about 2 million SWU and 9.3 million pounds U_3O_8 equivalent. This material was enriched in the former Soviet Union, but now resides in Kazakstan and should it be determined to be of Kazak origin, then it can enter the U.S. freely and thus further depress prices for all components, that is U_3O_8, conversion and SWU.

Mr. Chairman, having now described the causes of the industries' troubles, I will now describe in more detail the actual state of the mining, conversion and enrichment industries themselves.

REDUCTION IN U.S. URANIUM MINING

The Energy Information Administration (EIA) publishes an annual report on the status of the U.S. uranium industry. Last month the EIA's "Uranium Industry Annual 1999″ became available. It presents a depressing picture of the current state of uranium mining and milling in the U.S. Since the privatization of USEC in July 1998, all aspects of the domestic uranium industry have suffered tremendous declines, as evidenced by the following facts:

- expenditures for uranium exploration and development decreased by 59% from the 1998 level to $9.0 million;
- mine production of uranium declined by 5% from the 1998 level to 4.5 million pounds;
- three uranium processing facilities closed during 1999, 2 in Texas and 1 in Louisiana;
- employment in the U.S. uranium raw materials industry overall decreased by 24%, but in the key sectors of exploration, mining, milling and processing the decrease was almost 30%;
- see also Table 2 for salient statistics;

While uranium production from foreign sources will meet a large share of the U.S. nuclear utilities needs, the existence of a viable domestic source of supply is invaluable in keeping the price of fuel competitive. If the few remaining domestic producers are forced to close and reclaim their mines, and the industry continues to consolidate, uranium will become a seller's market with market conditions unfavorable to U.S. utilities that would then be fully dependent on imported uranium. It is imperative that a domestic supply be maintained to keep the price of uranium competitive with operational costs.

This subcommittee is very familiar with the problems the American people have faced due to over reliance on foreign oil imports. The loss of the front end of the nuclear fuel cycle would likewise be injurious to electrical consumers. The domestic uranium industry has established a considerable resource that will be lost if nothing is done to resurrect this industry. An investment of approximately $6 billion dollars has been made to create our current uranium resource base. As producers close their operations, records, land positions, skilled human resources and permits will be irretrievably lost. At this point only significant price escalation, such as those that resulted from the Westinghouse/cartel debacle, will fire interest in restarting the domestic industry. However, given that it can take in excess of ten years to permit a new mine and resource development may be forced to be created from ground zero, the ability of U.S. producers to create competitive uranium production when needed is questionable at best. Permitting is an extremely time consuming process and the investment needed would require assurance that a reasonable price would be in the offing for a significant period of time.

REDUCTION IN U.S. CONVERSION

ConverDyn is the sole manufacturer in the U.S. uranium conversion industry. Conversion represents less than 4% of the fuel cycle cost, but it is a critical step in the production of nuclear fuel for electric power production. Our facility in Metropolis, Illinois is the only remaining production facility in the U.S. and represents approximately 60% of the conversion capacity that exists in North America. Until 1992 there were two such facilities, but due to the depressed state of the uranium industry, the other facility was closed and all production was transferred to the Me-

tropolis unit. During the next several years a considerable sum of money was invested to expand output at Metropolis to the current capacity of 12.7 million kgs per year. This rate of production was achieved in 1998, but shortly thereafter the market collapsed due to aggressive sales by the privatized USEC of zero-cost government inventories and the HEU feed material stockpile build-up. The available new business reached a peak of 53 million kgs in 1997 and has steadily decreased since then to under 20 million kgs in 1999 and even less in 2000. Thus, we were forced to cutback production last year at Metropolis by 25% to 9.3 million kgs per year and employment was reduced by 50 to 350. Sales are expected to decline a further 10% in 2000, while the prices for new contracts in 2000 are averaging 30% below 1999 levels, which itself was 20% below 1998. Furthermore, the published prices for spot and long term conversion are now at near historic lows of $2.45-3.25 per kg, and it is doubtful that the sole U.S. converter can survive much longer at these kinds of operating rates and revenues. See Figure 5 for a time-line of major events associated with the deterioration of conversion prices.

REDUCTION IN U.S. ENRICHMENT

The hearing by the Subcommittee on Oversight and Investigations last April closely examined the dire state of the sole U.S. provider of enrichment services, USEC. For the record I will summarize here the following key points:

- employment at the two enrichment facilities at Portsmouth and Paducah have already been reduced by 500 immediately after privatization, and there are now plans to lay off an additional 625 this July, bringing the total cuts to almost 30% of the pre-privatization level;
- USEC profitability is projected to decline to $35-45 million in fiscal 2001 compared to an estimated $110-115 million in fiscal 2000;
- USEC stock has lost about $1 billion dollars in value since privatization just two years ago;
- USEC has no viable alternative new technology to replace its high-cost, outdated production technology;
- USEC lacks the capital for upgrades at its existing facilities or obtain new technologies without selling out its contract backlog;
- USEC is rumored to be close to shutting down one if not both of the enrichment facilities still operating in the U.S;
- the recent attempts by USEC to increase its purchases of SWU, this time on commercial terms, and its efforts to partner with another enricher in Europe or Russia, suggest that it will more and more just be a broker of international supplies.

These facts and statements do not bode well for the continuation of a strong and viable domestic enrichment supply in its current form.

The result of these U.S. government actions are two key impacts: First, national security is at risk because of the decrease in U.S.-based and U.S.-owned capability to provide, maintain and further develop the requisite skills in each step of the nuclear fuel cycle, be it uranium mining, conversion or enrichment; secondly, energy security is jeopardized since over 20% of U.S. electric generation from a clean, non-polluting source like nuclear is now dependent on foreign supply for most, if not all, of its fuel needs. At a time when there is rising concern about the import levels for other energy sources, notably oil, and nuclear is called upon to increase its output to cope with environmental commitments, it is imperative that this Subcommittee take a hard, close look at the future viability of the domestic nuclear fuel cycle supply situation. Clearly the nation's electrical needs and the utility industry would be better served to maintain the current fuel cycle infrastructure, than hoping to start it from scratch a few years in the future. The expenditure of funds today to preserve this industry from the misadventures caused by misuse of surplus government uranium stockpiles seems prudent if not essential.

CONCLUSION

The various actions of the U.S. government that I have discussed today, were all taken to accomplish different political goals. Each action by itself, and taken solely in its own context, was probably the best one to further U.S. interests. Unfortunately, when the results of these individual actions are viewed in totality, and with the benefit of time and hindsight, then it is clear that the domestic nuclear fuel cycle providers and their employees have indeed suffered enormous hardships to further the broadest definition of U.S. strategic interests, whether it is free trade or non-proliferation or helping totalitarian command societies to become free market democracies.

The end result of the actions taken to implement various U.S. government policies has been to force the domestic nuclear fuel cycle to the brink of collapse. Embedded in the Enrichment Privatization Act is the concept that domestic mining, conversion and enrichment capabilities are important and should not be impacted. However, to date, no mitigating actions have been taken by either Congress or the President.

Mr. Chairman, just in the past decade our nation has gone to war in the Middle East over energy. We invest billions of dollars annually essentially to ensure a secure oil supply from the Middle East and elsewhere. Among others, a recent report of the Hart-Rudman Commission has made it clear that energy looms even larger in our future national security. Meanwhile it is ironic that at home, the federal government has unwittingly been taking actions that have seriously undercut the ability of a key domestic industry to do its part in support of our energy security.

Given the importance of ample and secure energy supplies to our economy, to national security and to our well being, it is very important that the federal government take timely steps to reverse the damage that has been done and to ensure a viable domestic uranium industry.

RECOMMENDATIONS

Mr. Chairman, I would propose that this Subcommittee consider the following measures to alleviate the serious damage to the domestic nuclear fuel cycle players.

First, the playing field should be leveled for the domestic suppliers by enforcing the provisions of the USEC Privatization Act, which calls for the maintenance of a viable domestic industry. Also, a level playing field can be supported by continuing restrictions on foreign dumping, specifically by extending the lives of the Russian and Uzbek suspension agreements, and ensuring that Kazak EUP is determined to be of Russian origin.

Second, it is clear that privatization of USEC has been a massive failure in almost every respect and in the absence of any viable alternative mechanism, the enrichment industry should be re-federalized so that a long-term solution to outdated enrichment technology can be found, and the U.S. can once again be the world leader in this field.

Third, to ensure the continuation of the government-to-government HEU agreement between the U.S. and Russia, the HEU material should be taken into long-term government inventory, as was done for the deliveries in 1997 and 1998. The commercial agreement which the current administration facilitated is clearly not working, not least because of USEC's own actions. To prevent further deterioration of the market, I strongly suggest that the U.S. should take back all unsold uranium inventory at USEC.

Finally, Congress must create a program to get the producers and converter through the next three to five year period when the market can work off the artificial components now experienced and fuel costs will once again reflect reasonable production costs. We would very much welcome the opportunity to work with Congress to accomplish this important task.

Mr. Chairman, thank you for giving me the opportunity to address this subcommittee today.

Table 1

Russian HEU Agreement: Deliveries and Sales

Year	HEU (mt)	LEU (mt)	U_3O_8 equiv (Million lbs)	UF_6 equiv (Million kgU)	SWU (Million)	U_3O_8 Quota (M lbs, per USEC Privatization Act)
1995 to 3/1/2000	81+	2,385	63	24.5	14+	6
2000	30	915	23.7	9.1	5.5	6
2001	30	915	23.7	9.1	5.5	8
2002	30	915	23.7	9.1	5.5	10
2003	30	915	23.7	9.1	5.5	12
2004	30	915	23.7	9.1	5.5	14
2005	30	915	23.7	9.1	5.5	16
2006 through 2014	270	8,235	213.3	81.1	49.5	174

Note:
1. Sale of the conversion component of the HEU feed material is NOT restricted, whereas the U_3O_8 component is restricted as per the quota established under the USEC Privatization Act.
2. USEC is free to sell the SWU component as it pleases.
Source: USEC and USEC Privatization Act

Table 2

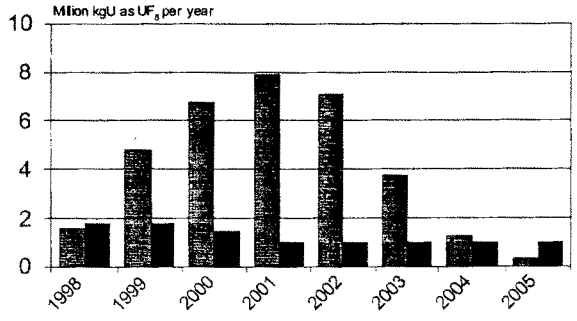
U.S. Uranium Statistics

Year	Employment (Person-Years)	Production (1,000 lbs U_3O_8)	Canadian Imports	U.S. Prices	Events of Note
1999	649	4,611	12,489	$10.17	
1998	911	4,705	14,366	$10.56	USEC Privatized
1997	794	5,643	16,713	$11.98	
1996	689	6,321	19,093	$15.40	
1995	534	6,043	16,799	$11.45	
1994	452	3,352	14,613	$9.82	
1993	380	3,063	na	$10.61	
1992	682	5,645	na	$9.19	
1991	1,016	7,952	na	$9.45	Dissolution of the Soviet Union
1990	1,335	8,886	na	$10.66	
1989	1,583	13,837	na	$11.34	NAFTA in effect as of 1/1/89
1988	2,141	13,130	na	$17.54	
1987	2,002	12,991	na	$22.38	
1986	2,120	13,506	na	$21.66	
1985	2,446	11,314	na	$19.03	

Source: U.S. D.O.E. Energy Information Administration "Uranium Industry Annual"; 1995, 1996, 1997, 1998, 1999

Figure 1

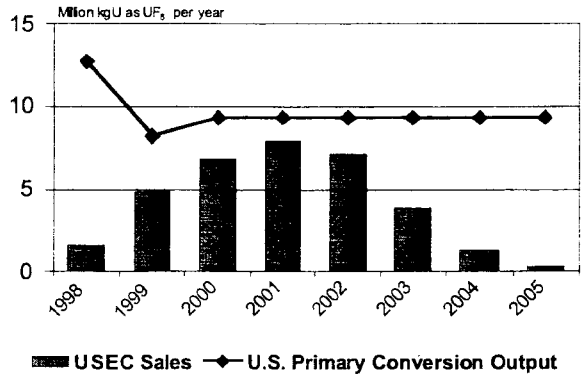
USEC Projected Natural Uranium Sales vs. U.S. Uranium Production



Source: USEC sales - "Nuclear Fuel," 7/13/98; U.S historic uranium production - U.S.E.I.A. data; Future production - International Nuclear, Inc. "Uranium Supply/Demand Analysis and Price Forecast 2000-2015" 1/2000

Figure 2

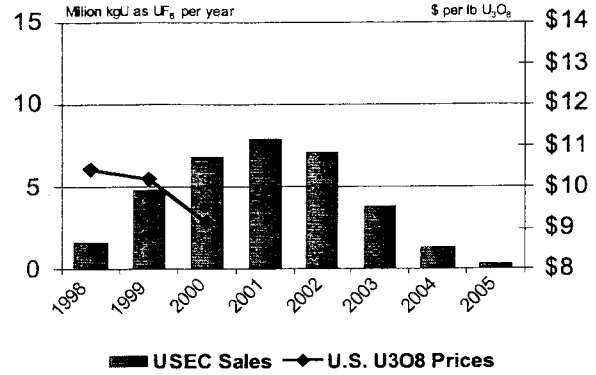
USEC Projected Natural Uranium Sales vs. U.S. Primary Conversion Output



Source: USEC sales - "Nuclear Fuel," 7/13/98; U.S conversion output - ConverDyn

Figure 3

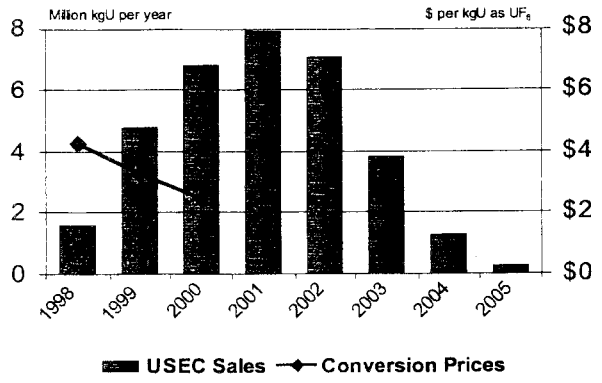
USEC Projected Natural Uranium Sales vs. U.S. Uranium Prices



Source: USEC sales - "Nuclear Fuel," 7/13/98; U.S uranium prices - annual average of Nukem, Ux, TradeTech and Nuclear Fuel

Figure 4

USEC Projected Natural Uranium Sales vs. U.S. Conversion Prices

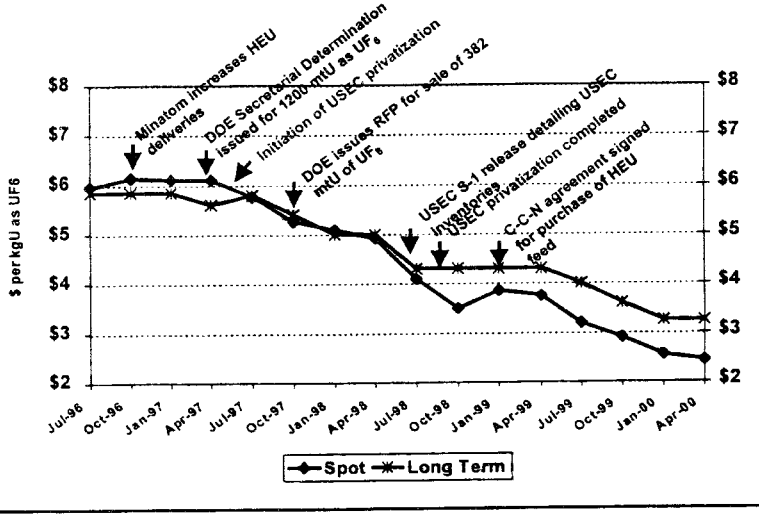


Source: USEC Sales - "Nuclear Fuel," 7/13/98; U.S conversion prices - TradeTech monthly prices

Figure 5

Conversion Price Indicators

July 1996 to Present



Source: Conversion prices - TradeTech monthly prices

THE NUCLEAR FUEL CYCLE

What are the steps in the nuclear fuel cycle?

There are four major steps in the production of nuclear fuel. These steps are components of the nuclear fuel cycle and are illustrated herewith.

1. Uranium Production—Uranium is a naturally occurring element in the earth's crust. When sufficiently concentrated by natural physical and chemical forces, it may be economic to mine the ore by open-pit or underground methods. Uranium is typically recovered from the ores by alkaline or acid leaching. Uranium is also produced by in-situ leaching and as a by-product of phosphate fertilizer, gold, and copper. The final product of uranium mining and processing is usually a mixture of uranium oxides referred to as either natural uranium concentrates, U_3O_8, or "yellowcake." Natural uranium concentrates contain 0.711 percent G5235U, the active isotope in the nuclear process. The remaining 99.3 percent is the inactive isotope ^{238}U.

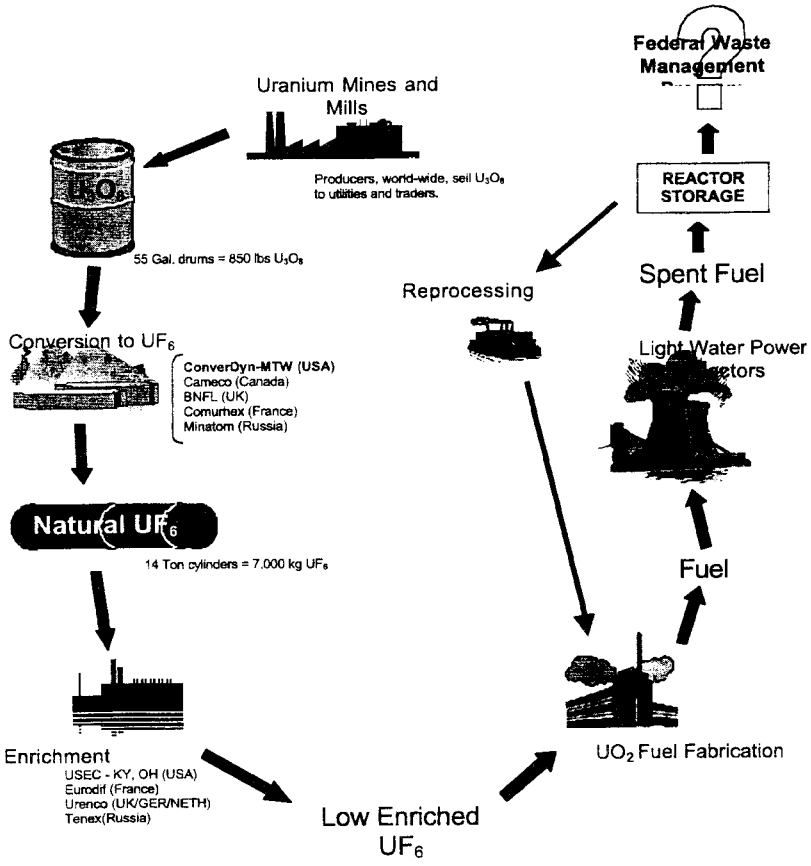
2. Uranium Conversion—Natural uranium concentrates in the form of U_3O_8 are converted to natural uranium hexaflouride (UF_6) in order to provide an appropriate feed material for the next step in the nuclear fuel cycle: enrichment. The conversion process includes feed preparation, reduction with hydrogen to UO_2, hydrofluorination to UF_4, fluorination to UF_6 (which is a gas at moderate temperatures), and purification. Uranium in this form retains the natural isotopic concentration of ^{235}U of 0.711 percent. Importantly, there is only one uranium converter left in the U.S.

3. Uranium Enrichment—Enrichment is a process of concentrating the ^{235}U isotope to higher levels of 3 to 5 percent in order to increase the efficiency of the fuel for nuclear reactors. Concentration of the ^{235}U isotope occurs by molecular weight in the gaseous diffusion process used in the U.S. and Europe, as well as in the centrifuge process used in Russia and Europe.

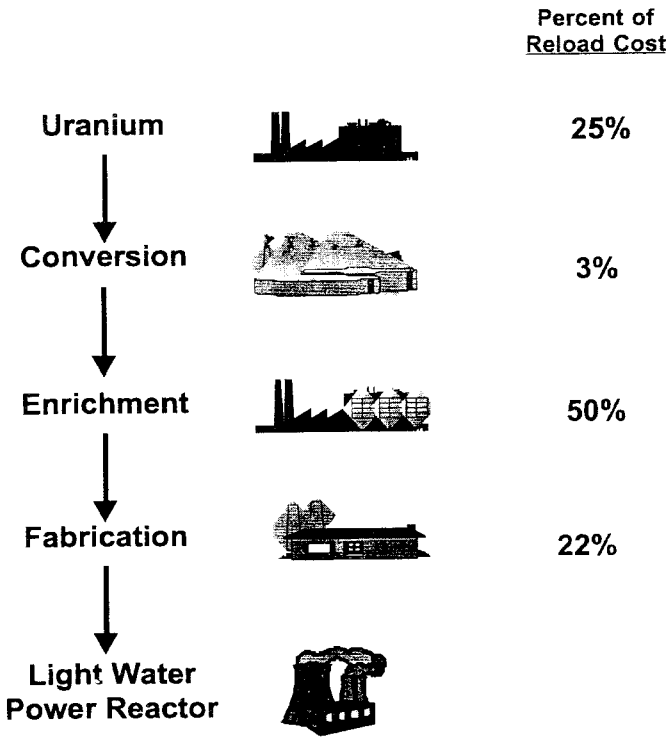
4. Fuel Fabrication—Enriched uranium hexaflouride is converted by fabricating companies to UO_2, pelletized, and inserted into zirconium alloy tubes which are then combined into bundles of nuclear fuel.

Each of these steps must be completed in order to produce a final product. Each step in the production process has a different character, different participants, different regional distribution, and a different value. These characteristics are referred to as the "Industry Value Chain." It is notable that most of the world's nuclear fuel cycle participants are foreign-owned, yet the U.S. is the world's largest user of nuclear fuel with over one hundred operating nuclear units.

The Nuclear Fuel Cycle



Nuclear Fuel Production



Mr. BARTON. Thank you, Mr. Graham.

We now want to welcome Dr. David Lochbaum, who is with the Union of Concerned Scientists, and is a nuclear safety engineer. Dr. Lochbaum has been personally responsible for pointing out a number of safety problems at operating nuclear plants around the country, and insisting, at some peril to his career, that those problems be corrected.

Your statement is in the record in its entirety. We welcome you to summarize it in 7 minutes.

STATEMENT OF DAVID LOCHBAUM

Mr. LOCHBAUM. Thank you, Mr. Chairman and members of the committee. Thank you for inviting the Union of Concerned Scientists to provide our views on nuclear power's future.

The future of the nuclear industry will depend on the credibility and commitment of the industry and its regulators to nuclear safety. That future could see existing plants retired prematurely, or see many licenses extended, or perhaps even see new nuclear plants. To succeed in the future, however, nuclear power must contain something that has been absent from its past, an effective regulator.

The nuclear industry's worst enemy has always been the few corner cutters that have focused public attention on unresolved safety problems. The past has shown that the key difference between safe and unsafe plants was plant owners effectiveness, meeting minimum safety standards.

The Nuclear Regulatory Commission is supposed to establish minimum standards and enforce them. The NRC has simply not done its job. As a direct result, millions of Americans have been placed at undue risk. Eventually the failure to enforce the standards is exposed. Costly repairs are required, but the damage to the industry and the NRC's credibility, which is still in need of repair, is likely to be the greatest long-term cost.

Three years ago, the General Accounting Office reported on how the NRC handled three troubled nuclear plants: Cooper in Nebraska, Millstone in Connecticut, and Salem in New Jersey. Salem was closed for over 2 years. The NRC had a list of 47 items that had to be fixed before the plant could resume safe operation.

The NRC knew about 42 of the items before Salem shut down. If each item had to be fixed before Salem could safely restart, why were they not addressed when the plant was running?

Salem is not an isolated case. UCS released a report last October listing 23 nuclear reactors that have been shut down for longer than a year, since 1984. The Donald C. Cook plant in Michigan, for example, has been closed since September 1997.

Among the items being fixed at Cook are things that have been wrong since it first started up in the early 1970's. Thus, this plant has always operated below the NRC's minimum standards. How far below; the plant's owner spent nearly 3 years and over $500 million to get up to the minimum standards.

Fire protection is another example. Following the 1975 fire in the Browns Ferry plant in Alabama, the NRC implemented more rigorous fire safety regulations. But the NRC has failed to enforce

these regulations. Instead, the NRC has granted more than 1,000 exemption and waivers to 103 plants.

In 1992, the NRC testified to this Congress about temporary measures that would be used by plant owners for about 6 months, until fire safety problems could be fixed. Eight years later, those temporary measures are still being used at U.S. nuclear plants, instead of meeting the minimum standards.

Nuclear power's past is dismal, but its future could be even worse. As Americans get older, we see medical professionals more often and spend more money on health care. As America's 103 operating nuclear plants get older, they see fewer safety inspectors and have less money spent on maintenance.

The NRC is allowing plant owners to cut back on safety inspections, based on performance data, compiled over the past two decades. Unfortunately, the NRC is neglecting a well-known fact that applies to light bulbs, computers, and nuclear plant components.

Equipment fails most often during the break-in and the wear-out phases. The NRC is using data taken from the peak performance period to allow plant owners to cut back on safety checks, ignoring the fact that failure rates will increase as components enter the wear-out phase. It could be a recipe for disaster.

Nuclear power can have a future only if its has an effective regulator. The agency has yet another plan to increase its effectiveness, but deeper changes to the NRC's culture will be needed to implement it successfully.

When nuclear plants are shut down for extended periods, a culture of complacency has often been identified as the root cause.

There are always senior management changes. New senior managers, or at least mentors, are recruited from outside the company, not because they have the missing plan, but because they have a proven track record for taking the actions required for any plan to be successful, and because new leadership is essential for changing the corporate culture.

The NRC's culture of complacency has been documented by the GAO, the NRC's Office of the Inspector General, and many others. The NRC's senior managers have strong technical backgrounds. Most are well intentioned, but they lack the experience and the independence to lead the broad-based transformation of the agency.

New managers are needed to shake up a system that has long accepted excuses instead of compliance, promises instead of performance, and luck instead of vigilance. Congress should compel the NRC to bring in the experienced management talent it needs to complement the capable technical talent it already possesses.

This new NRC management might determine it needs short-term budget increases to fund the agency's transformation. Congress must ensure that the NRC has the budget it needs to do this change.

Congress must also ensure that the NRC's transformation is achieved to restore its credibility and provide any hope for a nuclear future.

Thank you.

[The prepared statement of David Lochbaum follows:]

PREPARED STATEMENT OF DAVID LOCHBAUM, NUCLEAR SAFETY ENGINEER, UNION OF CONCERNED SCIENTISTS

Mr. Chairman and Members of the Committee, thank you for inviting the Union of Concerned Scientists to provide our views on nuclear power's future.

The future of the nuclear industry will depend on the credibility and commitment of the industry and its regulators to nuclear safety. That future could see many existing plants retired prematurely, or see many licenses extended, and even perhaps see new nuclear plants. To succeed in the future, however, nuclear power must contain something that has been absent from its past—an effective regulator.

The nuclear industry's worst enemy has always been the few corner-cutters that have focused public attention on unresolved safety problems. The past has shown that the key difference between safe and unsafe plants was plant owners' effectiveness meeting minimum safety standards. The Nuclear Regulatory Commission is supposed to establish minimum standards and enforce them. The NRC has simply not done its job. As a direct result, millions of Americans have been placed at undue risk. Eventually, the failure to enforce standards is exposed. Costly repairs are required. But the damage to the industry and the NRC's credibility—still in need of repair—is likely to be the greatest long-run cost.

Three years ago, the General Accounting Office reported on how the NRC handled three troubled nuclear plants—Cooper in Nebraska, Millstone in Connecticut, and Salem in New Jersey.[1] Salem was closed for over two years. The NRC had a list of 47 items that had to be fixed before the plant could resume safe operation. The NRC knew about 42 items *before* Salem shut down. If each item had to be fixed before Salem could safely restart, why weren't they addressed before the plant shut down?

Salem is not an isolated case. UCS released a report last October listing 23 nuclear reactors that have been shut down for longer than a year since 1984.[2] The Donald C Cook plant in Michigan, for example, has been closed since September 1997. Among the items being fixed at Cook are things that have been wrong since it first started up in the early 1970s. Thus, the plant had always operated below the NRC's minimum standards. How far below? The plant's owner spent nearly three years and over $500 million to reach the minimum standards.

Fire protection is another example. Following the 1975 fire at Browns Ferry in Alabama, the NRC implemented more rigorous fire safety regulations. But the NRC failed to enforce those regulations. Instead, the agency granted more than a thousand exemptions and waivers. In 1992, the NRC testified to Congress about temporary measures that would be used by plant owners for about six months until their fire safety problems could be fixed. Eight years later, those "temporary" measures are still being used at US nuclear plants instead of meeting the minimum standards.

Nuclear power's past is dismal, but its future could be worse. As Americans get older, we see medical professionals more often and spend more money on health care. As America's 103 operating nuclear power plants get older, they see fewer safety inspectors and have less money spent on maintenance.

The NRC is allowing plant owners to cut back on safety inspections based on equipment performance data compiled over the past two decades. Unfortunately, the NRC is neglecting a well-known fact that applies to light bulbs, computers, and nuclear plant components. Equipment fails most often during the break-in and wear-out phases. The NRC is using data taken from the peak performance period to allow plant owners to cut back on safety checks, ignoring the fact that failure rates increase as components enter the wear-out phase. It could be a recipe for disaster.

Nuclear power can only have a future if it also has an effective regulator. The agency has yet another plan to increase its effectiveness, but deeper changes to the NRC's culture will be needed to implement it successfully. When nuclear plants are shut down for extended periods, a culture of complacency has often been identified as a root cause. There are always senior management changes. New senior managers, or at least mentors, are recruited from outside the company. Not because they have the missing plan, but because they have a proven track record for taking the actions required for the plan to be successful, and because new leadership is essential for changing the corporate culture.

The NRC's culture of complacency has been documented by the GAO, the NRC's Office of the Inspector General, and many others. The NRC's senior managers have

[1] United States General Accounting Office, "Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action," GAO/RCED-97-145, May 1997.

[2] David Lochbaum, Union of Concerned Scientists, "The NRC's New Oversight Process: On the Road to Effective Regulation?" October 1999.

strong technical backgrounds. Most are well-intentioned. But they lack the experience and independence to lead a broad-based transformation. New managers are needed to shake up a system that has long accepted excuses instead of compliance, promises instead of performance, and luck instead of vigilance.

Congress should compel the NRC to bring in the experienced management talent it needs to complement the capable technical talent it already possesses. New NRC management might determine that it needs short-term budget increases to fund the agency's transformation. Congress must ensure that the NRC has the budget it needs. Congress must also ensure that the NRC's transformation is achieved, to restore its credibility and any hope for a nuclear future.

Mr. BARTON. Thank you.

Next we will go to Mr. Robert Ebel, Director of Energy and National Security, Center for Strategic and International Studies.

Welcome, and your full testimony is inserted in the record. If you would summarize, you have 7 minutes.

STATEMENT OF ROBERT E. EBEL

Mr. EBEL. Thank you very much, Mr. Chairman.

Mr. Chairman, at CSIS, we are nearing the completion of the detailed examination of the geopolitics of energy out to the year 2020. This is a study which is co-chaired by former Senator Sam Nunn and by James Schlesinger. We have four Congressional co-chairs: Senators Murkowski and Lieberman, and Representatives Taucher and Gilman.

I would like to share with you this afternoon our preliminary findings and policy considerations, inasmuch as they have particular relevance to current and future U.S. energy policy, and in particular, to future nuclear power policy.

Let me begin with our key findings. By the year 2020, the developing countries of the world will be consuming more energy, in absolute amounts, than the industrialized countries of the world.

In relative terms, the share of oil, coal, and nuclear power, in terms of total energy consumed, will each decline. The share of renewables, largely hydropower, will be unchanged, while the share of natural gas will increase.

By the year 2020, two-thirds of all the oil produced in the world will come from the Gulf, as compared with just 41 percent this year.

Global warming is attracting increasing attention. That, combined with the energy appetite of the developing world, holds tremendous implications for all of us.

I would like to isolate a particular finding. Our estimates indicate that electricity will be the most rapidly growing form of energy use during the coming two decades. This growth, not surprisingly, will be concentrated in the developing countries, where electricity use will more than double.

As these countries enter the electricity age, a particular concern emerges. Can adequate electricity supply be developed in these countries, while at the same time protecting the environment? What can we do to help assure that the developing world has the full range of energy options available to them?

Clearly, we will all benefit if developing countries have access to clean, adequate, and secure sources of energy. At the same time, these countries are not going to place environmental policy ahead of economic growth. To assist these consumers, it is essential that

clean coal technology is a viable option, given their high coal consumption.

Equally important, nuclear power must be promoted as a viable option in the developing world to supply electricity in rural areas, and to promote general industrialization.

Let me ask, does the United States have a forward-looking plan for nuclear power? No, it does not. Does Russia? Yes, the Minister of Atomic Energy recently stated that there are plans to quadruple the generation of nuclear electric power by the year 2030.

Does China? China today has 10 nuclear reactors under construction or planned, and will build 20 nuclear power stations by the year 2020. Does Japan, despite a recent shift in public opinion? Yes, the government currently plans to add 20 new reactors by the year 2010.

Mr. Chairman, I can visualize our leadership slipping away. The nuclear option faces a difficult choice: exercise the nuclear option through government support, and it is our judgment that that alone will not do it, or accept that pollution will worsen.

I noted earlier that the relative share of nuclear electric power in the worldwide consumption of energy will decline over the coming years. This decline will lead to a commensurate increase in worldwide carbon emissions, at a time when the world is increasingly aware of the need for remissions-free energy, and at a time when the developing world is confronted with dramatically large future energy requirements.

How can we respond? We propose a government/private sector partnership, to fund R&D efforts to design a fourth generation of nuclear reactors: smaller in size, producing less toxic waste, using a nuclear fuel having little military application.

We look at our assessments as a whole through the year 2020. We find that the stress prospects for instability and interference in energy supplies, but we do this only to alert policymakers as to just how fragile timely supplies of energy really are.

What lies beyond the year 2020? I can not say with any particular degree of certainly, other than anticipating mounting pressures on adequate supplies of energy, and particularly energy with minimal pollutant levels. That means nuclear, hydro, and other renewables.

Unfortunately, the future for hydroelectric generation is rather dim. Whenever an oil supply crisis emerges, a call for the greater use of solar, wind, geothermal, and biomass inevitably arises. Their future is always just around the corner, but we have yet to turn that corner. I cannot say for certain that we ever will.

That leaves the nuclear option. The nuclear industry is far more regulated than are competing forms of energy. With electricity becoming more essential to our way of life, is it now time to develop a set of criteria to measure the effectiveness of the individual forms of power generation, to give nuclear energy the benefit of a level playing field.

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

[The prepared statement of Robert E. Ebel follows:]

PREPARED STATEMENT OF ROBERT E. EBEL, DIRECTOR, ENERGY AND NATIONAL SECURITY, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

Thank you, Mr. Chairman.

Mr. Chairman, we at CSIS are nearing completion of a detailed examination of the geopolitics of energy out to the year 2020, a study cochaired by former Senator Sam Nunn and by James Schlesinger, former Secretary of Energy and of Defense. There are four Congressional cochairs: Senators Murkowski and Lieberman, and Representatives Taucher and Gilman.

I would like to share with you our preliminary findings and policy considerations, inasmuch as they have particular relevance to current and future U.S. energy policy and in particular to future nuclear power policy.

Let me begin with our key findings:

- By the year 2020, the developing countries of the world will be consuming more energy, in absolute amounts, than the industrialized countries of the world.
- In relative terms, the share of oil, coal and nuclear power, in terms of total energy consumed, will each decline. The share of renewables, largely hydropower, will be unchanged. The share of natural gas will increase.
- By the year 2020, two-thirds of all the oil produced in the world will come from the Gulf, as compared with just 41 percent this year.
- A growing influence of non-governmental organizations (NGOs) on energy supply and demand will come at the expense of host governments.
- Terrorism as threat to physical infrastructure and cyberterrorism as a threat to operating infrastructure will be of increasing concern.
- Global warming is attracting increasing attention and that, combined with the energy appetite of the developing world, holds tremendous implications for all of us.

I want to isolate a particular finding. Our estimates indicate that electricity will be the most rapidly growing form of energy use during the years 2000 to 2020. This growth, not surprisingly, will be concentrated in the developing countries, where electricity use will more than double. As the developing countries enter the electricity age, a particular concern emerges:

- Can adequate electricity supply be developed in these countries while at the same time protecting the environment?
- What can we do to help assure that the developing world has a full range of energy choices available to them?

Clearly, all will benefit if developing countries have access to adequate, clean, and secure sources of energy. At the same time, they will not place environmental policy ahead of economic growth. To assist these consumers, it is essential that clean coal technology is a viable option, given their high coal consumption.

Equally important, nuclear power must be promoted as a viable option in the developing world, to supply electricity in rural areas and to promote general industrialization, while keeping nuclear power as a viable option in the developed world.

Let me ask, does the United States have a forward-looking plan for nuclear power? No, it does not. Does Russia? Yes, the Minister of Atomic Energy recently stated that there are plans to quadruple the generation of nuclear electric power by the year 2030. Does China? China today has 10 nuclear reactors under construction and will build 20 nuclear power stations by the year 2020. Does Japan, despite a recent shift in public opinion? Yes, the government currently plans to add 20 new reactors by the year 2010.

I can visualize our leadership slipping away.

The nuclear option faces a difficult choice: Exercise the nuclear option, through government support (it is our judgment that the market alone won't do it). **Or** Accept that pollution will worsen.

I noted earlier that the relative share of nuclear electric power in the worldwide consumption of energy will decline over the coming years. This decline will lead to a commensurate increase in worldwide carbon emissions, at a time when the world is increasingly aware of the need for emissions-free energy, and at a time when the developing world is confronted with dramatically large future energy requirements.

How can we respond? We propose a government/private sector partnership, to fund R&D efforts to design a fourth generation of nuclear reactors—

- Smaller in size
- Producing less toxic waste
- Using a nuclear fuel having little military application.

Our assessments through the year 2020 stress prospects for instability and interference in energy supplies, but only to alert policy makers as to just how fragile timely supplies of energy really are.

What lies beyond the year 2020? I cannot say with any particular degree of certainty, other than anticipating mounting pressures on adequate supplies of energy, particularly energy with minimal pollutant levels. And that means nuclear, hydro and other renewables.

The future for hydroelectric generation is rather dim. Little unexploited potential remains. Indeed, there are pressures even today to remove hydropower dams in place because of various environmental concerns. And whenever an oil supply crisis emerges, a call for greater use of solar, wind, geothermal, and biomass inevitably arises. Their future is always just around the corner but we have yet to turn that corner and I cannot say for certain that we ever will.

That leaves the nuclear option. The nuclear industry is far more regulated than are competing forms of energy. With electricity becoming more essential to our way of life, is it not time to develop a set of criteria to measure the effectiveness of the individual forms of power generation, to give nuclear energy the benefit of a level playing field?

Thank you, Mr. Chairman.

Mr. SHIMKUS [presiding]. Thank you, Mr. Ebel. I appreciate your testimony. I will start with my 5 minute round of questions and discourse.

I am just going to add to part of your opening statement, Mr. Ebel. Not only do we not have a nuclear national policy for the foreseeable future, we really do not have a fossil fuel strategy. We do not have hydroelectric, we do not have really a biofuels strategy.

This is our second hearing. This is the fourth year on the committee, for myself. And the national energy policy that is aforecited is lacking. I think that came out in our hearing. So I appreciate your testimony.

I would first like to turn to Mr. Graham. Since I am a southern Illinois Representative, I do not represent Metropolis, but my good friend, David Phelps does, and has great concerns over the facility there.

Would you explain how the closure of the Converdyn facility would impact the enrichment facilities at Paducah and Portsmouth?

Mr. GRAHAM. Yes, sir, right now, 100 percent of what we produce in the form of conversion services are delivered to the U.S. Enrichment Corporation across the river.

At the rate of 8 million SWU a year, which they are currently producing, or at least they did in 1999, that represented approximately 75 percent of their fee component.

Should our facility in Metropolis close, then for the long-term prospects, the Paducah facility would rely on inventories and foreign supply. Once those inventories are depleted, it would be relying 100 percent on foreign supply.

There is not enough excess foreign supply to feed the U.S. Enrichment Facility. As I have stated before in prior testimony, we would be the first domino default in a nuclear fuel cycle in the states.

Mr. SHIMKUS. You testified that your present contracts are below the cost of production. Is that correct?

Mr. GRAHAM. That is correct, sir.

Mr. SHIMKUS. If this is correct, how are you going to stay in business?

Mr. GRAHAM. What we have is going forward. The market is such that any new contracts we sign today are below our costs. I will not say that for the record, but it is substantially for our operating costs.

As we look forward, new contracts make a larger percentage of our base load. There will reach a time, and we are forecasting by the end of this fiscal year, that the economics will be so detrimental that unless we can see something on the horizon, we can not afford to incur these substantial losses, and are facing closure.

Mr. SHIMKUS. Thank you.

I would like to turn to Mr. McNeill, and first say, "Beat Navy."

Second, Admiral Nimitz was the father of the nuclear Navy—is that correct?

Mr. MCNEILL. Admiral Rickover.

Mr. SHIMKUS. Rickover, that is right.

I am sure you listened to the opening statements, as most of us here did. Can you respond to Dr. Lochbaum's claim of safety concerns, because I think in your testimony you, in essence, stated how safe the industry has operated. I would like to give you an opportunity respond to those accusations.

Mr. MCNEILL. Yes, well, first of all, I am a promoter of a strong safety regulator in the industry. Clearly, the public is best served with the technology with a safe regulator.

Some of the examples that he has given, at least in his oral testimony, and I have not read the written testimony, but in the written testimony, they are factually correct. I think there are some interpretations of those, though, that bear at least some counter interpretations.

First of all, let us say, where his general comment is, it is that a large number safety deficiencies had been identified prior to a shutdown, and then the plant was not allowed to startup until those safety issues had been corrected.

I think, in general, and clearly we could debate individual cases here, but in many cases you would find that a large number of those safety deficiencies were minor to modest in nature, and may not individually, but to some extent collectively, have warranted the shutdown of the plant.

What they really should have done is focused management attention upon correction of those deficiencies. I think his observation was that when plants do run into trouble, you frequently see changes in management, as within most business organizations that have difficulty.

I think that is the clear message here, that each individual nuclear organization needs an internal renewal structure, so that it does not get complacent, and so that safety issues are addressed before they are collectively too large.

But we, in fact, have a very strong defense in depth. Even if you did not correct a certain deficiency here, and it caused a small problem, there are probably four other defensive measures in place that would prevent an accident from occurring. Clearly, there are even more than that, that would prevent endangering the general public.

Mr. SHIMKUS. Thank you. I would move on, but with respect to my colleagues, I think I will now move to my colleague from Ohio, for his 5 minutes.

Mr. SAWYER. Thank you, Mr. Chairman.

Mr. McNeill, thank you very much for your comments with regard to who bears the cost of an inefficient operation. It is com-

forting to know that that is the case, coming from a sound operator.

I do not know how widespread Dr. Lochbaum's corner cutters are, but I suspect that that is where the problem lies, and the reason that you would be such a strong advocate for a strong safety regulatory structure.

Can you describe the structure that you think would be effective in that regard?

Mr. MCNEILL. Yes, the concept is that it is risk based and it is predictable. That is the fundamental essence of what we need.

In its early years, when we had the Three Mile Island accident, and Browns Ferry, which was referenced, we did not have a historical perspective of operations and operational difficulties that, in fact, provided a basis for design that would have prevented those, to some extent.

After they did occur, this was about the time I entered the civilian industry, which was shortly after TMI.

Mr. SAWYER. Was that 1979?

Mr. MCNEILL. Well, 1979 was Three Mile Island, and actually I retired from the Navy in 1980, so it was shortly thereafter.

I entered the industry at a time that there was near pandemonium in responding to just series after series of requirement changes that were placed upon the industry, in response to the accident at Three Mile Island, and had come into place as a result of the fire at Browns Ferry.

We could not manage that, very candidly. That is why costs went up in operations. The temporary staffing levels of consultants at plants just grew by orders of magnitude and things of that nature. You could not manage it correctly.

Fortunately, as we have implemented those changes, and most of them were done by the end of the 1980's, the technical issues and the training issues around plant operation really sort of stabilized. However, the regulatory climate was such that it responded to all deficiencies in a similar manner, whether they were really important or not.

In fact, the examples that Mr. Lochbaum has outlined here, to some degree, were regulatory failures, where things were allowed to get out of hand. Millstone is clearly one of those particular instances, which there was not a proper regulatory response. But there was a lot of activity at the NRC at that point in time.

Mr. SAWYER. Can I assume that at least from a historical perspective that Dr. Lochbaum's assertion that the NRC has not been an effective safety regulator in that regard has some merit?

Mr. MCNEILL. It has some merit. I would not go as far as he has, and I think the NRC has recognized some of those deficiencies along the way.

But we have moved to understanding more of what is important with respect to safety of the general public, how to measure that, and how then to identify, both from a regulatory standpoint and from an operator standpoint, where to focus our attention, at any particular point in time, to sustain reliable and safe operation.

Mr. SAWYER. Dr. Lochbaum, could you comment on Mr. McNeill's observation?

Mr. LOCHBAUM. Well, first, I need to point out that prior to joining UCS, I was a consultant at one of Mr. McNeill's facilities, the Limerick plant in Pennsylvania. PECO had at that time, and still has, a very fine organization.

Your question was, what is the gap between fine line organizations and others. It is quite large, because I also was a consultant at some facilities that Mr. McNeill did not run, and there is a distinct difference.

There has been a problem at the NRC. They recognized the regulatory failure. They made the cover of Time in 1996, and not for good things, and they have made a lot of changes. So they are now facing the right direction, but they need some help in ensuring they have reached the right goal.

That was the theme of my comments, that they can not just have a plan to get to the right destination. They need some help in making sure that plan is successful.

I think they need some help from the outside, because the people they have are very good technically, but they have never overseen or led such a dramatic change that they are going to have to go through to downsize and still perform efficiency.

Mr. SAWYER. Would that mesh well with Mr. McNeill's observation, if I could paraphrase what you are saying, that there was not a sense of perspective in differentiating among large needs and small?

Mr. LOCHBAUM. I think that needs to happen. You have to focus on the right areas. I am concerned that the NRC's process for focusing on the right areas is still flawed, and it is still reactive, rather than proactive.

They need to get a better balance. They have to react to problems. I am not saying that. But they need to do a better job of preventing problems from occurring, like the Millstones and any other problems plants that we have had.

Mr. SAWYER. Thank you for your patience, Mr. Chairman.

Mr. SHIMKUS. The gentleman yields back. I now turn to my colleague from Kentucky, Mr. Whitfield, for 5 minutes.

Mr. WHITFIELD. Thank you, Mr. Chairman.

Mr. McNeill, could you tell me what percent of your enriched uranium or SWU comes from domestic sources?

Mr. MCNEILL. I do not have a specific number, but it is a large percentage. I would think it is in the neighborhood of above 75 and probably closer to 85 percent.

Mr. WHITFIELD. Mr. Graham and others, who are not on the panel today, have expressed some concern that the U.S. may be heading to a position where there may not be a domestic source of enriched uranium. Is that of concern to you?

Mr. MCNEILL. To some extent, yes. I am torn on this issue, because the more turmoil there is in the marketplace in the short term, the lower cost I get, and the more economic it is for me to generate electricity.

But if I put a long term perspective on that, I think there is value to a balanced approach to maintaining a viable energy supply, or at least a North American energy supply. Let us put it that way. I do not know specifically that it has to be purely U.S., but let us say a North American, I think, supply would be viable.

Mr. WHITFIELD. Now how would you feel if the Commerce Department grants an exemption to the suspension agreement and allows USEC to purchase commercial SWU from Russia?

Mr. MCNEILL. I think, while it is not on the record, I think in the press you have seen at least excerpts of a letter that I wrote to both the Secretary of Energy and Secretary of Commerce, objecting to that particular thing. It is mostly around making USEC the monopoly controller of a low cost supply.

Mr. WHITFIELD. So basically, your position is that if the Commerce Department does that, they should not make USEC the sole source?

Mr. MCNEILL. Right, that source ought to be available to all users.

Mr. WHITFIELD. Mr. Magwood, I know you have been very much involved on issues relating to USEC. What is your position on whether or not the U.S. should have a policy that guarantees a domestic source of enriched uranium?

Mr. MCNEILL. That is a very difficult subject, Mr. Whitfield. I think that one of the things that we certainly try to do, in creating USEC and in privatizing USEC, is to find a way to have a long term solution to having a viable enrichment enterprise.

If you recall, back in 1992, when the law was passed to form USEC, there was a great deal of concern in Congress and, in fact, on this panel, about the future of the Enrichment Enterprise, and the need to do something.

The fact that we are now seeing reasons for concern, I do not think all that original policy was made jointly by the Administration at the time, and also by the Congress. I think what it does, it does call into some clarity the fact that a lot of things have happened in the nuclear fuel market at the same time, and these have led to significant problems, such as Mr. Graham had outlined.

I think that there are very, very real reasons to want to have, from a government perspective, a domestic enrichment capability. How we actually go about doing that and how we make sure that that stays in place is a very complicated issue that the Secretary has asked the Enrichment Oversight Committee to think about. I think you are familiar with that, and we are continuing to study that. The Secretary has asked us to look at a lot of options about that.

So it is something that is being looked at actively in the government right now, and I do not think we have a clear path forward, at this point. It is a very complicated issue.

Mr. WHITFIELD. Well, you know, Mr. Graham, from his testimony today, it sounds like the uranium mining industry is not going to be around very long, unless some action is taken, relatively soon. Do you agree with that?

Mr. MCNEILL. Well, I think that Mr. Graham's assertion was really focused on the future on ConverDyn. I have met with Mr. Graham, or at least his employees at ConverDyn, to talk about this issue. I take them at their word that if action is not taken, that ConverDyn could well shut down before the end of the year, and I think that is a very serious matter.

The uranium issues are a little more complicated. But ConverDyn is the only domestic converter. I think that really crys-

tallized the issue, when the CEO of the only domestic converter tells you that he is going to shut his plant down, unless action is taken. So it is something that we take extremely seriously.

That said, it is not clear what the government role here is. It is clear that we are concerned about it. It is not clear that the Department should ask Congress for money to sustain ConverDyn. It is not clear that the Congress would do that if we ask for it. But it is something that I think the Congress and the Administration have to work on together. We have to do so very quickly, obviously, from Mr. Graham's comments.

Mr. WHITFIELD. You know, for the third time in less than 2 years, the shipments under the Russian HEU agreement have been interrupted, and most recently by the lawsuit by the Swiss trading company, which I think they won in their courts, and now they have filed suits in New York and Kentucky. If they win those lawsuits, what will the impact of that be?

Mr. MCNEILL. Well, I guess I should not speculate on the lawsuits at this point.

Mr. WHITFIELD. I am not asking you to speculate. But do you have any idea, if they win, what would the impact be?

Mr. MCNEILL. If they win, I am not sure I know all the impacts, quite frankly. I think there are lots of ways that enrichment could flow.

There are lots of questions about moneys that come into question with those lawsuits. It does not necessarily mean that the flow of enrichment would stop coming to the U.S. from Russia, if these lawsuits were to be successful. It simply means that somebody would have to pay money to somebody else.

I think that the crux of your point is, is Russia a reliable supplier? I think that is something that all of us have to wrestle with over time.

I think that if you look at the history of the HEU agreement, it has actually been rather successful. While there have been problems, we have converted 80 metric tons of hydrogen enriched weapons taken out of Russia.

From a national security and non-proliferation perspective, I think you have to say that, in many ways, the HEU agreement has been very successful.

That said, it is also clear that there continue to be needs for the government stay involved very carefully and to watch the process, and to continue to guide USEC and the Russian executive agent, as the process goes forward.

That is what we are doing right now. The government is very involved in the negotiations. We are working very closely to understand what is happening, what the proposals are, and evaluate the proposals, and we are staying engaged.

Mr. WHITFIELD. Mr. Chairman, thank you.

Mr. SHIMKUS. The gentleman yields back his time. I will now turn to my colleague, Heather Wilson.

Mr. WHITFIELD. I did not yield back time. My time had expired, Mr. Chairman.

Mr. SHIMKUS. Well, the gentleman's time has expired. With that, I will move to Congressman Heather Wilson for your 5 minutes.

Ms. WILSON. Thank you, Mr. Chairman; beat Army.

I have a couple of questions.

Mr. SHIMKUS. The gentlewoman's time has expired.

Your time has expired.

Ms. WILSON. Thank you, Mr. Chairman.

Mr. Graham, last week, some folks from the USEC agreed to members of Commerce Committee staff on the SWU plan, on the purchase of commercial SWU from Russia. Their general view was that the plan would get a better price on the SWU that USEC purchased under the U.S./Russian HEU agreement.

What I would like you to do, if you can, to the extent you are aware of this proposal, is tell us about this proposal and how it would affect the domestic uranium and conversion industries.

Mr. GRAHAM. I will do my best, Congresswoman Wilson.

It is our understanding that the agreement with USEC and the Russian counterpart is one to fix the price going forward, such that the current agreement and the current pricing for USEC does not place USEC under such duress. The current price is almost equal to their operating cost.

What it does, when we bring additional material into the market place, be it any form through government action, it will continue to add more material to an already over-supplied market.

By conditioning their long-term agreement on a short-term, what they call sweetener, to bring more SWU in for them to sell, that SWU is transported as EUP. Of course, EUP has all three components, the uranium, conversion, and enrichment.

So, in summary, what it does, it just enters into the market, with no or little restrictions, more material that would further stress the uranium market, both domestic and internationally, and quite definitely, the conversion market, putting us at greater risk to exit the market earlier.

Ms. WILSON. Mr. Magwood, I wonder if you would comment on that and on the SWU agreement, and what you think this agreement does, in terms of U.S. energy security. I recognize there is a balance here with national security and non-proliferation.

Mr. MAGWOOD. Let me say, in response to that, when we learned of the proposal, it certainly was something we were very concerned with, because of the issues that you raised.

This is an issue that is really an open item in the government right now. It is something that is being looked at very closely. The Secretary is looking at it, personally.

My understanding is that USEC was instructed not to finalize the agreement until there was further review by the government, because of these issues. For that reason, it is still under investigation. At this stage, we are trying to understand what the impacts are, and what path forward to choose.

Ms. WILSON. Thank you. Also, Mr. Magwood, I had another question on a slightly different subject, on your projections for U.S. electricity demand over the next 20 years and beyond, and your long-range strategy for keeping nuclear power as a viable long-range option.

I was struck by some of the charts and the testimony and the comments about the fact that current nuclear reactors are not going to be replaced, and the sense, in various pieces of testimony, that this is going to be a dying source of electricity for this country.

What will replace that, and is there any strategy to keep this as a viable part of U.S. energy supply?

Mr. MAGWOOD. One the things that we have always found very interesting is to try to look at projections to the future. I think that one of the practices that I have always enjoyed is simply going back in history and seeing how accurate projections, 20 years out, have been. In general, they are not very good.

I am aware that there are projections that show that nuclear disappearing in 20 or 30 years. While we understand how those projections were arrived at, we do not agree with them.

We think that their projections underestimate exactly how many nuclear power plants will be relicensed. We think they overestimate the cost of relicensing a nuclear power plant.

It is my understanding, as I stated in my testimony, that the vast majority of nuclear power plants will seek new licenses, and with those 20 years extensions, U.S. plants can be expected to operate well into the middle of the century.

For our part, we are working closely with the industry to find technologies to keep existing nuclear power plants in operation, as long as they can be safe and economic.

We are finding ways to make them more efficient than they are now. We are finding ways to incorporate advanced control technologies, and we are working very closely with EPRI, the Electric Power Research Institute, to do that.

Beyond that, we are also working with our international partners to explore next generation nuclear power technologies; technologies beyond our advanced light water reactor technologies, which are currently being built overseas. We would like to see some of them built here, but right now, they are being built in places like Japan and Korea.

We think that there will first be opportunities for next generation nuclear power and for advanced light water reactors to be built in this country, some time over the next 10 years. It is up to people like Mr. McNeill to see if the economic case is there. I think that there are certainly reasons to look at nuclear power as an option.

Beyond 10 years, we want to try to find these new technologies, and explore these new approaches to nuclear power that can be much more efficient to what is available, and certainly safer and more reliable. These are things the Department is currently actively working on.

Let me say, just in response to an early comment that I think Mr. Ebel made, that simply because the U.S. does not set out a target for how many nuclear power plants we want to see built, and the government does not issue targets, it does not mean we are not interested in nuclear power. It simply reflects the fact that our role as government is to promote research and development technology, and provide options for industry to make the choices.

So it really is not up to the government to build nuclear power plants. It is up to the government to make sure the technology is available, if industry wants to build nuclear power plants.

Mr. WILSON. I would ask unanimous consent for one additional question.

Mr. SHIMKUS. Without objection, the gentlewoman may proceed.

Mr. WILSON. Thank you.

I find your answer to be startling. You talk about this investment in research and development, and the appropriate Federal role. Yet, in your testimony on page 9, nuclear energy, research, and development has collapsed in this country.

How can we talk about these things in general terms, without making the R&D investment? And do you believe that the R&D investment in nuclear energy is sufficient?

Mr. MAGWOOD. "Collapse" is really good word for it. Yes, our R&D investment in nuclear energy fell completely down to zero in 1998, I was with the office which it happened. It was a very disconcerting event.

Since that time, and since the time I have been the Director of the office, we have been working very hard with the Congress and within the Administration to reverse that.

We have brought nuclear R&D back, somewhat. While we do not have the high levels of the past, we are up to about $50 million in research and development activities, right now.

Our Nuclear Energy Research Advisory Committee, as Dr. Klein indicated, has recommended that that be increased from about $50 million now, to about $200 million to $300 million, out about 5 years from now.

We certainly would like to work toward higher levels of nuclear R&D funding, and I think that if we do get funding like that, we will be able to show real value for it, for the country.

Mr. Chairman, I would like to note that Mr. McNeill was trying to get attention.

Mr. WILSON. My time has expired. Thank you, Mr. Chairman.

Mr. SHIMKUS. I will ask unanimous consent for 1 additional minute for you, so Mr. McNeill can give his response to the question.

Mr. MCNEILL. In this response, I speak for myself, personally, and not representing the industry.

Right now, the competitive prices of electricity do not really support the projected cost of a new light water reactor. They are too large. They are 1,200 to 1,400 megawatts in size. That kind of plant, in my opinion, only fits in a controlled economy like China, Taiwan, Japan.

In light water reactors, you have to have significant safety systems and containment. They take too long to build. Historically, they have taken up 10 or 12 years. But even if you were to build one today, it would probably take you 6 years, and you are building new gas-fired plants in 2 or 2½ years.

I think the promise looks at smaller, let us say, 120 megawatt plants that are modular in design. There are some designs that are under consideration at MIT, here in the United States and in South Africa. They do have the promise of both lower cost and, in fact, the elimination of the threat of fuel meltdown which, you know, was the event that occurred at Three Mile Island.

But we are several years away from having a confidence in that design with which we could undertake an investment of it right now. I am not so sure that extensive research is required for that specific purpose today. It is an engineering effort, more than anything else.

Mr. SHIMKUS. The gentlewoman yields back her time. We are going to a second round of questions, for those who want to stay. Then we will move to the second panel.

I would like to first just make some observations, and talk about, one, part of the initial nuclear growth was based upon energy productions, or energy demand, that really did not occur; and part of the energy dereg debate that states have addressed are the stranded costs issues to address the growth. So as much as we have projections of demand, based upon my short time, looking at this debate, they do not always fulfill.

But I am concerned, and consistently discuss energy security. So I would like to ask Mr. Ebel, if the sealanes were closed today, and I know this is mostly the nuclear table, but let us just assume that that is true for the importation of the fuel that we are receiving from Russia, and the fact that we have one facility, what would that do to demand and cost, simplistically?

Mr. EBEL. Well, I know you have had hearings on oil and gas. I am sure, during those hearings, you have touched upon the rising dependence of this Nation on oil. Our dependence on oil reaches, let us say, 56 percent, and is growing, and it is unlikely to ever come down.

Now I have listened to the testimony today about the generally deplorable status of our domestic nuclear fuel supply situation. Here we have an opportunity to maintain a healthy domestic fuel supply situation, to keep us from becoming overly dependent on foreign sources of supply. We should not miss that opportunity to do so.

We did not have that opportunity, when it comes to oil. Our supply of oil simply is declining physically at a time when demand is growing.

So I think this country would be remiss and would stand at risk if we were to let our domestic nuclear fuel supply industry decline. If the shipments were to stop today, I would presume that the domestic industry could respond. But 10 years from now, it probably could not.

Mr. SHIMKUS. Thank you. I am also intrigued by the discussion of the smaller units and the modular design. I was under the impression that part of the high cost of nuclear power has been the fact that no two plants are the same.

With regulatory changes as the industry grew, who has any assurance that a modular design, even of a small plant, would be accepted and not pose the same risk as previous nuclear plants, Mr. McNeill?

Mr. MCNEILL. Well, I think this is one of the lessons that the industry has learned. In fact, it had learned that toward the tail end of the last construction cycle when, in fact, the SNUPSS plants, or the Standard Nuclear Unit Power Supply System, had been designed. In fact, we built two of them, and there were a whole bunch of them on the drawing boards, when the Three Mile Island happened.

So I think we understand now that the essence of standardization and, in fact, licensing activities that occurred in the 1980's, of licensing a design, is an appropriate mechanism to ensure that we

were able to use that, without extensive changes during the construction process.

So you have got a pre-approved design by the NRC. You then go license a site, and you build the plant. We have not tested all that licensing process yet, but that is what is in the regulation, to date.

Mr. SHIMKUS. Thank you, and I wanted not to leave Dr. Klein out. But in your testimony, you talked about the importance of a centralized storage facility; am I correct? I hope I am still remembering that correctly, and that is not from any notes.

Mr. KLEIN. You are correct.

Mr. SHIMKUS. I would reiterate the importance of that, and the failure of us, as a body, and the importance of that, really, the costs and the safety issues involved in probably over 60 sites across the Nation, because we do not have a centralized site.

Mr. KLEIN. There were about 72 sites. What happens is, as each facility becomes full with nuclear fuel, they will have to build additional storage facilities at their sites. So what you end up is having 72 additional dry cask storage facilities, or one centralized storage facility.

In our commission's view, and in subsequent analysis, it shows that it is much better to have one facility, designed to handle that spent fuel, rather than put that burden on each utility site to store that fuel. So it is both an operational and an economic advantage, to have one centralized facility.

Once we get to a repository, we will have to have a centralized storage and processing facility, anyway. It would be beneficial if we could do that, as soon as possible, so that additional reactors do not have to build at reactor. So it is both operational and economic.

Mr. WHITFIELD [peresiding]. Mr. Sawyer?

Mr. SAWYER. Everybody is bailing out here. Thank you very much, Mr. Chairman.

Mr. Graham, you spoke about three events and their devastating impact on the American nuclear industry. The one that struck me most was your portrayal of the effect of the privatization of USEC.

Is it your sense that it ought to be re-Federalized and, if so, what form should that take? Would it be a stock buy-back? Would it involve full price? If that is the problem, what is the solution? That got your attention, did it not?

Mr. GRAHAM. Yes, Congressman Sawyer, that is a difficult question. You know, I had testified in an earlier hearing regarding the U.S. Enrichment Corporation, and had stated that of the events occurring in our industry, had one or the other of the two significant events, the HEU and privatization, occurred, the industry could have handled it. We could have worked it into the ongoing operations of the industry. Both of them occurring simultaneously is devastating us.

When we look at the U.S. Enrichment Corporation, and the aspect of re-Federalizing it, I know for a fact that in our industry, we are not incurring such pain, prior to the privatization.

The method of returning it to where it came, I think, would return us to where we have a level playing field and a competitive market place. That is really all we are asking for, to level the playing field.

The mechanism to get it, we have thought about. We have looked at it ourselves. It would be difficult, I think, at this point, because of the deterioration of the corporation. A lot of value has been lost. A lot of infrastructure has been lost.

But I think our recommendation is that the government and industry get together and tackle the problem, and come up with a solution. Without it, I think the long term, as Mr. McNeill has indicated, is in jeopardy.

Mr. SAWYER. Are you suggesting it might be easier and more efficient to start from the ground up, and rebuild that capacity?

Mr. GRAHAM. If you are referring to the technology, I think not. It is there. It is what it is. I think it is outdated. It is not the best. It is not the most economical.

I think one would have to look at the value of the company as it is today. I think the capitalization is $450 million, and probably the debt is another $500 million.

I think the U.S. Government received $1.9 billion. There would be a slight profit in taking it over again, but I think it would be a difficult procedure to do. But I think it can be done, again, in conjunction with the industry.

Mr. SAWYER. Thank you.

Mr. Ebel, you spoke in terms of government support to expand the nuclear industry.

Mr. EBEL. Yes.

Mr. SAWYER. Can you expand upon what you were talking about; what forms that might take if, in fact, the market is not sufficient?

Mr. EBEL. Well, yes, it is our judgment that the market, by itself, will not do it. It will require government support.

We would recommend in our study that a joint government private sector partnership in the development of a kind of reactor that would meet the needs of today, which is reduced proliferation, to try to be proliferation-resistent, low cost, modular.

That is modular, in part, because it needs to respond to the needs of developing countries, where you could build, as their demand for electricity grow. That would be moral support, yes; but financial support, also.

Mr. SAWYER. Do I hear you correctly, that you are talking largely about research and development, in terms of that, or are you talking about capitalization?

Mr. EBEL. Well, there are, I think, available some thoughts about what a fourth generation reactor would look like, and we should proceed from that basis.

Mr. SAWYER. Are there other comments?

[No response.]

Mr. SAWYER. Thank you, Mr. Chairman.

Mr. WHITFIELD. Yes, Mr. Ebel, I was pleased to hear your comment that we are quite dependent upon foreign oil. Many of us are concerned about becoming dependent upon enriched uranium from foreign sources.

I think, Mr. McNeill, you also said you would be concerned about that, but not so much, as long it was a North American source. How many sources are there in Canada, for example?

Mr. MCNEILL. Well, there are mines in Canada. They process unenriched uranium. There are no enrichment facilities there. I do not know the extent to which there are conversion facilities.

My issue was around, we have a fairly stable political climate in North America. I do not think we are subject to the risks that we are by going to Europe or Asia for supplies.

Mr. WHITFIELD. But if you did have to rely exclusively on Europe or Asia, you would be more concerned?

Mr. MCNEILL. I would be more concerned, yes. I think from a national security perspective, I would be concerned.

Mr. WHITFIELD. Mr. Magwood, if the Secretary of Commerce, Mr. Daley, called this afternoon and asked, would you support the exemption to the suspension agreement, so that USEC would be able to buy this commercial grade uranium from Russia, what would be your position?

Mr. MAGWOOD. I would probably refer him to Secretary Richardson.

Mr. WHITFIELD. Do you have any idea what he might say?

Mr. MAGWOOD. I said earlier that this is really under active analysis. I think Congress and DOE are working together, to some degree on this. I expect that we will be able to have some position on that, fairly soon.

Mr. WHITFIELD. What is the status of the RFP for the construction of the two uranium hexoflouride conversion facilities in Paducah and Portsmouth?

Mr. MAGWOOD. We have made a commitment, and we are on track to meet that commitment, to have that RFP in final form, on the streets, in October. We are still on track to do that.

Mr. WHITFIELD. Okay, thank you. I have no further questions. Mr. Burr?

Mr. BURR. Thank you, Mr. Chairman. I have just a few general comments. I apologize, because I can not see names, so I am going to try to ask you questions that are open to all of you.

Mr. Chairman, as I sat here and heard the questions about the possible re-Federalization of USEC, the one thing that went through my mind was, I wondered whether we could afford the buy-out of Mr. Timber's contract, based upon his parachute that is there. But I am sure that is something we will tackle. I would not want him to think, because he was not here, that I had forgotten about him.

If I understand the participation of nuclear to our overall market, it is about 16 percent. Am I accurate? Is it not?

Mr. MCNEILL. I think it is closer to 20 percent.

Mr. BURR. It is closer to 20 percent. That is even more important.

Will the absence of a permanent disposal facility for spent reactor fuel accelerate the closure of nuclear generation in this country? I would open that to anybody that would like to respond. Yes, sir?

Mr. MCNEILL. I am not so sure that it will accelerate the closure. I think that the impacts of the government's failure to fulfill its responsibilities under the Waste Policy Act clearly increases the cost of electricity from nuclear power plants, because we have to provide alternative mechanisms of storage, rather than moving it directly to the permanent storage.

This is probably the risk. In Minnesota, for instance, there is a State law which limits the amount of temporary storage there is. If that is not resolved, it could force the shut down of plants in that state.

Also, you are exposing the Federal Government to significant legal liabilities, because it is under contract to take this material, and it is going to fail to do that. It is a contract law resolution issue that that could be.

There are several other impacts here that are, to some extent, more psychological, such as the failure to resolve that issue provides a forum for idea logs that do not like nuclear power, to argue that we ought to shut the plants down, or we should not develop new plants, and things of that nature.

Mr. BURR. But if I understand what you have said, if plants who meet capacity in their pool file for an expansion of their pool, and that expansion is not granted, whether it is the pressure within the community or the approvals that they have to go through, then it would accelerate the closure of the facility, because of the lack of storage.

Mr. MCNEILL. If there is no other alternative, yes.

Mr. BURR. And with the exception of the permanent site, or the pools that they currently use, there is no other option right now, is there?

Mr. MCNEILL. Well, the other option is temporary cask storage onsite.

Mr. BURR. And we have sort of talked about that up here, and it was received about like some of the President's budget.

Mr. MCNEILL. Well, I just got done building one. I am moving my first fuel there, next month.

Mr. BURR. Is there anybody that would agree that this stands a chance of accelerating closure of facilities?

Mr. KLEIN. I think it certainly does. I think the plant that Mr. McNeill referred to, Prairie Island, is a classic example. I think there are other States that could implement similar situations that could cause a difficulty.

I think the bottom line on not moving forward with the centralized storage facility and a permanent repository, and we will need them both at some point in time, is that the ratepayers are paying twice. They are paying for a permanent facility, and then they have to pay additional costs for additional reactor storage.

Mr. BURR. How many people at the table believe by 2010 that the Department of Energy will have taken spent fuel? Is there anybody at the table from the Department of Energy?

It really concerns me when you do not believe that the Department of Energy will take spent fuel by 2010. Did you just not hear my question?

Mr. MAGWOOD. I think Mr. McNeill was trying to distract me, so I would not hear the question.

I think that we are on track to do that. I think that the Department has a plan to go forward to open Yucca Mountain in 2010. I do, however, think that it will require a great deal of hard work, from both the Administration and Congress, to get the money to do that.

The funding profile for the Yucca Mountain project is going, by I think 2003 or so, to begin to accelerate pretty dramatically. If the funds to move this along are not available, we are going to be in trouble.

Let me say that just since the 1998 viability assessment came out on Yucca Mountain, the funding for the Yucca Mountain project is about $100 million behind what the projections were, back in 1998.

So, on the path we are on now, we are not going to make it. I think it is going to really take more resources to make this happen, but I do think it is possible.

Mr. BURR. You have got five gentlemen sitting beside you. I would assume that they all pay Federal taxes. They live in some member's district. None of them believe that you will have taken this by 2010, and there are many more of them that live in the districts of each of us who say, how is this money being spent?

We have got some accountability that is tied to the release of funds, that says there has to be an expectation that there is an end point to this; that we can, with confidence, turn to an industry and say, it will be taken, not it might be taken, or it might be taken if we do this. It will never be taken, would probably be better situation than what we are in right now.

But we understand the statement you are making. We know that at some point, we have to work to make sure that more of that money, on the annual basis, is appropriated. We just have to have a belief that there is a will at the Department of Energy to live up to the date, and I guess you are telling me that there is.

Mr. MAGWOOD. My understanding is that the Director of the Office of Civilian Reactor Waste Management, Mr. Ritkin, will be up here in 2 weeks to talk about this in great detail.

He and I did confer before this hearing. He is very confident that they are on a track to take spent fuel, on the schedule that they have projected. He is, however, concerned about the funding.

Let me just add one last thought. That is that I believe that while there are a few plants that could become endangered, because of the delay in taking spent fuel in the original schedule, I think that the forward motion of the program provides some confidence to people that are operating plants right now that there is a plan to take care of it.

I think that that is as important as the actual taking of spent fuel, when you look at the longer term. Hopefully, those who did not rise to the occasion and support the Department, in saying that they are sure that the Department will meet the schedule, at least believe that we are moving in the right direction, and doing the best we can if they do not believe we are doing the best we can, we certainly hope they will come back and tell us how we can do better.

Mr. BURR. Well, I can assure you, I think that as the time goes on and as the money gets to be more, I think that the Congress will weigh in, even more boisterous than we have. I have given up the belief that I ever participate in a hearing in Congress where somebody from a Federal agency walks in and says, "You gave me too much money." Clearly, I expect the request for more.

This is my last question. This is to the whole group, Mr. Chairman. A 20 percent loss, over some period of time, of generated electricity; what replaces it? Is there anybody that believes that new nuclear is going to be built?

[No response.]

Mr. BURR. Okay, then I would assume that your answer to that replacement is new not nuclear. For the other four, what replaces that lost nuclear generation?

Mr. KLEIN. I think in the short term, what we will see to meet that capacity, as others have said, is the additional burning of natural gas, because it is quick, and those costs will be passed on to the consumer.

I think the difficulty that we have in planning is that we do not look as far, long term. When you talk about building baseload coal and nuclear plants, you end up taking time. It takes time to build them and get them licensed.

We are making decisions now on the short term for things that we can accomplish fairly quickly. We need to have an infrastructure and a policy in place that will let us make these long term decisions for a stable electrical supply, that will not be subjected to rapid increases of costs, with an interuptable supply.

For example, if there is an interruption of oil, as we had seen previously, that will impact the cost of natural gas. Then we will see those costs immediately passed on to our electricity bill.

So I think, as a country, we need to look at long-term energy strategies that include nuclear and coal as our base load.

Mr. BARTON. I am told that the gentleman's time had expired about 5 minutes ago.

Mr. BURR. The gentleman's time had expired about 5 minutes ago. The gentleman from Kentucky was very generous to me.

Mr. BARTON. He told me he liked North Carolina.

Mr. BURR. I would just say to the chairman, I am very enlightened at the fact that the Department of Energy raised their hand in the belief that we would build new nuclear, and I have not heard that out of the Department of Energy before today.

Mr. BARTON. Did they say what century we will build new nuclear?

Mr. BURR. Clearly, I was not quite that crafty.

Mr. BARTON. Okay.

Mr. BURR. Thank you, Mr. Chairman.

Mr. BARTON. Does the gentleman from Virginia wish to ask questions?

[No response.]

Mr. BARTON. Has the gentleman from Ohio been given a chance to ask questions? He has been given two chances?

Well, I have some questions, but I am going to submit them for the record. We still have a coal panel, and we really want to give them an equal opportunity.

I want to thank you gentleman for coming. It is obvious there is a lot of interest in the nuclear industry. We look forward to working with you in the coming years to revitalize our industry. This panel is released.

If we could have our next panel come forward, as soon as the first panel has vacated the witness table.

This is our second panel. We want to welcome Mr. Robert Kripowicz, who is the Principal Deputy Assistant Secretary in the Office of Fossil Energy, from the Department of Energy.

Like I told your contemporary on the first panel, we appreciate your willingness to appear on a panel with private sector employees. It does facilitate our hearing. We want to thank you for having your testimony in on time. We appreciate that.

So we are going to recognize you, Mr. Kripowicz, for 7 minutes. Your statement is in the record. Then we are going to go to General Lawson, Mr. Bailey, Mr. Gehl, and Dr. Schobert. So welcome to the committee.

STATEMENTS OF ROBERT S. KRIPOWICZ, PRINCIPAL DEPUTY ASSISTANT SECRETARY, OFFICE OF FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY; RICHARD L. LAWSON, PRESIDENT AND CEO, NATIONAL MINING ASSOCIATION; PAUL C. BAILEY, VICE PRESIDENT, ENVIRONMENT, EDISON ELECTRIC INSTITUTE; STEPHEN M. GEHL, DIRECTOR OF STRATEGIC TECHNOLOGY ALLIANCES, ELECTRIC POWER RESEARCH INSTITUTE; AND HAROLD SCHOBERT, DIRECTOR, THE ENERGY INSTITUTE, PENNSYLVANIA STATE UNIVERSITY

Mr. KRIPOWICZ. Thank you, Mr. Chairman and members of the subcommittee. I appreciate the opportunity to represent the Department of Energy, and to discuss our views on the future of coal.

Rather than address every point in my prepared statement, in the interest of time, I would like to focus on one key aspect of the future of coal, and that is technology.

Coal is our most abundant fossil fuel resource. Its low cost is one of the major reasons why the consumers of this Nation benefit from some of the lowest electricity rates of any free market economy. But abundance and low cost alone do not guarantee coal's future. Environmental acceptability has been, and will continue to be, the key factor in the future in the use of coal.

I am convinced, and I believe my colleagues on this panel share this view, that advanced technology can overcome concerns about coal's impact on the environment.

For the last 30 years or more, the use of coal has been challenged with increasingly stringent environmental requirements. Each time, the Nation's coal scientists and engineers have responded.

For example, when the 1970 Clean Air Act was passed, many utilities installed scrubbers, but scrubber technology was expensive and unreliable.

Today, because of our investment in technology, scrubbers are one-fourth as expensive as those of the 1970's, and reliability is no longer a serious concern. That investment alone has saved American ratepayers more than $40 billion since 1975 in reduced compliance costs.

Nitrogen oxides are another example. When acid rain and urban smog became major environmental issues in the 1980's, we had very limited technology to control nitrogen oxide pollutants or NO_X.

But we invested in research and in the Clean Coal Technology Program, and today we have advanced burners that reduce NO_X at one tenth the cost of controls in the 1980's. Nearly 75 percent of

today's coal-fired generating capacity use these lower-polluting burners.

Today, as a result of technology, we can burn coal in a fluidized bed boiler, and eliminate 95 percent of the sulphur and nitrogen pollutants inside the combustor, removing the need for a scrubber.

We now have entirely new ways to use coal to generate electricity; by gasifying it, rather than burning it. One of the cleanest power plants in the world operates outside of Tampa, Florida. At its heart is a coal gasifier and a system that produces coal-derived gas with virtually the same environmental characteristics as natural gas. It is a product of our Clean Coal Technology Program.

The future of coal is a future driven by technology. At the Energy Department, we are developing new technology for coal that could produce a virtually pollution-free energy plant by the year 2015.

I have displayed on the easel an artist's concept of such a plant. We call it our "Vision 21" concept. I have brought this drawing to make one key point: the coal plant of the future may not look at all like "your father's power plant."

A Vision 21 plant would be capable of processing a wide range of fuels; coal alone, or coal mixed with petroleum coke; or in this concept, coal mixed with municipal waste from a major metropolitan area.

It would gasify this fuel, or combust it in an advanced combustion process. Perhaps it would incorporate fuel cells or turbines, or a hybrid combination of the two.

In one concept, it would generate only electric power. In other configurations, it would produce multiple products, processing some of the coal to make liquid fuels or high value chemicals, in addition to power.

As a power plant, a Vision 21 plant would incorporate technologies being developed today that could double the efficiency of power generation. That would reduce carbon emissions by 40 percent or more; a major step forward in greenhouse gas control.

As a fuel producer, we estimate that such a plant could produce liquid petroleum substitutes in the $20 per barrel range. That would be a major step forward in reducing our growing dependence on foreign oil.

Most importantly, a Vision 21 plant would have near zero emissions of today's regulated air pollutants. That means it could be sited near urban centers where future demand for electric power is likely to be the greatest. To make that point in the artist's concept, our engineering team configured a plant for Roosevelt Island in the East River in New York City.

Let me stress that this is not "pie-in-the-sky" speculation. Each of the major components of a Vision 21 plant has either been demonstrated, or is in the development stage today. The key will be to link them together in a commercially viable concept, competitive with natural gas.

Skeptics might say, "Okay, you have solved the air pollution problem, but what about global climate change?" The plant still uses coal, albeit, much more efficiently, and it still emits carbon dioxide, a greenhouse gas.

That is where the second of our major coal priorities will play a role. Carbon sequestration is a relatively new part of our program,

but it holds significant promise. Carbon sequestration is the capture and either storage or recycling of carbon gases to prevent their buildup in the atmosphere.

There are a variety of ways to do this, but virtually all will require more research before they are proven reliable, affordable, and environmentally safe. That research is recently underway, and industry, to its credit, is coming to the table.

In one of our first major competitions, we received more than 60 proposals with private sector cost-sharing averaging around 40 percent. Within the next few weeks, we will announce the first set of winning projects. In almost all of them, the industry contribution will be above the 40 percent mark. This is a very positive development, and beyond our original expectations.

So, Mr. Chairman, we do not see coal as a fuel that has seen its better days. Coal has faced challenges before, and it faces them today. But we have called on technology before to meet those challenges, and we believe we can call on technology, again.

That concludes my opening statement.

[The prepared statement of Robert S. Kripowicz follows:]

PREPARED STATEMENT OF ROBERT S. KRIPOWICZ, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY

Mr. Chairman and Members of the Subcommittee. I appreciate the opportunity to discuss the important role that coal—and especially cleaner coal technology—can play in continuing to strengthen our nation's economic future while at the same time, improving our environment.

Today, coal is an indispensable part of our nation's energy mix. Because of its abundance and low cost, coal now accounts for more than half of the electricity generated in this country.

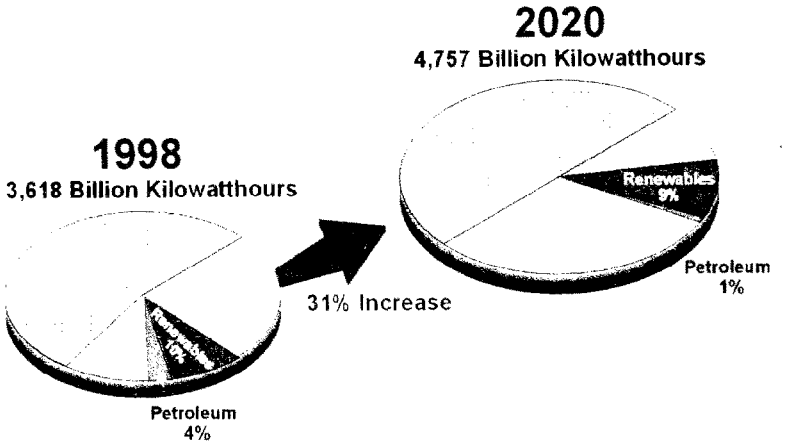
Coal is our nation's most abundant domestic energy resource. One quarter of all the world's known coal supplies are found within the United States. In terms of energy value (Btus), coal constitutes approximately 95 percent of U.S. fossil energy reserves. Our nation's recoverable coal has the energy equivalent of about one trillion barrels of crude oil—comparable in energy content to all the world's known oil reserves. At present consumption rates, U.S. coal reserves are expected to last at least 275 years.

Coal has also been an energy bargain for the U.S. Historically it has been the least expensive fossil fuel available to the country, and in contrast to other primary fuels, its costs are likely to continue to decline as mine productivity continues to increase. Between 1988 and 1997, minemouth coal prices (in real 1992 dollars) declined by $9.40 per ton, or 37 percent; between 1998 and 2020, prices could decline by another $5.00 per ton (1998 $), or about 1.5 percent a year. The low cost of coal is a major reason why the United States enjoys some of the lowest electricity rates of any free market economy.

COAL CONSUMPTION FOR ELECTRICITY PROJECTED TO CONTINUE RISING

America's coal industry—81,000 miners working in 25 states—produces approximately 1.1 billion tons of coal per year. Just under 950 million tons goes to U.S. power plants (the rest is used for industrial purposes, such as steelmaking, or is exported). According to the Department's Energy Information Administration (EIA), domestic coal demand could increase by 20 percent by 2020, growing to 1,316 million tons, primarily because of increasing coal use for electricity generation.

As this chart shows, although coal's overall contribution to the nation's electric power supply is projected to decline somewhat—from 52 percent in 1998 to 49 percent in 2020—the substantial growth in U.S. power consumption means that the U.S. will mine and use more coal in the foreseeable future.



Electric Power Generation. Coal will continue to supply about half of the nation's electric power through 2020. The significant increase in U.S. power demand will likely require coal production to increase from 1,118 million tons in 1998 to 1,316 million tons in 2020.

Source: Energy Information Administration Annual Energy Outlook 2000

A key element in EIA's projection is that very little new capacity is planned during that time period, about 7% of existing capacity (or around 21 gigawatts). Most of the increased generation from coal-fired units will come from existing plants increasing their hours of operation. The primary barrier to construction of new coal-fired power plants will be intense competition from natural gas combined cycle powerplants. These natural gas-fired plants have much lower capital costs than coal plants and are very low pollutant emitters.

Electricity restructuring is another important development in the industry. Using authorities provided by Congress in the Energy Policy Act of 1992 and other statutes, the Federal Energy Regulatory Commission has taken action to make wholesale electricity markets more competitive. To date, 25 states have taken action to introduce competition into retail electricity markets and many others are considering this option. The Administration sent its own comprehensive legislative proposal to Congress more than two years ago. Both the House Commerce Committee and the Senate Energy and Natural Resources Committee have announced plans to mark up legislation this month to update the federal statutory framework for the electricity industry. A comprehensive restructuring bill will both protect the reliability of our electric system and facilitate the smooth functioning of restructured electricity markets. Properly implemented, restructuring will be good for consumers. the economy, and the environment. Restructuring can also be good for coal—the Administration's analysis of its comprehensive restructuring proposal projects that coal-fired generation would continue to increase through 2015 under competition, and that competition modestly increases coal-fired generation above reference-case levels in the near-term.

COAL AND THE ENVIRONMENT

Largely because of improving pollution control technology, the nation has been able to use more coal while improving the quality of its air. Coal use has *more than doubled* since 1970 while emissions of sulfur and nitrogen Pollutants *have declined* by 70 percent and 45 percent respectively.

EIA's coal Projections reflect existing environmental regulations only. Whether expectations for future growth in coal demand actually materialize will depend largely on the nation's coal users' ability to comply with increasingly stringent environmental regulations. Increased compliance costs can lead to early retirement of a unit, or to less use of the coal-fired generating unit as it becomes more costly to

operate. The most critical regulations and policy initiatives are air pollution related and include:

- **Rules to address the Regional Transport of Ozone (the ozone "SIP Call" and related rules promulgated by EPA).** The SIP Call rule required 22 Eastern states and the District of Columbia to reduce nitrogen oxide (NO_X) emissions by specified amounts by May 2003. Although the rules are being revised to comply with judicial direction, the primary mechanism to achieve the required reductions is expected to be additional NO_X reduction requirements at coal-fired power plants.
- **Revised National Ambient Air Quality Standards for Particulate Matter and for Ozone.** These revised standards were promulgated in 1997, with anticipated annual compliance costs for full attainment of $37 billion per year and $10 billion per year, respectively. The Supreme Court will be reviewing the EPA rules. Both are significant for power plants because they will lead to additional reductions in emissions of NO_X and sulfur dioxide (SO_2) which are precursors to fine airborne particles.
- **Mercury regulations.** Under a court sanctioned agreement, EPA is scheduled to decide by December 15 whether or not it is necessary to control mercury from coal-fired power plants. If EPA deems it necessary, the agency must promulgate regulations by December 2003.
- **Enforcement initiative.** On November 3, 1999, EPA filed lawsuits against seven utility companies, and issued an administrative order against an eighth, charging violation of new source review requirements. The civil actions, now in the discovery stage, all seek retrofit of state-of-the-art control technology. A total of 33 gigawatts of capacity is involved in EPA's initiative—over 10% of total U.S. coal-fired capacity. The basic allegation is that activities at these plants were modifications requiring new source permits. In the only settlement to date, the Tampa Electric Company (TECO) agreed to 85% reductions in NO_X and SO_2 by 2010, retirement of significant coal capacity, and payment of a $3.5 million civil penalty.

The 305 gigawatts of existing coal-fired powerplants can be categorized into three groups: (1) very large and relatively new plants, (2) very small and relatively old plants, and (3) those in between. The first category will probably be able to continue to operate economically, even with the new regulations. Many of the smaller plants in the middle category will not, and in fact several utilities have recently announced plans to replace some older coal units with new natural gas-fired units.

The pivotal group is the third group—moderate size coal plants with significant remaining operational lifetimes. It is this group which will benefit most from development and deployment of advanced emission control technologies. The greater the success of DOE and its private sector partners in developing more effective, and lower cost mitigation technologies, the more of these plants which will continue to operate, and the lower the overall cost of electric power will be to the consumer.

A major caveat is that none of the projections assumes the implementation of new regulation to address climate change concerns. DOE is also pursuing technologies to reduce greenhouse gas emissions from coal (and natural gas) power plants—both by increasing efficiency of the power generating process and by capturing and sequestering carbon gases. Although these technologies are longer term and unlikely to be available prior to 2015, they could allow for the use of coal as a fuel for new generating plants while substantially reducing or even eliminating emissions of greenhouse gases to the atmosphere.

Measures to reduce greenhouse gas emissions before 2015 could lead to significant reductions in domestic coal use. Impacts on domestic coal use would likely be directly related to the amount of reduction in greenhouse gas emissions that takes place within U.S. borders. For a given level of greenhouse gas emissions commitment, provisions that allow the U.S. to meet the commitment by (1) relying on purchased emissions reductions from sources in other countries, (2) sequestration of carbon dioxide through forestry activities, and (3) additional reductions of non-carbon dioxide greenhouse gases would reduce the impact of any such obligation on the level of domestic coal use.

CLEAN COAL TECHNOLOGY—THE INVESTMENT IS PAYING OFF

With coal expected to remain one of the nation's lowest cost energy sources, its future will be determined largely by the availability of affordable technology that can reduce the impact of its use on the environment.

In the mid-1980s, the United States began an unprecedented joint public-private investment in a new generation of cleaner coal technologies. The Clean Coal Technology Program led to 40 projects in 18 states, over half successfully completed.

More than $5.6 billion has been committed to this program, with private industry and states investing two dollars for every one from the federal government. Today, because of the Clean Coal Technology Program and the research efforts that undergird it:

Pollution control costs are significantly lower.

In the mid-1980s, the only options to reduce smog-causing nitrogen oxide (NO_X) pollutants from coal-fired power plants cost $3,000 per ton of NO_X. Today, technologies such as low-NO_X burners demonstrated in the Clean Coal Technology Program have reduced NO_X control costs to less than $200 per ton. Nearly 75 percent of the nation's coal-fired generating capacity now uses low-NO_X burners. The cost of selective catalytic reduction, which removes NO_X from coal flue gases, has been cut in half because of technology advances.

Similarly, in the 1970s, scrubbers—the flue gas treatment devices that remove sulfur pollutants from the exhausts of coal-fired boilers—were expensive, unreliable, and posed waste handling problems. The Federal Govemment's R&D program (both at DOE and EPA) and DOE's Clean Coal Technology Program helped improve scrubber technologies. Today, flue gas scrubbers are one-fourth as expensive as the vintage-1970s units and operate much more reliably. The reduced costs, alone, have saved American ratepayers more than $40 billion since 1975. Today, advanced scrubbers produce a waste product that can be recycled into wallboard or easily disposed of in a safe, powder form, rather than the sludge of older systems.

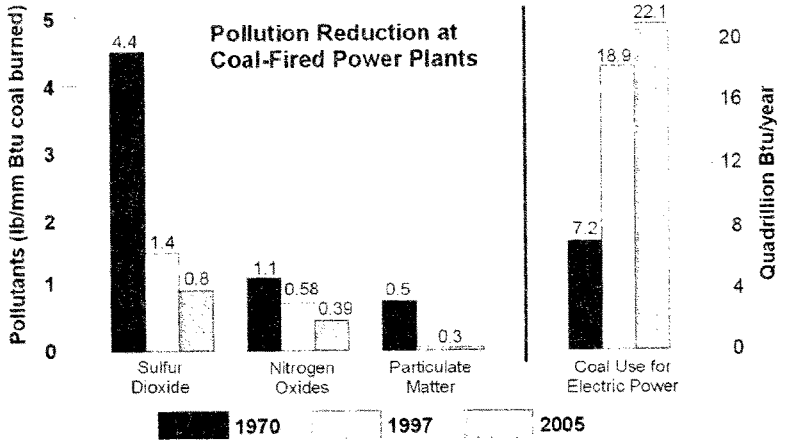
Coal combustion is cleaner.

In the 1970s and 80s, DOE's R&D program helped develop the fluidized bed coal combustor—an advanced coal-burning technology that removed sulfur pollutants and limited the formation of NO_X Pollutants inside the boiler, eliminating the need for scrubbers or other post-combustion controls. The new technology found widespread acceptance in the industrial boiler market.

The Clean Coal Technology Program helped move this clean-buming technology into the larger-size, utility market. Using this technology, coal-fired Power plants can reduce sulfur emissions by more than 95 percent and NO_X emissions by more than 90 percent, even when burning high-sulfur coal.

Utilities have a new option for coal-based power.

The Clean Coal Technology Program also pioneered a fundamentally new way to use coal to generate electricity. Rather than burning it in a boiler, gasification-combined cycle technology first converts coal into a combustible gas, cleans the gas of virtually all of its pollutants, then burns the gas in a turbine, much like natural gas. More than 99 percent of sulfur, nitrogen, and particulate pollutants can be removed in the process.



Moreover, heat from the turbine can be used in a conventional steam cycle to generate a second source of electricity, increasing overall power plant efficiencies.

Because of the Clean Coal Technology Program, the nation now has three full-scale, pioneering coal gasification combined cycle power plants located in Florida,

Indiana, and Nevada. These are among the cleanest fossil fuel power generating facilities in the world.

Steel mills have an environmentally attractive alternative to coke ovens.

Much of the nation's coal not used by power plants is shipped to steel mills for use in making the coke needed for the steelmaking process. Coke production, however, is a significant source of air pollutants, including air toxics. The Clean Coal Technology Program demonstrated a way to use coal directly in the blast furnace, displacing coke virtually on a pound-for-pound basis. Direct coal injection offers the steel industry a clearly superior economical and envirom-nental alternative to traditional coke-making.

THE FUTURE

When the Department of Energy issued the Comprehensive National Energy Strategy in April 1998, the first of its five overarching goals was to:

> **Improve the efficiency of the energy system**—*making more productive use of energy resources to enhance overall economic performance while protecting the environment . . .*

One of the major strategies to achieve this goal is to demonstrate cost-effective power systems that can achieve electrical generating efficiencies greater than 60 percent.

Today's coal-fired power plants convert only about a third (between 33-35 percent) of the energy value of coal into electricity. The rest is typically discarded as waste heat. The Clean Coal Technology Program has demonstrated new technologies that can boost efficiencies to nearly 45 percent. Advances now in the DOE research and development program—for example, more energy-efficient gas separation technologies, improved turbines, and coal-capable fuel cells could push coal power plant efficiencies into the 60-percent range.

What are the benefits of a more efficient coal-fired power plant?

Cleaner operation is one, since a coal plant that uses less fuel to generate the same amount of power will emit fewer emissions. Reduced greenhouse gas emissions is another benefit; a 60 percent efficient coal power plant can cut carbon dioxide emissions by more than 40 percent. A third is cost to consumers. Improving the efficiency of a power plant can lower costs of the electricity generated, perhaps by up to 20 percent.

The Vision 21 Concept. It may be possible in the future to eliminate virtually all of the environmental concerns at a coal-based power plant.

DOE is developing a concept for a new fleet of energy facilities that would incorporate breakthrough technologies in advanced power generation and pollution controls. With a target date of 2015, this new energy concept, called *Vision 21,* would incorporate technologies that would reduce SO_2 (sulfur dioxide) and NO_X emissions to near zero, and cut in half the amount of carbon dioxide emitted from the plant.

Moreover, the *Vision 21* concept could incorporate various coproduction options—producing not only electricity but other high-value products such as hydrogen, clean transportation fuels, chemicals and other commercial commodities. By developing a multi-product energy facility rather than just a single-product electrical generating plant—it may be possible to boost overall coal use efficiencies to more than 80 percent. Improving the efficiency of tomorrow's coalfueled energy facilities can be beneficial companion to improving end-use energy conservation efforts. For example, by raising the efficiency of U.S. coal-fired power plants to 50 percent, the nation could achieve fuel savings equivalent to weatherizing 400 million homes—more than 5 times the number of homes in the United States.

Carbon sequestration. Even with improved efficiencies, a future coal-fired power plant still may not be able to achieve the substantial greenhouse gas reductions that may be necessary to counter concerns about global climate change. Therefore, one of the keys to coal's long-term future (and to the future of other fossil fuels) may be the emerging technology of carbon sequestration.

Only a few years ago, concepts for capturing greenhouse gases at their point of emission, or even from the ambient air, and either storing them for centuries or recycling them into useful products were considered laboratory curiosities. Today, the opinion is much different.

DOE has set a goal of developing technologies that can capture and sequester carbon dioxide at costs as low as $10 per ton of carbon. This is equivalent to adding only $^{2}/_{10}$ths of a cent per kilowatt-hour to electricity rates that today range from 4 to 12 cents per kilowatt hour.

Carbon sequestration—if the technology can be successfully developed—could be the only option that doesn't require large-scale turnover of the world's energy infrastructure. Along with low-carbon and carbon-free energy supply technologies, such

as natural gas and renewable energy systems, and more energy-efficient end-uses, carbon sequestration could become an important 3rd option in reducing the buildup of greenhouse gases.

CONCLUSION

The United States needs a variety of energy sources to continue the unprecedented economic expansion that has made us the envy of the world. At the same time, Americans have consistently ranked environmental quality as one of their highest priorities for both current and future generations.

While the U.S. will continue to expand the role of renewable and other alternative energy resources in its energy portfolio, coal will continue to provide a large share of the overall energy—and the dominant share of electricity—that can keep our economy growing. New technologies can make it possible to use all of our domestic energy resources—including our largest resource, coal—in ways that are compatible with our goals to protect the environment.

Over the past 20-year history of the Department of Energy, we have made substantial progress in improving the environmental acceptability of coal use while, at the same time, keeping the costs of coal-derived energy low. Through the continued public and private investment into advanced, more efficient, and cleaner coal technologies, coal can remain a beneficial contributor to America's energy future.

Mr. BARTON. Thank you, Secretary Kripowicz. We appreciate that.

We now want to hear from General Richard Lawson, who is President and CEO of the National Mining Association. He assumed that position after a career in the United States Air Force, where he was a Four Star General, and a Vietnam combat veteran, with over 73 combat missions.

We appreciate your service to your country, sir, and we appreciate your testimony today on behalf of the National Mining Association. Your statement is in the record in its entirety. We would ask you to summarize it in 7 minutes.

STATEMENT OF RICHARD L. LAWSON

Mr. LAWSON. Thank you, Mr. Chairman, and members of the committee.

I am Richard Lawson, the President of the National Mining Association. Thank you for inviting the mining industry to participate in this hearing.

Mr. Chairman, the United States has the resources to have an energy policy that supports the use of all domestic fuels, while at the same time balancing economic security, social, and environmental considerations.

Unfortunately, we do not have such a policy in place today. Our policies are not balanced. They support the environmental extreme over the reasonable. As a result, our energy future is vulnerable on several fronts.

We are now dependent on imports for 54 percent of our oil supplies; a far higher dependency than just before the 1991 Gulf War, when I appeared before this same committee to talk about exactly this same subject.

Reserve margins in our electric utility industry are lower than ever before, making our electricity supply vulnerable to the unexpected plant outage or heat wave. Policies that govern access to our domestic fossil reserves are preventing us from taking full advantage of our own energy sources: oil, natural gas, uranium, coal, and even hydropower.

You asked me to talk about coal and coal-fired electricity. Coal is the mainstay of both the U.S. and the global energy supply. Coal provides almost a quarter of the energy that we use in our country today. It is the fuel that generates over half of our electricity. Your home State of Texas, Mr. Chairman, is the No. 1 user of coal; over 110 million tons, last year.

Globally, coal's contribution to the energy mix is about the same as the U.S., 25 percent. In developing countries, that percentage is higher, 35 percent. Coal represents nearly 95 percent of the U.S. fossil energy reserves, and almost 70 percent of the worldwide fossil reserves.

So coal will continue to be used, because it is widely available, it is reliable, and it provides the fuel for low cost electricity.

Here in the United States, the Energy Information Administration expects coal use to increase by some 200 million tons over the next 20 years. In developing countries, including China, coal use will increase by some 1.8 billion tons, mostly to make electricity. I use these numbers to illustrate my point: coal is here to stay in the United States and elsewhere.

While coal is used more efficiently with lower emissions today than ever before, technologies are being developed which will convert coal into electricity with even greater efficiency, while effectively eliminating emissions.

Changes in policy are required, however, both to maintain current coal generating capacity, and to ensure that the future fleet of electric power plants include coal-fired capacity.

There are constraints on coal supply. Recent actions by the Administration to declare large areas of public lands as national monuments, along with attempts to place large blocks of forest service lands off limits for any use, are reducing the quantities of coal reserves available for mining.

There are even more constraints on coal use. The Environmental Protection Agency has proposed, or is attempting to implement, many new regulations that affect not only new coal-fired capacity, but will have the effect of either shutting down existing coal capacity, or requiring expensive modifications.

The possibility of stringent requirements to reduce greenhouse gas emissions, such as those suggested by the Kyoto Protocol, compound the problem. I have discussed these issues in my written statement, and I will not repeat them here.

Taken individually or collectively, these actions have the same effect. Existing coal capacity will be shut down. New coal capacity will not be brought on line.

Research on new technologies is ongoing, and will continue using and building upon the results of the DOE Clean Coal Technology Program. Efficiency and emission reduction goals, and the technologies needed to achieve these goals, are described in the technology road map, contained in my written statement.

Incidently, Mr. Chairman, your action in sponsoring the Energy and Climate Policy Act of 1999 in the House has helped move these technologies along.

Vision 21, outlined by Deputy Assistant Secretary Kripowicz, is an important part of this research effort, to develop the zero emission coal-fired power plant of the future. The coal industry is work-

ing on a number of projects to sequester carbon as those technologies will also be vitally important in the future, if it is found that reduction of CO_2 emissions is indeed necessary.

In addition to initiating a program that focuses on existing generating capacity, and continuing the R&D programs that address long-term technology needs to improve efficiency and reduce emissions from coal-based generation, two additional elements are needed.

First is a financial incentives program, designed to cushion the financial burden of applying technologies to existing coal utilities, to improve emissions control and increase efficiency. Second is a demonstration program that provides tax incentives and/or financial assistance to deploy the initial commercial scale applications of advanced coal-based generating technologies.

This is required to reduce the significant risk inherent in using first of a kind technologies; a risk the utilities can not take in this new area of deregulation.

Mr. Chairman, all energy sources have a unique and important role to play in meeting the growing energy demands of tomorrow. National energy policy should use all available domestic energy to permit the realization of the maximum national energy security.

Of necessity, our greatest and lowest cost domestic energy source, coal, can and should be a major source of energy for the electric generation industry of the future.

We look forward to working with this committee to make our Nation's energy future, and coal's future, a positive reality.

[The prepared statement of Richard L. Lawson follows:]

PREPARED STATEMENT OF RICHARD L. LAWSON, PRESIDENT, NATIONAL MINING ASSOCIATION

Mr. Chairman, members of the committee, I am Richard L. Lawson, President and CEO of the National Mining Association. National Mining Association (NMA) represents the producers of most of the nation's coal, metals, industrial and agricultural minerals; the manufacturers of mining and mineral processing machinery, equipment and supplies; and the engineering and consulting firms, financial institutions and other firms serving the mining industry. Our members operate in all regions of the country; produce all qualities of coal and all types of minerals for both the domestic and the overseas markets. I appreciate the opportunity to present the industry's views on national energy policy, energy security and most specifically, the role that coal has to play in both.

Mr. Chairman, I would like to commend you for holding this series of hearings on the Nation's Energy Policy and the security of our energy supply. The availability of reliable and reasonably priced energy has made our country the economic powerhouse that it is today. Our nation should have an energy policy that balances economic, security, social and environmental considerations and at the same time supports the availability of reliable and reasonably priced energy. We do not have such a policy in place today. These hearings can provide the impetus needed to put our nation's energy policy back on track, and we are pleased to be asked to be a part of the effort.

Nearly nine years ago to this day, June 25, 1991, I appeared before this same committee to give our views on exactly this subject. The Gulf War had just concluded, and this committee was considering legislation that ultimately became the National Energy Policy Act of 1992 (EPACT).

In 1991, our economy was just recovering from the last real economic downturn experienced. Energy consumption was lower than in the late 1980's and in 1990. As the Gulf War ended, we were importing approximately 46 percent or our petroleum requirements. United States' energy policy was under review in an effort to find a way to reduce our import requirements while expanding our use of domestic energy resources such as coal. EPACT was passed to address this problem but, because it was never fully implemented, our energy supplies remain vulnerable.

In 2000, our economy is stronger than it has ever been, but our energy supplies are again vulnerable. We are importing 54 percent of our petroleum requirements. But, our vulnerability to supply disruptions extends beyond imported oil. Reserve margins in our electric generating system have never been lower. Our nation has moved from promoting the use of domestic resources, such as coal and the nuclear power that we have in place, to a policy that is totally imbalanced toward the environmental extreme and a policy that all but ignores the strides made in technologies to burn fuels more cleanly and efficiently. Most importantly, energy policies have not produced the energy security envisioned in EPACT.

Fortunately we do have the elements to put a sound energy policy back on a more balanced footing. This can only happen however, if we as a nation have the will to do so.

My statement today will focus on two points:

- Use of all types of energy will increase in the United States, and globally, to sustain economic growth, improve standards of living and support an expanding population. It is necessary that both energy and environmental policies take this reality into account and be carefully balanced to support, not hinder, long-term economic growth while supporting national energy security.
- Coal, a mainstay of both US and global energy supply through its use to generate electricity, will continue to be used because it is widely available, it is reliable, and coal is low cost. As electricity use increases, so too will coal use. While coal is used more efficiently with lower emissions today than ever before, technologies are being developed which will convert coal into electricity with even greater efficiency while effectively eliminating undesirable emissions. *Changes in policy are required however, both to maintain current coal generating capacity and to ensure that the future fleet of electric power plants include coal fired capacity.*

I. ENERGY IS REQUIRED TO SUPPORT ECONOMIC GROWTH

A. Energy in the United States—an asset that is vulnerable to supply disruptions.

There is no such thing as a "bad" domestic energy source. Energy, whether it is from coal, oil, natural gas, uranium or renewable sources, is the common denominator that is imperative to sustain economic growth, improve standards of living and simultaneously support an expanding population. This relationship is clearly illustrated in Figure One that shows that as GDP has increased in the United States, energy use has grown in near tandem. Although technological advances and greater energy efficiency means that we are using less energy today for each unit of economic output than in the past, growth and prosperity cannot occur without the basic energy building block. The United States is fortunate to have a large domestic energy resource and an established energy infrastructure that supplies reliable and low cost energy to consumers from industry to households. Sound, balanced energy and environmental policies are required keep this energy infrastructure is in place.

Economic expansion is expected to continue with an accompanying increase in energy use. According to the U.S. Energy Information Administration (EIA)[1], economic growth, expressed in terms of real GDP, is expected to increase on average 2.2% per year through 2020. Reflecting greater efficiency trends, energy consumption is expected to increase by just over 1% per year over the same time. In absolute terms, energy consumption will increase from 95 quadrillion BTUs (quads) to 121 quads by 2020. *This is of course, provided that we do not implement policies that would prevent this growth.*

The EIA forecast shows that consumption of all energy sources except nuclear power will grow over the next 20 years. This is illustrated in Figure 2. Natural gas consumption is forecast to increase from 22 quads to 32 quads by 2020. Petroleum use will increase from 37 to 49 quads. Coal, which comprises more than 90% of our domestic fossil energy resource, will increase from 22 to 27 quads. Coal will supply the current 22+% of total energy demand as it does at present. Coal consumption will increase from the current 1 billion tons to nearly 1.3 billion tons.

Much of the energy that is used today in the United States is in the form of electricity. The future will not be different. In 2020 electricity is forecast to supply 52% of non-transportation end use energy and coal is expected to generate over 50% of that electricity. Meeting new demands for electricity while maintaining the highest environmental standards in the world is an achievable goal. But, this goal will require both new electric generation capacity and an upgrade of our existing fleet for both efficiency and environmental reasons.

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[1] All U.S. forecasts in the section are from *the Annual Energy Outlook 2000.* Energy Information Administration, DOE, December 1999

Unfortunately, the failure to balance energy and economic security with sensible, effective environmental policies is affecting the availability, reliability and cost of energy and will ultimately affect our economic future. The current trend to make energy policy totally dependent upon restrictive environmental policies means that our nation's energy supply is becoming increasingly vulnerable. Three examples illustrate this point.

- **Petroleum:** The recent decline in petroleum availability and increase in petroleum prices clearly illustrates our vulnerability to outside forces. As the President of the American Petroleum Institute pointed out to this committee on May 24, the US petroleum industry is precluded from developing the vast majority of our domestic reserve. This increases dependence on imported sources and the United States now imports over 54% of our petroleum requirements. That dependency, according to the draft Department of Energy Strategic Plan, is expected to be over 60% by 2020. This is as much a matter of national security as economic security.
- **Electricity:** The late May report from the National Electric Reliability Council (NERC) points out the sensitivity of our nation's electricity supplies to extended heat wave conditions or higher than anticipated generating unit forced outages. For a number of reasons, including a series of initiatives by the Environmental Protection Agency to ratchet emission standards below Clean Air Act requirements, new generating capacity is not being built as needed. Reserve margins are very thin and electric power outages, or spikes in the costs of electricity could occur. This is an example of environmental policy taking total priority over energy and economic considerations with the result—a vulnerable electric system.
- **Coal:** The long term use of our greatest domestic energy resource, coal, is being put at risk on two fronts: through the Administration's actions to deny access to public lands for resource exploration and development which removes low cost reserves from the US energy base; and through the continuing barrage of actions by the Environmental Protection Agency which are making the use of coal in electricity generation ever more difficult and expensive.

Our nation's energy supplies do not have to be vulnerable to outside events and they certainly should not have to be vulnerable due to our own unbalanced policies. Meeting new demands for energy while increasing use of ALL domestic energy and supporting economic growth can and should be complimentary with maintaining the highest environmental standards in the world.

B. Global Energy Requirements:

Energy use will increase at an even faster pace in many countries throughout the world according to the "International Energy Outlook 2000" published by the U.S. EIA. As illustrated in Figure Three, the rate of growth in energy consumption in the developing world, excluding Africa but including China, India and the countries in South America exceeds 3.5% per year through 2020. Conversely, United States and other industrialized countries will see an increase of approximately 1.0% or less per year on average. This rapid increase in energy use in the developing world will occur no matter what policies are in force in the developed world. Energy is required to support the economic growth that is both expected, and needed in these countries to raise the standard of living while supporting increases in population which, according to recent estimates of the World Energy Council will be as much as 10.1 billion by 2050 (as compared with 5.3 billion in 1990).

Just as in the United States, energy demands worldwide will be met with an increase in the use of electricity. Again to cite the International Energy Outlook, demand for electricity in developing countries will outstrip the rate of growth in energy use. Electricity generation is expected to increase by an average 4.3 percent per year between now and 2020. In other words, while energy use doubles, the use of electricity in these countries will nearly triple in this time period.

All fuels will be required to meet these new energy demands and coal use will dominate in these countries. By 2020, some 3.6 billion tons of coal will be consumed in the regions comprising the "developing countries" (that figure is about 1.8 billion today). Over 44 percent of the electricity used in these countries will be generated from coal. Coal will be used because it is indigenous to many countries and is relatively low in cost. At this point, a future without coal use is unthinkable.

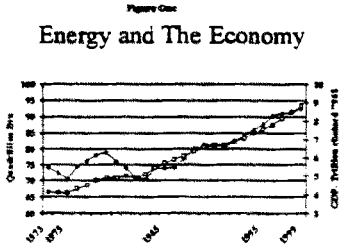
Coal use in the future will not be limited to the developing world. Coal is now, and will continue to be, used in all regions of the world. Coal use in the industrialized world will remain at approximately 1.6 billion tons, increasing in the US, Canada, Australia and Japan and decreasing only in Western Europe and in the countries of the former Soviet Union. Coal is now, and will remain, an important and major part of the global energy mix.

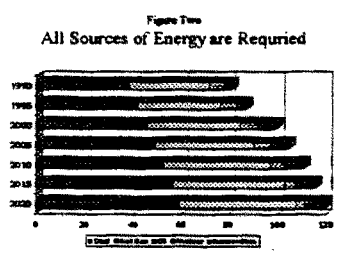
II. COAL IN THE UNITED STATES

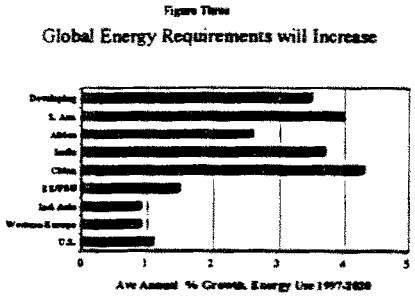
In 2000, the United States will mine and use over 1 billion tons of coal. Economically recoverable coal reserves comprise over 85 percent of the US fossil reserve base. Coal reserves are geographically distributed throughout the US and coal is mined in 26 states and coal, or electricity generated from coal, is used in all 50 states. The coal industry contributes some $161 billion annually to the economy and directly or indirectly employs nearly 1 million people.

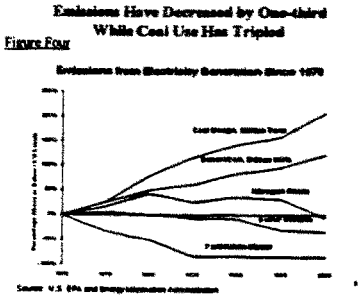
In 1999, over one half of U.S. electricity is generated from abundant, low cost, domestic coal. The 950 million tons of coal used by electric utilities is more than triple that used in 1970, but emissions have declined as illustrated in Figure Four.

The economy of the 21st century will require increased amounts of reliable, clean and affordable electricity. According to EIA forecasts, electricity use will increase by 1.1 trillion Kwh or 34 percent over today's levels by 2020. Other forecasts, including that done for the American Gas Association[2] and for the Gas Research Institute[3] show an even greater increase in electric generation growth. Coal, the nation's most abundant energy resource, is expected to play a major role in electricity's future. In 2000, generators are expected to use 986 million tons to produce over one half the electricity required. By 2020, and under a business as usual forecast, generators are expected to use 1.177 billion tons of coal, again to produce approximately one-half of the electricity to be generated.









Coal could do even more than these "business as usual" scenarios would suggest, and could do so more efficiently and with lower emissions than even today with the use of new combustion technologies now being developed. However, there are many obstacles that could prevent coal from playing even its expected role in meeting future energy demands.

III. CONSTRAINTS ON A GREATER ROLE FOR COAL

A. Coal Supply:

On the supply side, recent initiatives by the Administration to remove public lands from access for any purpose including exploration for and development of coal and mineral resources, will over time, reduce the amount of coal reserve.

[2] Fueling the Future, February 2000, Washington Policy and Analysis, Inc.
[3] Coal Outlook and Price Projections, April 2000, Hill and Associates, Inc.

- In 1996, the Administration used the little-used Antiquities Act to create the Grand Staircase-Escalante National Monument. This action removed 23 billion tons of mineable coal reserves in Utah's Kaparowits coal field.
- Last fall, the Environmental Protection Agency (EPA) failed to support the policies adhered to by every administration since 1977 regarding the application of the Clean Water Act to valley fills at Appalachian coal -mines. The state of West Virginia has indicated this action will affect two-thirds of the states' surface mines and one-fourth of the state's underground mines. The same policies may negatively impact Kentucky coal production and production in other Appalachian states. Development of coal reserves is as affected as current production.
- Over the past 6 months the U.S. Forest Service has issued three major regulatory proposal dealing with resource planning and construction and maintenance roads policy that may negatively impact the coal industry's ability to acquire and access leased Federal coal on or near Forest Service lands. The latest initiative, the Roadless Area land withdrawal proposed by the Forest Service will have even broader implications as this affects lands throughout the United States, not just in the western part of the country.

A more than adequate coal reserve base is quickly being depleted, not by mining, but by government fiat.

B. Coal Use

Proposed changes in regulations could have an even greater effect on the use of coal in existing electric generators. These include:

- The EPA's announced intention to change New Source Review requirements so that even routine maintenance will invoke requirements to obtain new permits that could necessitate installation of stringent emission control equipment even on existing plants now meeting Clean Air Act Requirements;
- The EPA proposed state implementation plan (SIP) call rule under Section 110 of the Clean Air Act which would require an 85% reduction in NO_X emissions from utilities in 22 eastern states by May 2003;
- The EPA proposal to declare coal waste a "hazardous by-product" which would make coal ash disposal much more difficult and in effect would preclude today's commercial use of coal ash; and,
- The EPA rule on Regional haze that imposes a comprehensive new program utilizing significant control technologies and other requirements on states to control particulate matter beyond levels already required under state and federal law.

All these proposals would make the use of coal in existing generating facilities more expensive and extremely problematic.

And, in the long term, there is the possibility that terms of the Kyoto Protocol on climate change or other international agreements to reduce greenhouse gas emissions would result in a sharp reduction of coal used.

Actions and policies which are designed to eliminate coal use will have serious implications for the reliability of our electric generating capability. Over one-half of the nation's electricity (and a greater percentage of base load generation) is generated by coal. Over 41 percent of the existing electric generating fleet is coal fired. This cannot be quickly replaced for a number of reasons, including the time and money that is required to develop the infrastructure necessary to switch to alternative sources. Natural gas use will increase, but it cannot replace over half the nation's electricity supply on either a timely or a cost effective basis.

III. TECHNOLOGY DEVELOPMENT IS IMPORTANT FOR THE FUTURE

Solving our nation's energy supply problems will require that the Administration and the Congress work to implement more balance energy and environmental policies that encourage the development and use of all fuels rather than work to prohibit the use of any one energy source.

There are retrofit and repowering technologies available today that enhance environmental performance and efficiency of existing coal-based generation plants. And, there are new technologies being developed that are now, or will soon be, ready for deployment that will effectively eliminate health-based emissions and substantially improve efficiency.

It is important that any national energy policy includes provisions to encourage the development and deployment of these new coal based technologies. Without these new technologies our electric generators will become much more dependent upon natural gas, already more costly than coal and likely to become even more ex-

pensive if as estimated by the National Petroleum Council [4] over $1.2 trillion will be needed for exploration, development and infrastructure improvements if gas supplies are to be adequate in 2010.

A. Research is Ongoing

Efforts to develop and deploy new coal based technologies have been underway for some time, efforts designed to expand upon and use the results of the joint industry-DOE Clean Coal Technology program. For example:

- National Mining Association, the Edison Electric Institute, the Association of American Railroads and the Center for Energy and Economic Development have adopted a technology road map that sets research and performance goals for advanced coal technologies, which if reached, would result in coal-fired power generation at far greater efficiencies than today with lower emissions of pollutants as defined by the Clean Air Act of 1990 and with sharply lower CO2 emissions of today. A number of companies are involved in co-funding with the Department of Energy the Power Systems Development Facility in Wilsonville, Alabama. This near-commercial plant demonstrates advanced gasification, pressurized fluidized bed combustion, high temperature/high pressure gas filtration and advanced turbine systems.
- The Department of Energy's Vision 21 program has a goal to design a power plant that will have generating efficiencies of more that 60% using coal, with near zero emissions of traditional pollutants and a reduction of CO2 emissions by 40% plus.
- The Mining Industry of the Future program, a joint mining industry-DOE research venture is involved in finding ways to explore for resources, and then mine, process and transport more efficiently at lower cost and with less environmental impact. Results of this program will enhance coal as a fuel for electric generators from a cost and quality standpoint.

Beyond control of the traditional emissions, the industry also recognizes that carbon sequestration will be vitally important if it is found that reduction of CO2 emissions is necessary. The Department of Energy recently awarded over $7 million dollars to several of our national laboratories for research proposals designed to test several ways to sequester carbon. Two projects that are outside of that DOE effort hold particular promise for coal:

- The Zero Emission Coal Alliance (ZECA), a consortium of researchers from Los Alamos along with US and Canadian coal interests, is researching a technology that would create hydrogen from a coal-water slurry and produce a pure CO_2 stream. A fuel cell would convert the hydrogen to electricity and the CO_2 stream would react with magnesium oxide to be permanently sequestered. ZECA hopes to pilot this new technology within five years.
- Los Alamos National Laboratory is testing a new method of sequestration of carbon in semi-arid lands, a method that if successful, will add to the agricultural capability of vast areas of the globe while sequestering significant amounts of carbon.

B. A Technology Strategy is Required to Take Technology from Demonstration to Commercialization.

To ensure that coal based generation can contribute to the future electricity requirements of the country, any national energy policy must include a strategy to move these new technologies from development and deployment to commercial use. In addition to continuing R&D programs that address long term technology needs to improve efficiency and reduce emissions from coal based generation (such as that described above), two additional elements are needed:

- A Financial incentives program designed to cushion the financial burden of applying technologies to existing coal utilities to improve emissions control and increase efficiency; and
- A demonstration program that provides tax incentives and /or financial assistance to deploy the initial commercial-scale applications of advanced coal-based generating technologies. This is required to reduce the significant risks inherent in using "first of a kind" technologies, a risk the utilities cannot take in this new era of deregulation.

The elements of such a proposal are being developed.

Mr. Chairman, all energy sources have a unique and important role to play in meeting the growing energy demands of tomorrow. National energy policy should

[4] "Natural Gas, Meeting the Challenges of the Nation's Growing Natural Gas Demand" February 2000, the National Petroleum Council.

use all available domestic energy to permit the realization of the maximum national enrgy security. A sound national energy policy should be one that balances energy with environmental protection, these are not mutually exclusive objectives and both can be achieved with benefits to our economy and society at large. Of necessity, our greatest and lowest cost domestic energy source coal—can and should be the major source of energy for the electric generating industry of the future. We look forward to working with the committee to make our energy future, and coal's future, a reality.

Mr. BARTON. Thank you, General. Thank you for those kind words, also, about some of the legislation that I have sponsored.

We would now like to hear from Mr. Paul Bailey, who is Vice President of the Environment at Edison Electric Institute. In prior positions, he has been a Special Assistant at the Department of Energy, working in the Fossil Energy Department.

Mr. Bailey, your statement is in the record. We ask you to summarize it in 7 minutes.

STATEMENT OF PAUL C. BAILEY

Mr. BAILEY. I will do that. Thank you, Mr. Chairman.

Good afternoon, Mr. Chairman and members of the committee. We appreciate the opportunity to appear today on behalf of the Edison Electric Institute and the electric utility industry. EEI is the association of the U.S. investor-owned electric utilities and industry affiliates worldwide.

Mr. Chairman, under your leadership, this committee has addressed a number of important energy issues, including reporting of legislation to restructure the electric utility industry.

We are witnessing the transformation of the electric utility industry, which will entail substantial changes in fuel mix for power generation over the next two decades.

Today, energy policy is being driven, to a substantial degree, by environmental policy. However, energy policy and environmental policy are both critical national goals that must be harmonized. The United States dramatically reduced air emissions, while electricity generation from coal-fired power plants has doubled.

While an air emissions policies will have a significant impact on our future energy choices, other policies will also play a role. These include clean water, waste disposal, the re-licensing of nuclear and hydro plants, and energy siting and drilling constraints.

Various policies have the effect of foreclosing options in the future. For example, because of relicensing issues, nuclear waste disposal uncertainties, and requirements that may render hydroplants uneconomic, both nuclear and hydro capacity are at risk. In addition, there are a number of environmental regulations that affect coal-fired electricity.

The cumulative impact of these rules on the use of coal in electricity generation has not been adequately considered in the context of energy policy. For example, the availability of coal-fired generating plants to meet demand over the next few years in key parts of the country could be in question, due to the implementation schedule for EPA's NO_X SIP Call Rule and 126 Petition Rule.

The potential adverse consequences of many of these rules could be avoided by balancing energy supply needs with air quality improvements.

In terms of future generation, the combination of environmental policies and electricity deregulation have led utility and non-utility power suppliers to opt for natural gas, which will make an important contribution to the future generation mix. However, natural gas supply is not without its own limitations.

Administration officials and others have opposed closing offshore drilling sites, even as current wells are being depleted. Additionally, the siting and building of gas pipelines also face environmental challenges.

Mr. Chairman, in short, my message to this committee today is that we need to recognize that maintaining electricity options is a sound energy policy objective that should be pursued simultaneously with the country's environmental objectives.

Too often, we consider the impacts of individual environmental regulatory initiatives separately, without considering their cumulative implications. Let me urge that we take a broader perspective that will enable us to make better decisions that will not needlessly close off options for tomorrow's electricity supply.

As we go forward, this committee can take a proactive role by encouraging and supporting policies that provide regulatory flexibility, along with market-based incentives in order to achieve the Nation's environmental goals in the most efficient manner.

As an example, EEI, along with its members, has been seeking such new approaches. We have been discussing the idea of integrating various air quality initiatives faced by coal-fired electric utilities, in a manner that would provide flexibility and regulatory certainty. We believe this approach has the potential to help us meet environmental goals at a lower cost.

In closing, I respectfully urge the committee to continue the examination you have initiated today of the long-term prospects for energy supply options and the cumulative impact of our environmental regulatory agenda on future energy policy.

Thank you, Mr. Chairman.

[The prepared statement of Paul C. Bailey follows:]

PREPARED STATEMENT OF PAUL C. BAILEY, VICE PRESIDENT, ENVIRONMENTAL AFFAIRS, EDISON ELECTRIC INSTITUTE

Good morning, Mr. Chairman and Members of the Committee. I appreciate the opportunity to appear today on behalf of the Edison Electric Institute (EEI) and the electric utility industry to address the U.S. energy policy with respect to nuclear and coal power.

My name is Paul Bailey, and I am the Vice President for Environmental Affairs for EEI. EEI is the association of the U.S. investor-owned electric utilities and industry affiliates worldwide. We have 200 member companies in the U.S. and 50 affiliate members in 18 countries.

Mr. Chairman, under your leadership this committee has addressed a number of important energy issues, including reporting of legislation to restructure the electric utility industry. Twenty-four states have already acted to deregulate and we are witnessing the transformation of the electric utility industry, which will entail substantial changes in fuel mix for power generation over the next two decades.

As you are aware, policy-making is difficult without knowing the future consequences of decisions made today. This is certainly the case with respect to the electric utility industry. There are a number of major challenges on the horizon with respect to the future of electricity supply that have been raised by recent regulatory initiatives in the area of environmental policy.

Most in this room are probably too young to remember the "energy crises" of the 1970s and the 1980s, the consequence of which was an intense focus by Congress, the public and the media on energy policy. Today, despite recent spikes in gasoline, heating oil, and electricity prices, energy policy is not a topic of concern. This doesn't

mean that energy policy is not an issue. It's just as important as it was in the last two decades, but it's being made today with little or no public discussion.

When the nation was grappling with the energy crises in the 1970s and 80s, it was in the context of a vigorous and evolving body of environmental policy with public support. Energy policy had to be made in the context of environmental policy goals and one of the debates was over the appropriate balance between two sets of legitimate policy goals.

Today we have a strong environmental regulatory framework, the operation of which has the effect of making energy policy by default. The implications of environmental policy-making for future energy supply are no longer subject to public scrutiny. In essence, energy policy is now being driven by environmental policy. Energy security and environmental protection are worthy national goals that must be balanced and harmonized. In that regard, the United States has dramatically reduced air emissions while electricity has fueled economic growth. At the same time that the nation has doubled generation from coal-fired power plants, we have reduced electric utility emissions of sulfur dioxide ($SO_2$2) and nitrogen oxide (NO_X) emissions. $SO_2$2 emissions fell by 30% from 1970 to 1997 and under Phase II of Title IV of the Clean Air Act Amendments of 1990 will be capped at 60% below 1980 levels. NO_X emissions have also declined and will continue their downward trend with the implementation of the second phase of Title IV this year. (See Figure 1).

There are other regulatory policies dealing with other air emissions and greenhouse gases that have an impact on future fuel choices for the generation of electricity. In addition, there are other regulatory policies addressing areas such as cooling water intake, waste disposal, the re-licensing of nuclear and hydro plants, and energy siting and drilling constraints.

Environmental and policy actions have the effect of removing certain fuel options today from consideration for tomorrow's energy supply. However, there is no serious public consideration of whether the consequences of those policies are acceptable. This is especially true of electricity where the generation of power is based on a number of fuel sources. Our economy is becoming increasingly electricity intensive as we move into the 21st century. We will need all fuel options for the generation of electricity to support the continued growth of the American economy. But the long-term prospects for the current inventory of available options are highly uncertain.

Let me highlight just a few examples. Today our electricity is generated by coal (56%) nuclear power (20%), natural gas (11%), hydropower (10%), some oil, and some renewables.

Nuclear energy accounts for 20% of our generating capacity, but over the next ten years 10% of the plants must be re-licensed (2010), and by 2015, 40% must be relicensed. The availability of nuclear power will depend on the decisions made during the re-licensing process. In addition, there is further uncertainty raised by the still-unresolved issue of the permanent disposal of nuclear waste.

Hydroelectricity accounts for 10% of our generating capacity, but between now and the year 2020, the operating licenses of 239 hydro plants will expire, representing more than 25% of total hydro generating capacity. The re-licensing process is long and arduous and it is an open question whether the renewed licenses will include further operational constraints on the power generating functions of these dams in order to achieve environmental policy objectives, which could render even licensed facilities uneconomic. In addition, consideration is being given to breaching dams in various regions of the nation as a means of restoring fish migration routes.

The situation for coal-fired generation is quite different. Here it is not a matter of getting a new license to operate. There are a number of environmental regulations recently initiated, or soon to be initiated, that focus on coal-fired electricity. These regulatory policies are wide-ranging and include the recent NO_X SIP Call Rule, the pending 126 Petition Rule, impending rules on New Source Review, the recent EPA enforcement actions, regional haze rules, and the possibility of a new regulatory program focusing on mercury emissions. (See Figures 2 & 3). The cumulative effect of all these rules for the generation of coal-fired electricity have not been considered, but it may not be inaccurate to suggest that there is an issue of whether a number of coal-fired generating plants are going to operate at all. In fact the reliability of the power supply could be in question, as it relates to the implementation of the NO_X SIP Call Rule and 126 Petition Rule. EPA has set an unrealistic, arbitrary compliance deadline of May 2003. The agency has been deaf regarding cautions as to the potential for near-term power supply interruptions resulting from the complexity of equipment retrofits and the short implementation schedule. For instance, a recent study suggests that already capacity short areas of the Midwest could see a "sizeable reliability risk" as utilities attempt to retrofit a large por-

tion of their baseload power plants to comply with these rules—a risk that could be lessened or removed, simply with a more appropriate implementation scheme.

In terms of the future of generation, including coal, the combination of environmental policies on the fuel choices that I've mentioned today and electricity deregulation, have led utility and non-utility power suppliers to opt for natural gas. Clearly, natural gas will be an extremely important component of the future generation mix. It's role is expected to increase and replace some coal and nuclear baseload capacity. However, natural gas supply is not without its own limitations. Administration officials and others have proposed closing off-shore drilling sites, even as current wells are being depleted. Finally, the siting and building of gas pipelines raises environmental issues that can delay or impede construction and thus increase costs.

As the case of natural gas suggests, there is no fuel choice panacea, thus underscoring the importance of the interplay between environmental and energy policies for this country's long-term energy future.

This is not, Mr. Chairman, to say that the lights are going out. Viewing the uncertainties in each of the fuel options for generating electricity helps us define the electricity supply issues that are now looming large on the horizon. In short, I'm trying to illustrate the point that we are making decisions today that may remove or severely restrict tomorrow's fuel options for the generation of electricity. Until today, Mr. Chairman, there has been no one even raising the question, and I thank you for your leadership in that regard.

In closing, let me suggest a few guidelines that I hope the committee will find helpful:

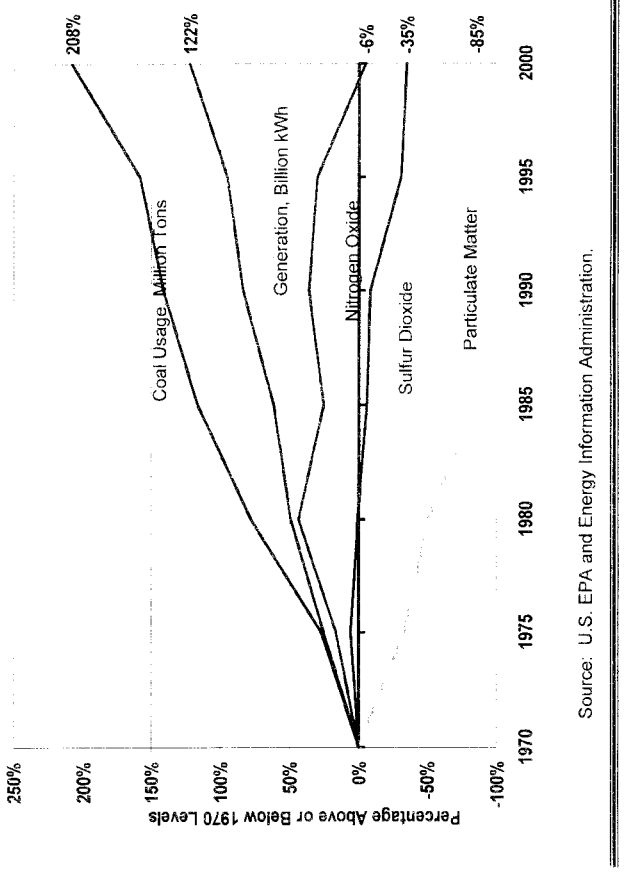
First, there is a tendency to consider the implications of individual environmental regulatory initiatives separately, without considering the *cumulative* impacts of those initiatives on energy supply. For example, the timing and lack of harmonization of the NO_X SIP Call Rule and 126 Petition Rule have the potential to cause short-term power supply interruptions. Taking the broader perspective suggested in my testimony will be helpful in defining key energy policy issues for public scrutiny and decision.

Secondly, we should celebrate the successes of our nation's environmental policies, but also recognize that we may be approaching the point of diminishing returns. We are now trying to regulate at the margin, where the cost of each additional ton or pound of emission reduction may be very high. In order to preserve future fuel options, including coal, a consideration of alternative regulatory approaches is in order, in the context of the energy supply issues raised here today. We should compare the traditional command-and-control approach with policies that encourage greater regulatory flexibility, market-based incentives rather than prescriptions, and performance rather than pre-ordained standards.

As an example, EEI has been in the forefront of developing new approaches. We have been engaged in discussions that would integrate the various air regulatory initiatives faced by coal-fired electric utilities in exchange for flexibility in achieving emissions goals and regulatory certainty. We believe this approach has the potential to help us to meet air quality goals at a lower cost.

However, we should not make the same mistake we've made in the past. The energy policy issues raised here today should be considered along with environmental policy issues. I urge the committee to continue the examination you have initiated today of the long-term prospects for energy supply options and the cumulative implications of our current environmental regulatory programs for the future.

Electricity Generation
Since 1970
(Figure 1)



Source: U.S. EPA and Energy Information Administration.

Major EPA Air Quality Programs for Electric Power Plants (Figure 2)

Current

Ozone NAAQS (1-hour)/SIPs	1970	Title IV (acid rain) permits	1995
SO2 NAAQS/SIPs	1970	Title IV SO2 Phase 1	1995
NO2 NAAQS/SIPs	1970	Title IV NOx Phase 1	1996
Total Suspended Particulates NAAQS/SIPs **	1970	Compliance Assurance Monitoring	1995
Carbon Monoxide NAAQS/SIPs	1970	Credible Evidence	1995
New Source Review	1970	Periodic Monitoring	1995
Citizens' Suits	1970	Mercury Emission Reporting	1999
Prevention of Significant Deterioration	1977	TRI	1999
Class 1 Areas	1977	NSR Enforcement Initiative	1999
LAER and Offsets for Nonattainment Areas	1977	Title IV NOx Phase 2	2000
Visibility - Section 169A	1977	Title IV SO2 Phase 2	2000
PM-10 NAAQS/SIPs	1978		
Lead NAAQS/SIPs	1978		
Title V Permitting	1992		
Continuous Emission Monitors for SO2 & NOx	1995		
Flow Monitoring	1995		

** Phased out after PM-10 standard

Major EPA Air Quality Programs for Electric Power Plants (Figure 3)

Future

NSR Reform Rule	2000
TRI - Mercury	2001
NOx SIP Call	2003
NOx State Petitions	2003
U.S./Canada NOx Treaty	2003
Ozone (8-hour) NAAQS	2007
Possible Mercury MACT standard	2007?
Possible short-term SO2 NAAQS	2007?
Possible Title IV SO2 Phase 3	2007?
Kyoto Protocol	2008?
PM2.5 NAAQS	2008
Regional Haze	2010
Future NAAQS revisions	Every five years
Possible TMDL (water-based) NOx controls	?
Possible TMDL (water-based) Mercury controls	?
Generation Performance Standards	?
Renewable Requirements	?
Labeling and Disclosure Requirements	?
Air Quality Related Values	?
New NAAQS for CO2?	?

In Litigation

Mr. BARTON. Thank you, Mr. Bailey.

We would now like to hear from Mr. Steve Gehl, who is the Director of Strategic Technology Alliances for Electric Power Research Institute, which we call EPRI.

Your statement is in the record in its entirety. We would ask that you summarize it in 7 minutes, sir.

STATEMENT OF STEPHEN M. GEHL

Mr. GEHL. Thank you, Mr. Chairman, and good afternoon, members of the committee. Thank you for the opportunity to comment on the role of coal power and the national strategy and policy. I would like to emphasize four points in my testimony this afternoon.

First, achieving the goals of global electrification will require a broad portfolio of power generation technologies. One of the greatest threats to the environment and global security in the new century is the current unavailability of commercial energy to nearly half the world's population.

Our first priority should be efficient global electrification. This will provide the infrastructure for sustainable productivity growth or the efficient use of resources and reduced reliance on foreign oil.

Consistent with this goal, the U.S. needs an integrated environmental and energy policy that allows us to meet environmental targets with minimal disruption of the economy. The bottom line is that there is no one silver bullet for either fuel or technology choices.

We need a broad mix of energy technology: coal, natural gas, nuclear power, and renewables to confidently meet rapidly growing user requirements for electricity.

Second, coal will have a continuing role in the electricity generation portfolio, if we develop advanced technologies for coal utilization. In the near term, the continued use of coal will be predicated on improving the energy conversion efficiency and environmental performance, while retaining coal's cost advantage.

The advanced technologies for coal utilization described in the EPRI Electricity Technology Roadmap, in DOE's Vision 21, and the material that General Lawson referred to, all have the potential to achieve substantial improvements in energy conversion efficiency, greater than 50 percent, and in some cases, much greater than 50 percent; as well as greatly reduced capital costs of a coal-fired power plant, thus making new clean coal generation competitive with natural gas combined cycle technology in the timeframe of 2010 to 2020.

Another approach that we have heard about this afternoon, carbon sequestration, decreases the net CO_2 venting of fossil fuel use, either by capturing CO_2 at the point of generation and storing it, or by removing CO_2 from the atmosphere.

However, there are many environmental chemical and physical challenges that have yet to be resolved as part of the larger R&D agenda in this area.

Third, the U.S. should undertake a focused R&D program to develop the needed coal utilization and carbon sequestration technologies. Existing R&D programs are insufficient to meet the requirements of clean and abundant electricity for the 21st century.

The EPRI Electricity Technology Roadmap documents the funding shortfall in several key technology areas, and concludes that additional funding of approximately $2 billion per year, $700 million of that for coal technology, will be needed over the next 10 years to resolve the energy carbon conflict with the urgency anticipated in public policy proposals.

Failure to maintain coal as a key element of a national and global energy strategy can have disastrous consequences. A recent EPRI study concludes that the current regulatory policy direction fails to reconcile proposed emissions reductions with the realistic timelines for developing the technologies that can decrease the cost of these emissions. This is particularly so for CO_2.

Moreover, our study concludes that the relatively short horizon of proposed regulations does not allow sufficient time to make a transition to a sustainable U.S. energy system, without excessive disruptions and risks.

Fourth, public/private collaborative efforts are needed to develop a robust generation technology portfolio. Collaboration is the most effective way, in EPRI's experience, to ensure the necessary resources are committed and properly focused on the results that will make a difference.

Importantly, this means that industry should be a partner with government in defining, financing, and managing the R&D efforts. This means also that the current trends in energy-related R&D investment must be reversed.

U.S. energy industry today invests only about one-half of 1 percent of its revenues in R&D, and the trend is downward. Moreover, U.S. Federal energy R&D funding is at its lowest level in 30 years, relative to GDP.

Energy has been and remains at the bottom of the R&D investment ladder. To reverse this situation, we must align public and private support to leverage scare R&D dollars, pursue technology opportunities over a longer time horizon, and create incentives for investing in the power system of the future.

Mr. Chairman, I would like to conclude with the following recommendations. First, we must recognize that policies to reduce greenhouse gas emissions must encourage universal global electrification as the foundation for economic growth and environmental protection.

Second, we must develop a broad portfolio of advanced generation technologies, including coal-based options, to meet U.S. and global needs for the coming decades.

Third, we must coordinate the efforts of policymakers, scientists, and technologists to assure the cost effective approaches for long-term reduction of greenhouse gas emissions.

Finally, we must increase R&D support for the coal option and create the leadership and incentives for the formation of public/private consortia to conduct the needed research and deploy the resulting technologies.

Mr. Chairman, thank you for your time and attention. I welcome your questions and comments.

[The prepared statement of Stephen M. Gehl follows:]

PREPARED STATEMENT OF STEPHEN M. GEHL, DIRECTOR, STRATEGIC TECHNOLOGY AND ALLIANCES, EPRI

Mr. Chairman and Members of the Committee: Thank you for this opportunity to address the Subcommittee on Energy and Power. I would respectfully request that the Subcommittee enter the following written remarks into the record as well as my oral testimony.

EPRI commends the leadership of the Subcommittee in addressing the critical issues surrounding the continuing roles of nuclear and coal power in our national energy strategy.

EPRI, the Electric Power Research Institute, was established 27 years ago as a non-profit, collaborative R&D organization to carry out electricity-related supply, delivery, end-use, and environmental R&D in the public interest. EPRI has been supported voluntarily since our founding in 1973, and we have from the outset enjoyed the strong support of the state public utility regulatory commissions. Our members, public and private, account for more than 90% of the kilowatt-hours sold in the U.S., and we now serve more than 1,000 energy companies and related institutions in more than 40 countries. EPRI operates as an independent technical organization maintaining access to and engaging the best technical talent in the world. Over nearly three decades, EPRI has established a global network of technical and business expertise that can be brought to bear to solve the toughest energy and environmental problems.

I would like to emphasize four points in this testimony:

I. ACHIEVING THE GOALS OF GLOBAL UNIVERSAL ELECTRIFICATION AND ENHANCED ENVIRONMENTAL QUALITY WILL REQUIRE A ROBUST PORTFOLIO OF POWER GENERATION TECHNOLOGIES.

EPRI has developed an Electricity Technology Roadmap to identify societal goals and aspirations over the next few decades, and the electricity-based technologies needed to meet these goals. (The Executive Summary of the Roadmap is attached to this written testimony.). Based on this work, it is clear that an important driving force for the world's energy future will be the environment including climate change risks. It is equally clear, however, that environmental issues cannot be resolved without simultaneously addressing economic development issues. In fact, it is the current unavailability of commercial energy to nearly half the world's population that is the greatest threat to the environment and to global security in the new century. Our first priority should be to achieve efficient, universal electrification on a global basis. This will provide the essential infrastructure needed for sustainable productivity growth, efficient use of all resources, decarbonization, plus significantly reduced competition for politically unstable sources of petroleum.

Consistent with this goal, the U.S. needs an integrated environmental and energy policy that allows us to meet our environmental targets with minimal disruption on the economy. The bottom line is that there is no one silver bullet for either fuel or technology choices. While projections out to 2050 and beyond are speculative, we can draw some general conclusions. First, the needed energy portfolio must include fossil fuels (coal and natural gas with sequestration of CO_2), nuclear energy and renewables, plus end use efficiency improvements, and the growing use of hydrogen as an energy carrier. Second, electricity will be fundamental to the marketability of this broad energy portfolio in its cleanest form for both stationary and mobile energy needs. Thus EPRI's electricity technology roadmapping analyses indicate that a robust mix of energy technologies will be needed to confidently meet rapidly growing domestic and global needs for electricity. Unfortunately, these technologies are not yet commercially available and the current levels of investment in developing them are insufficient to assure timely, broad-scale deployment.

II. COAL CAN PLAY A CONTINUED IMPORTANT ROLE IN THE ELECTRICITY GENERATION PORTFOLIO IF WE DEVELOP A SUITE OF ADVANCED TECHNOLOGIES FOR COAL UTILIZATION.

Coal now provides about 55% of U.S. electricity generation, and about one third of electricity generation worldwide. Moreover, despite growing contributions from natural gas and renewables, we anticipate that coal will continue to be the backbone of global electricity generation well into the 21st century. It is a vast resource in key markets as diverse as the U.S., Canada, China, and India, all with strong economic and security incentives to use their indigenous resources.

However, the continued use of coal will be predicated on improving its energy conversion efficiency and environmental performance while retaining coal's cost advantage. Several advanced technologies for coal utilization are under development.

Clean-coal technologies, such as integrated gasification combined cycles (IGCC) and pressurized fluidized-bed combustion (PFBC), have the potential to achieve >50% electricity conversion efficiency at the same cost of electricity as equivalent natural gas combined-cycle systems. Compared with natural gas, coal has a significant fuel cost advantage that offsets the higher capital cost of coal-based options. Current forecasts indicate that these technology advances have the potential to make new clean-coal generation competitive with gas on a cost-of-electricity basis in the 2010 to 2020 timeframe.

As another example, DOE's Vision 21 program includes a coal refinery or "powerplex" concept with hydrogen separation, chemical production, and carbon dioxide sequestration in addition to electricity generation. The result would be a far more efficient and complete utilization of coal's total resource value. But this technology will require major infusions of R&D funding beyond currently planned expenditures to achieve commercial viability before 2020.

Ultimately, the factors that will limit the long-term future use of coal, as well as other fossil fuels, are the carbon dioxide (CO_2) emissions and the resulting effects on climate. Economic carbon capture and safe, long-term storage technologies can extend the environmental lifetime of fossil fuels within a global carbon emissions budget. Sequestration reduces the "net CO_2 venting" of fossil fuel use, either by capturing the CO_2 at the point of generation and storing it over the long term in sinks, or by transferring CO_2 from the atmosphere. Potential sinks include geological formations and terrestrial ecosystems, as well as the ocean. The worldwide terrestrial carbon reservoir is larger than the atmosphere, and the ocean reservoir is larger still. Many environmental, chemical, and physical challenges remain to be resolved, however, as part of the larger R&D agenda in this area.

Sequestration is valuable for both the carbon reduction it achieves and its role in moderating the risk of investing in future fossil-fuel-based generation. That risk hinges on the uncertainty regarding future limitations on greenhouse gas emissions. However, the availability of low-cost sequestration has the potential for removing or at least weakening the linkage between fossil fuel usage and carbon emissions. This would give the potential investor greater confidence in deploying and operating fossil (and in particular, coal) plants.

III. THE U.S. SHOULD UNDERTAKE A FOCUSED R&D PROGRAM TO DEVELOP THE NEEDED COAL UTILIZATION AND CARBON SEQUESTRATION TECHNOLOGIES.

Existing R&D programs are insufficient to meet the requirements of clean and abundant electricity for the 21st century. The EPRI *Electricity Technology Roadmap* documents the funding shortfall in several key technology areas and concludes that incremental additional funding of approximately two billion dollars per year ($700M per year for coal technology) over the next 10 years is needed to resolve the energy/carbon conflict with the urgency anticipated in public policy proposals. This reinforces the recent reports by the President's Council of Advisors on Science and Technology (PCAST) concerning the need for increased clean energy development funding, and a forthcoming report of the National Coal Council addressing the need for carbon sequestration research and development, and development of advanced clean coal generation options. Increasing the funding for development of the coal option will create the needed leadership focus and incentives to stimulate formation of the public/private consortia that must conduct the range of needed R&D, and commercially deploy the resulting clean energy technologies.

Failure to maintain coal as a key element of national and global energy strategy can have disastrous consequences. Recently, EPRI conducted a study to evaluate the combined economic and market impacts of current policy direction, as defined by a series of reductions in emission limits of sulfur dioxide, nitrogen oxides, and CO_2, planned to occur over the next decade. The overarching conclusion of the study is that the current policy direction fails to coordinate and reconcile these proposed emission reductions with realistic timelines for the development and deployment of the technologies required to make the reductions efficiently. This is particularly the case for CO_2 emissions. Moreover, the relatively short horizon of the proposed regulations does not allow sufficient time to make a transition to a sustainable U.S. energy system without excessive disruptions and risks. As The Energy Daily commented last week in an article on the EPRI study, "In layman's terms: It would waste a lot of money, and it might not even be possible."

Avoiding the trap posed by near-term emissions regulations will require:

- an accelerated effort to improve the efficiency of fossil generation and develop advanced technologies for carbon management; and

- close coordination of the efforts of policy makers, scientists, and technologists so that emissions regulations reflect both a scientific rationale for reducing emissions and the availability of cost-effective technologies to meet the regulations.

Finally, although these comments focus on coal-based electricity generation, there are clearly many parallels between the likely future of the coal option and that of nuclear power. Like advanced coal technologies, nuclear power can play an important role in fostering domestic energy security and protecting the environment. And like coal, the future of nuclear power can be jeopardized by failure to aggressively develop advanced technologies for the economical power plants of the future. DOE/industry initiatives such as the Nuclear Energy Plant Operations (NEPO) and Nuclear Energy Research Initiative (NERI) are important steps in providing the needed leadership and research funding. However, as in the case of coal research, additional funding is needed to assure the timely availability of nuclear energy solutions to U.S. and global energy needs.

IV. PUBLIC/PRIVATE COLLABORATIVE EFFORTS ARE CRITICAL TO DEVELOPING A PORTFOLIO OF COMMERCIALLY VIABLE GENERATION TECHNOLOGIES

Fourth, I want to emphasize the importance of a public/private collaborative approach to the comprehensive energy R&D initiative needed to develop advanced coal utilization technologies. Collaboration is the most effective way in EPRI's experience to ensure that the necessary resources are committed and properly focused on results that make a difference. Importantly, this means that industry should be a partner in financing, defining, and managing the R&D efforts. This means also that the current trends in both private and public sector energy-related R&D investment must be reversed.

The lack of realistic incentives for R&D investment by the energy industry and its suppliers—given the need that exists—is alarming. The U.S. energy industry today invests about 0.5% of its revenues in R&D, and the trend is downward. In comparison, the overall U.S. industry average is around 7%. Energy has been, and remains, at the bottom of the R&D investment ladder, a prescription leading to a precarious and threatening future, especially given the increasingly central role that energy will play in global economic and environmental issues in the 21st century.

U.S. federal energy R&D funding is also at its lowest level in 30 years relative to GDP. We believe the reasons for the broad decline in federal energy R&D support include the current availability of cheap energy and competing energy constituencies whose advocacy arguments tend to cancel each other out. At the same time, state and local R&D funding programs naturally tend to address needs specific to their constituencies in preference to broader collaboration on issues of strategic national and international importance.

With private-sector budgets cut and refocused on near-term results, collaborative efforts enable companies to explore R&D options that otherwise would be screened out, and to pursue opportunities for a longer time horizon. At the same time, it permits federal dollars to be stretched. Thus, the alignment of public and private support permits the leveraging of increasingly scarce R&D dollars on issues of joint importance.

CONCLUSION

I would like to conclude with the following recommendations:

1. Recognize that policies to reduce greenhouse gas emissions must encourage *universal global electrification,* particularly in the developing world, as the foundation for economic growth and environmental protection.
2. *Develop a broad portfolio of advanced technologies*—including coal-based options—to meet U. S. and global needs for generation, energy security, and greenhouse gas reduction in an increasingly diverse world.
3. Coordinate the efforts of policy makers, scientists, and technologists to *assure cost-effective approaches for the long-term reduction of greenhouse gas emissions.*
4. *Increase R&D support for the coal option,* and create the initial leadership and incentives for the formation of public/private consortia to fund and conduct the needed research, and to deploy the resulting technologies.

Thank you for your time and attention, and I welcome your questions and comments.

Mr. BARTON. Thank you, Mr. Gehl.

We would now like to hear from, last but not least, Dr. Harold, is it Schobert?

Mr. SCHOBERT. Yes, sir.

Mr. BARTON. He is a Professor of Fuel Science at Penn State University, and the Director of their Energy Institute, and to my eyes, bears a striking resemblance to Karl Marx, which we know your philosophy is totally different.

But when I saw you walk in the room, I really thought that you were maybe his great, great grandson or something.

So welcome to the committee. Your testimony is in the record in its entirety. We ask you to summarize it in 7 minutes.

STATEMENT OF HAROLD SCHOBERT

Mr. SCHOBERT. Thank you, Mr. Chairman. Never in my life had I had an introduction like that.

I would like to point out, sir, that the usual resemblance that has been mentioned is Jerry Garcia.

Mr. BARTON. Well, that is what my Democrat friend, Mr. Boucher, says.

Mr. SCHOBERT. All right, well, thank you, Mr. Boucher.

Well, that gets things off to a great start.

Mr. Chairman and members of the subcommittee, I am pleased to be here to talk about coal today. I thank you for the opportunity, as well as the remarkable comments on my appearance.

I certainly believe that there is a great future for coal in the United States in our energy economy. I believe that will be true at least through the middle of this new century and probably beyond.

I believe that for two reasons. The first is the importance that exists today for coal in electric power generation, and the continued importance of coal in that area for quite some years to come.

In preparing my oral remarks for you today, I was very much hoping that Mr. Kripowicz and General Lawson would talk about Vision 21, which spares me from repeating much of what they said.

I believe that the Vision 21 concept that was outlined to you by Mr. Kripowicz is a bold, exciting, and remarkable initiative undertaken by the Department of Energy. We, at Penn State, certainly are very intrigued by it, and very supportive of it, and look forward to seeing the time when it comes to fruition.

The other reason, sir and members of the committee, that I believe that coal has very important future is that we have to recognize that burning coal in power plants is not the only thing to do with it.

There are many other potential new uses for coal. Some of these, at least, derived now from a much greater understanding of the fundamental chemical basis of coal. That understanding is the fruition of many years of long, patient work that was undertaken mostly by the national laboratories in various universities, with support from the Federal Government.

I would like to give you just two examples of what I mean by that. The first is an example that bears directly, not only on our energy economy, but our national security. That is the prospect of making the next generation of military aviation fuel from chemicals derived from coal.

This is a program that is already underway. The reason behind it is that the next generation of aircraft will be so lightweight and so high performance that there is a significant problem, simply in absorbing the heat that these airplanes generate.

If the conventional jet fuel that is in use now is used also as a coolant on the aircraft, it will decompose to form carbon in the fuel line or burn a nozzle. I think the implications of that are pretty obvious.

The extreme temperatures that a fuel in the future will have to withstand without decomposing are 900 degrees Fahrenheit. We have learned that a fuel that will take that temperature can be made largely consisting of components of coal. So we perceive that a coal-based jet fuel is a significant component of the liquid fuel scenario in the future.

The other area is in the production of high tech carbon materials from coal. You might, at first sight say, well, okay, carbon material, that is not really burning the coal, so it is not energy; but in many ways it is.

In a single example, carbon/carbon composites, these are materials that are lighter than aluminum, stronger than steel, and will not rot, rust, or corrode. A car made from carbon/carbon composites will be substantially lighter, and therefore require substantially less gasoline. We have heard both from this panel and the previous panel on the concern for imported oil, and the effect of that on our economy.

Therefore, even though we are not using the coal necessarily to burn it to release its energy content, using the coal to produce high tech carbon materials can result in energy savings in other sectors throughout the energy economy.

In conclusion, I would say two comments, which I hope do not appear to be self-contradictory. First of all, I do believe, and I echo the comments of the others on this panel, that coal has a great future. It is and will be an important component of our national energy economy for decades to come.

The other comment, in conclusion, actually, and I do not know whether I stole it from Mr. Kripowicz, or vice versa, but I have been paraphrasing the Oldsmobile ad that said, and you may have seen it on television, "It is not your father's Oldsmobile."

Well, what we are looking at in the 21st century is not your father's coal industry, either. It is going to be a great one, but it is going to be very different.

So, Mr. Chairman, I thank you.

[The prepared statement of harold Schobert follows:]

PREPARED STATEMENT OF HAROLD SCHOBERT, DIRECTOR, THE ENERGY INSTITUTE, AND PROFESSOR OF FUEL SCIENCE, C211 COAL UTILIZATION LABORATORY, THE PENNSYLVANIA STATE UNIVERSITY

Mr. Chairman and members of the Subcommittee, I am pleased to be here today to discuss aspects of the role of coal in a national energy policy. My perspective is two-fold. First, as Director of The Energy Institute at Penn State University, I have some appreciation for what is possible to be achieved with coal, and how research and development on coal can help us achieve national energy goals. Second, in my role as Professor of Fuel Science, I regularly teach an introductory, general course on energy to our future taxpayers and voters. In that course we discuss the pros and cons of a variety of energy sources—coal, nuclear, petroleum, gas, and renewables.

Introductory comments

The ways that we use coal are undergoing a major change as we move into the 21st century. These changes *are* happening. They provide both opportunities and challenges for the coal industry. The changes result from environmental considerations and from technological innovation. One of the changes is driven by regulation

and legislation on environmental issues. These include the 1990 Clean Air Act Amendments and possible future limitations on greenhouse gas emissions. The second major change is in growing markets for clean liquid fuels, specialty chemicals, and advanced, "high-tech" carbon materials.

Certainly there are those who, once again, are sounding the death knell of the coal industry. I contend there's a lot of life in the old corpse yet. The Energy Information Agency (EIA) predicts that coal will continue to dominate electric power production well into the first quarter of this century. New technologies are being designed to burn coal more efficiently and to eliminate emissions. Furthermore, the 21st century will be the "carbon century", with carbon materials proliferating into new markets in industries and consumer products. These changes *are* coming. They are starting to happen *now.* Coal is transitioning for a new role in a new century. The nay-sayers are wrong. Coal will have a vibrant and exciting future. But, to paraphrase the car ads that claimed "It's not your father's Oldsmobile," it's not going to be your father's coal industry, either.

Listening to the barrage of problems, criticism, even invective, facing the coal industry, it is easy to forget that coal is the backbone of America's energy economy. The majority share of electric power production, as well as much process and space heating, belongs to coal. Most of us have heard some of the proposals that would adversely affect the coal industry: a carbon tax, reliance on natural-gas-fired turbines for electric power generation, carbon dioxide reductions, mandates for using "renewables", and of course the tired old epithet that "coal is a dirty fuel." Global warming—real or imaginary, friend or foe . . . carbon dioxide emissions—a threat to the planet, benign, or good for agriculture . . . while the debate rages on, the debaters occasionally pause long enough to agree on one point: coal is the "bad guy."

According a 1995 EIA estimate, coal reserves are about a trillion tons worldwide, more than 235 times the world's annual consumption. Unquestionably, coal has great potential as a future source of energy. There is little doubt that coal combustion *must* continue as a major contributor to the energy economy for the near- to mid-term future. However, environmental pressures may militate against expanded markets for coal as an energy source, and *the* problem is likely to be carbon dioxide emissions. The National Research Council (NRC) pointed out in 1995 that, "Of all the environmental issues facing the future use of coal, none is as potentially far reaching as the worldwide concern over global climate change". The heat generated in arguments about the Kyoto Accord sometimes seems to be about as large as the heat generated by burning the world's annual coal production. It is likely that environmental pressures on present-day, conventional coal utilization will only intensify. This factor, taken by itself, would cause us to question the long-term future of the coal industry. Environmental issues also severely impact the metallurgical coke industry, the present source of most chemicals from coal. The traditional coal industry and coal markets in the dawning of the 21st century are under increasingly intense assault.

The immense reserve base of coal shows that it can be a significant contributor to the world's energy markets for decades, likely centuries. But why waste coal by burning it? Steady progress in understanding the molecular structures of coals places us on the verge of being able to do rational chemistry with coals—that is, deliberately to select specific coals as starting materials to produce specific, selected high-value chemical products. This opens a route to chemicals from coal that does not rely on by-product coal tars—or on the metallurgical coke oven—as the feedstock. The molecular structures in coals could be ideal "monomers" for the aromatic polymers and engineering plastics that have burgeoning applications and markets. At the same time, tremendous opportunities also exist for coals as precursors to high-value carbon materials. Taking coal in these directions—high-value chemicals and premium carbon products—represents profitable opportunities for innovation, leadership, and new directions for the coal industry in the 21st century.

Electric power generation

In preparing this testimony, I have assumed that others testifying to this Subcommittee today will discuss applications of coal in the electric industry in some detail; so, my own remarks on this topic will be limited. By far the largest market for coal in the United States is electric power generation. Between half and two-thirds of our electricity comes from coal-fired plants. As I face a new crop of students each semester, I never cease to be amazed by the number of people who have no idea that coal is the fundamental basis of our energy economy.

New and forthcoming regulations under the New Source Performance Standards will force utilities to become much more efficient. In the past, emission regulations were based on the firing rate; that is, they were expressed in "pounds per million Btu." New regulations will be based on the generating capacity of the plant, in

"pounds per megawatt." As a result, the more efficient plants—those able to generate a greater number of megawatts per ton of coal consumed—will enjoy a tremendous advantage.

This leads to a new vision for energy generation in the 21st century. Appropriately, it's called "Vision 21." A Vision 21 plant is more than a facility for generating electricity. The new plants, sometimes called "energy-plexes," will be highly efficient and very clean plants that produce not only electricity with near-zero emissions, but also steam, clean liquid fuels, chemicals, and possibly hydrogen, all from a single facility. The Department of Energy (DOE) expects that Vision 21 plants will be commercialized around 2015. Vision 21 plants will be the largest single user of coal, and will eventually replace existing power plants. The Vision 21 concept has been endorsed by the President's Committee of Advisors on Science and Technology. The plants fit the strategic goals of the National Mining Association's Technology Roadmap for the Mining Industry and the President's climate change initiative.

Coals vary widely in their compositions and properties. Vision 21 energy-plexes need to be designed from the ground up for a particular kind of coal. To build the foundation for commercialization of Vision 21, research and development are underway today.

Liquid aviation fuels

Oil production is expected to peak some time between 2010 and 2020. That assumes that there will be no disruptions to the current oil supply as a result of military conflicts or more effective control of the supply by oil-exporting countries. Regardless, the question of how liquid aviation fuels will be made after 2020 is timely, given the large lead time to develop an alternative fuel source for our very large liquid fuel market. Here in the United States our cars, trucks, and buses burn more than 140 billion gallons of gasoline and diesel fuel annually. The Air Force alone uses about three billion gallons of jet fuel each year, about 10% of the U.S. market for aviation fuel. Complicating this situation is the fact that the United States has a significant, and growing, dependence on imported petroleum. American Petroleum Institute statistics for the week of April 14 show that our imports of crude oil and petroleum products were 11,135,000 barrels/day, which represented 69% of the total refinery input of 16,111,000 barrels/day. We are "hooked on oil." Clearly, the dependence of military readiness and response capability on a vital material such as fuel, which is less and less a domestic resource, represents a grave security threat.

Projected trends in future energy utilization do not provide much cause for optimism. Global primary energy demand is expected to climb by 40% by 2010, and fossil fuels, which today provide at least 90% of the energy in most industrialized countries, will still account for about 90% of that greatly increased total. Approximately 80% of the oil currently being produced comes from fields discovered before 1973. Production from many of those fields is now declining; within the next decade the supply of readily accessible crude oil will not be able to keep up with demand. If China, India, and the Third World nations were to industrialize by 2020 to the level enjoyed *now* by the United States, their energy demand would require a three-fold increase in oil production. Of course, with the demise of the former Soviet Union, additional petroleum reserves may become available in the west. Already there is considerable interest in the Caspian Sea deposits controlled by the Central Asian republics of Kyrgyzstan, Uzbekistan and Tajikistan. However, this oil source may not have a significant impact in the 2010 time frame.

Reliance on foreign oil sources also imposes substantial ancillary costs. In 1996, the Persian Gulf OPEC nations controlled 70% of the world's crude oil reserves; all OPEC nations together totaled 84% of crude reserves. A study published by analysts at RAND has shown that the Pentagon spends up to $60 billion per year to protect the $30 billion of Persian Gulf oil imported into the United States. In other words, *every dollar's worth of oil coming into the U.S. from the Gulf costs two dollars to protect.* Given this perspective, it's important for us to remember that coal constitutes over 94% of proven American fossil fuel reserves, and coal utilization in the United States will not be resource-limited at any time at least through 2040. Furthermore, we possess 24% of the world's coal reserves. Clearly, coal represents a potential source of aviation fuels and other clean liquid fuels that is domestic-based and thus provides a secure source well into this new century. The situation has been expressed eloquently by Richard L. Lawson, president and CEO of the National Mining Association, who has stated that, "There is no such thing as a bad domestic energy resource."

Though current jet fuels (JP-8 for the Air Force and Jet A/Jet A-1 for commercial aviation) are made from petroleum, there is a vital need to assess the capability of coal to augment the supply of aviation fuel in the future. In addition to meeting concerns about supplies, new aviation fuels will need to meet increased thermal sta-

bility requirements, caused by the higher temperatures and higher heat loads in future aircraft. Two target fuels have been identified with increased temperature capability above JP-8 (whose maximum useable temperature is 325°F): JP-8+225 (550°F maximum) and JP-900 (900°F maximum). The goal of present research and development on the use of coal for aviation fuels is to determine the suitability of coal-based aviation fuels as candidate JP-900 fuels. Of course, this must be done economically and must result in fuel that meets the thermal stability and combustion requirements of current aviation fuels. Given current economic constraints, coal-based fuels will not be produced in stand-alone coal-conversion plants, but will be incrementally incorporated into existing refinery operations.

The NRC has forecast that, "by the second decade of the twenty-first century . . . the cost of synthetic fuels [will be] reduced by process and systems advances and . . . concerns over the supply and price of competing fuels [will] increase". Indeed, all of us have seen the recent increase in petroleum prices, especially at the gas pump. As indicated above, our dependence on imported oil has increased significantly. DOE statistics show that, between 1985 and 1997, the importation of petroleum more than doubled, from 4.3 to 8.9 million barrels per day. Three years later, it's up to 11 million barrels per day. Therefore, it is prudent—in fact, vital—for the United States to have a research and development program on coal-based alternative liquid transportation fuels, because coal is our most abundant energy source. We've seen gasoline prices double—or worse. We've seen truckers and farmers protest the soaring price of diesel fuel. Significant price changes in imported oil can have major impacts throughout our economy. How many times do we have to repeat the lesson before we've finally learned it? For the everyday consumer, the obvious concern is gasoline prices; for industry and farmers, it's diesel fuel prices. For our national security, a research and development program must address the need for aviation fuels capable of meeting military operational requirements to allow coal-based fuels to enter the operational arena by around 2020.

Non-fuel uses—Carbon materials

The Energy Policy Act of 1992 calls attention (in Title XIII, Section 1304) to the need for "a program of research, development, demonstration, and commercial application with respect to technologies for the non-fuel use of coal, including—

"(1) production of coke and other carbon products derived from coal;
"(2) production of coal-derived, carbon-based chemical intermediates that are precursors of value-added chemicals and polymers;"

To the best of my knowledge, the Energy Policy Act of 1992 was our last serious attempt to have something resembling a national energy policy. Here, I address some issues on carbon products from coal; I will later touch on chemical intermediates.

What can we do with carbon? Everything. Already, we rely every day on various forms of carbon, mostly in ways we seldom pay attention to. Carbon purifies air and water. Carbon lubricates. Carbon helps make steel and aluminum. Carbon is in our tires. Carbon rods are in batteries; carbon "brushes" help electric motors work. Carbon is the invisible workhorse of our daily lives. But with our new century comes new and exciting roles for carbon.

Carbon fibers are stronger than steel, lighter than aluminum, and corrosion-proof. Developing the technology to make carbon fibers at low cost will kick off the next revolution in industry, even more impressive than the way silicon technology revolutionized electronics. Carbon foams are a third the weight of aluminum and ten times as good at dissipating heat. "Pyrolytic" carbon has a role as heart valves and other replacement body parts. The new world of carbon nanotubes has wide horizons, with promising applications from wires only one molecule thick to light-weight, high-capacity storage of hydrogen. Carbon is emerging from its behind-the-scenes role as the invisible workhorse to take center stage as the star of 21st century technology.

Where can we get these new carbon materials? By turning to the oldest and richest source of carbon of all—coal. Coal *is* a carbon material; most coals contain 80 to 95% carbon (neglecting the ash residue). Most high-tech carbon materials are essentially 100% carbon. The challenge is to develop the technologies for making these new materials from our coals. The potential economic payoff is huge. A valuable coal might sell for $50, and a high-tech carbon material also for $50—but the coal is $50 *per ton,* and the carbon is $50 *per pound.*

Developing premium carbon products from coal is an initiative that is in the direct national interest. Potential advantages for our nation include (but are certainly not limited to) decreasing national reliance on imported petroleum and petroleum products, improving fuel efficiency and reducing vehicle exhaust emissions, and reducing total carbon dioxide emissions. Since all coals are carbon-rich solids, they are

potential starting materials for other, higher value materials via conversion to new carbon-based solids.

Activated carbons are used mainly as adsorbents for liquid- and gas-phase applications. The amount of coals used worldwide for producing activated carbons is about 200,000 tons per year. This represents nearly half of the world's annual production of activated carbons from all sources. Significant growth potential exists for this product, primarily for water and air purification. The liquid-phase applications of activated carbons from bituminous coals include water purification, decolorizing, food processing, and gold recovery; the gas-phase applications cover air purification, gas treatment, and solvent recovery.

Molded graphite articles have a wide range of applications, from high-tonnage uses as electrodes in electric arc furnaces, to specialty graphites for high-technology needs in chemical vapor deposition and epitaxial deposition devices. Manufacture of electrodes for steel making was a $2.2 billion business ten years ago, and has now grown to $3-3.5 billion worldwide. (In the United States, the market is $1-1.5 billion.) Currently, petroleum coke is used to make these graphite articles. Consumption of petroleum coke by the graphite industry amounts currently to 350,000 tons per year. About 7.5 million barrels of "coker feed" are needed to provide coke only for the graphite industry (not taking into account all the other applications and uses of petroleum coke outside the graphite industry). The potential exists to replace petroleum coke with coal. Displacing this coke with coal would allow refiners to divert the coker feed into making lighter, potentially more valuable products. Anthracites tried in commercial graphitization processing have shown some potential for producing these graphite articles. Meta-anthracite, of very limited value as a fuel (selling for less than $25/ton) because of its poor combustion performance, may be even better than the more conventional anthracites. The value of meta-anthracite in graphite production would exceed its value as a fuel by at least ten times.

Carbon/carbon composites have an array of applications: turbine blades, clutches, and brakes in the aerospace industry; exhaust nozzles, rocket nozzles, and afterburner components; connecting rods and pistons in automobile engines; and sporting goods. When continued research and development on carbon composites gets the price under $5 per pound (it's currently $8-10 per pound) an enormous potential exists for their use in the automotive industry. There is a long-established relationship between vehicle weight and fuel efficiency. Any saving in vehicle weight translates directly into reduced gasoline consumption. Since gasoline is the dominant petroleum product, this saving is further compounded into a reduced demand for petroleum and reduced reliance on imports. (For the week ending April 14, motor gasoline production was exactly 50% of total refinery output.) Carbon-carbon composites are about 40% lighter than aluminum and 80% lighter than steel. Every 5% reduction of fuel consumption in the nation's vehicle fleet represents a saving of a hundred million gallons of fuel. It is not accurate to claim that every barrel of gasoline saved saves two barrels of crude oil, since the other refinery products (jet fuel, diesel, and so on) are valuable too. But, assuming that the only saving would be in the crude equivalent to the gasoline itself, the potential saving from a 5% reduction of fuel consumption is 2.4 million barrels of crude. For the week of April 14, the OPEC "basket" crude price was $23.77 per barrel. At these prices, the savings to the nation in cost of imported petroleum would be nearly sixty million dollars for each 5% reduction of gasoline used. It's important to note that this projected saving is not a result of some government-enforced reduction in driving, but simply through lighter vehicle weight achieved using premium carbon products. The saving in gasoline also relates to a saving in carbon dioxide emissions. Fuel economy also directly affects other vehicle exhaust emissions, notably the unburned hydrocarbons and carbon monoxide that contribute to smog formation. Replacing vehicle components by lightweight premium carbon products will improve the fuel efficiency; reduce emissions; and will impact our dependence on imported petroleum.

The specialty carbon market is a $2.5-3 billion industry around the world, and about $500-750 million in the United States. I touch on only a few examples here. Molecular sieving carbons (MSC) are used commercially for separation of gases, such as taking oxygen or nitrogen from air. In the United States, MSC is used for air separation by Air Products and Chemicals Inc. Likely, more companies will be engaged in producing MSC as we move forward into the new century. Activated anthracites are microporous with a significant fraction of the pores having molecular dimensions; this suggests that molecular sieve materials could be produced from anthracites. Coal tar pitches are raw materials for carbon fibers, used in many applications including carbon/carbon composites, and for mesocarbon microbeads (MCMB), used in rechargeable batteries. A single, tantalizing trial of an anthracite, selected with no particular care for its chemical or physical properties, showed 75-80% of the reversible capacity that MCMB has when used in lithium batteries. This

suggests that, with appropriate selection and perhaps some modest pretreatment, anthracite could be used as an electrode material in these batteries. The cost differential is enormous: about $18/lb for MCMB vs. *6¢/lb* for anthracite. Liquids from coal extraction and liquefaction can be used for making carbon fibers and graphitic materials. There are also potential advantages in using coal-based coke for making carbon electrodes.

Non-fuel uses—Chemicals

Coals, as well as the other fossil fuels—petroleum, natural gas, bitumens, and oil shales" are hydrocarbon resources. In principle, there are many ways of using valuable hydrocarbons. Burning them is only one choice. Other utilization strategies, the so-called non-fuel uses, also deserve attention. When combustion is the primary application of a resource, as with coal today, it is easy to lose sight of the fact that other alternatives even exist. Today, the major non-fuel use of coal is production of metallurgical coke. About 500 million tons of coke are produced annually in the world. Coal tars, a by-product of this industry, remain an important source of certain types of chemicals, called aromatic hydrocarbons. (Currently, the non-fuel uses of fossil hydrocarbons in the chemical industry are dominated by petroleum products.)

Evaluation of the potential for coal in future chemical production, as with energy generation, presents a "good news/bad news" story. As I've indicated, the good news is that the immense reserve base of coal can be a significant contributor to the world's chemical, and energy, markets for decades, and likely for centuries. The aromatic molecular structures present in coals could be ideal feedstocks for the high-tech polymers and engineering plastics that have burgeoning applications and markets. The bad news is that the traditional source of coal chemicals, liquids from by-product metallurgical coke ovens, is steadily decreasing. So, as opportunities increase for applications and markets for coal chemicals, the traditional source of those chemicals is in a steep, and likely irreversible, decline.

It's easy to forget that, until about 1950, the world's organic chemical industry was based on coal. Most of those chemicals derived from coal tar, and, in turn, much of the coal tar was a by-product of the metallurgical coke industry. The development of the coal tar chemical industry, and its impact on the scientific development of organic chemistry, represents heroic endeavors in industrial chemistry and organic chemistry. This story has been told often, and well, in various sources on the history of chemistry.

Despite the success that the coal tar industry once enjoyed as provider for the organic chemical industry, and despite a growing demand for aromatic chemicals for specialty polymers and other high-value-added products, the future of the coal tar industry seems dim at best. There seems to be a consensus that there will never be another by-product coke oven battery built in the United States, in part because of environmental constraints. This fact alone would cause the coal tar chemicals industry to move out of the United States. Not only that, it also appears that the coke industry may go "back to the future," in that future coke ovens may revert to a variant of the earlier beehive oven. While beehive ovens certainly produce coke, ironically much of the heat is generated by burning the by-product tar right in the oven. In essence, the beehive oven works by burning up the very materials one would want to save (at least for the organic chemical business). The situation is made even worse because total coke demand is decreasing, due both to improvements in blast furnace technology that reduce the coke burden and, more importantly, to a steady shift to electric furnace technology. Even if no other constraints existed, coal tar production is tied directly to metallurgical coke demand, and would likely be dropping in any case.

In the past half-century the organic chemical industry has been taken over largely by petroleum- and natural-gas-derived feedstocks. However, coal tar still reigns supreme in the market for complex aromatic compounds. This is a market with great growth potential, thanks to a steadily increasing demand for advanced aromatic engineering polymers, high-temperature heat-resistant polymers, thermoplastic polyesters, and related materials that will be made from these specialty aromatic compounds. As I've mentioned, an interesting situation confronts us: a market for a class of chemicals is increasing steadily while the principal source of those chemicals is declining.

So, while we know that coal can supply the steadily growing demand for these aromatic chemicals as precursors to the market for aromatic engineering polymers and related advanced materials, we must also recognize that the potential market demand cannot be supplied by coal tar from coke ovens. The increasing demand for monomers based on aromatic and phenolic compounds results from the significant growth of markets for existing aromatic polymer materials, and from the rapid de-

velopment of advanced aromatic polymers—engineering plastics, polyester fibers, polyimides, and liquid crystalline polymers (LCPs). Using LCPs as an example, most, such as Celanese's "Vectra" and BP-Amoco's "Xydar" are made from chemicals that could be produced from coal. About 50% of the global market for LCPs is in the Asia-Pacific region. Despite their cost, LCPs are enjoying 25% annual growth worldwide and are fully expected to maintain that growth rate. There is a clear need for developing alternative sources of aromatic chemicals in the near future.

Concluding remarks

A new coal industry is dawning. The incentive comes from the combination of the unique molecular nature of coals with the expanding opportunities for aromatic specialty chemicals and monomers and ever-increasing demand for carbon-based materials. At the same time, environmental concerns about carbon dioxide emissions from combustion may provide a disincentive for future construction of large coal-burning power stations based on today's conventional technology. Expansion of the non-fuel uses of all hydrocarbon resources, but particularly coals, is desirable, because coal has the potential to become more important as source not only of energy but also chemical feedstocks and premium carbon materials in the next century.

This situation represents a subtle, but significant, shift in thinking. Coal utilization in today's world is dominated by combustion (not only direct combustion of the coal itself, then combustion of coal products such as coke and synthetic fuels). Nowadays, the attitude seems to be that if some amount of useful byproducts can be made along the way, doing so represents just a small, added bonus. Instead, we should view coal as a hydrocarbon source having multiple prospective uses, all of which deserve equally serious consideration as prospective uses for this valuable material. That is, coal is a resource that can be converted to chemicals and polymers, to carbon materials, or to energy. Combustion applications of coal will dominate in the near-term and likely will remain important for decades, but to ignore now the potential for alternative uses is only to short-change ourselves in the future.

Mr. BARTON. Thank you, Doctor.

I want to find out what all these bells mean, before we start questions. I think we're going to go back in at 4:30 or 4:15, so the Chair is going to recognize himself for the first 5 minutes of questions. I think we are going to be here until at least 10, unfortunately. It is a recess until 3:45 on the floor.

Mr. Kripowicz, when we passed the Clean Air Act amendments, back in the early 1990's through this committee, the goal was to reduce SO_2 emissions in half by the year 2000. Could you give us any information, or anybody else on the panel—have we met that goal?

Mr. KRIPOWICZ. To my knowledge, we have exceeded that goal. I do not have the exact numbers; but, yes, we have met that goal.

Mr. BARTON. Coal was reputed to be the big culprit in SO_2 emissions. So if we have actually met the goal, nationally, then coal has done its part. The scrubber technology that you talked about has come a long way since then.

Mr. KRIPOWICZ. And the use of low sulphur coal; the combination of those two things has led to the reduction in SO_22.

Mr. BARTON. Okay, I would like to ask General Lawson, since you are here on behalf of the mining industry, when we have some of our environmental group witnesses, they talk about, coal may be environmentally correct now, at the use for generation as a fuel source in the power plant.

But if you take the total life cycle and how much it costs, the environmental damage mining it, getting it out of the ground, and transporting it, we still should not be using coal. Could you comment on that a little bit?

Mr. LAWSON. Well, here is what I tell them, when they give that sort of a statement, Mr. Chairman. Coal, today, in the United

States, is enabling it to have the cheapest electricity anywhere in the world. In our records across the coal industry, in terms of efficiency, we are twice as efficient as the No. 2 producer of coal on the earth.

In terms of safety, we are now rated by the Department of Labor as number 22 out of 23 industries, measured for safety. We were beat out by accountants and financial advisors only, last year.

Mr. BARTON. Well, they do damage in other ways.

Mr. LAWSON. And I suspect if the market keeps jumping up and down, we may get them this year.

I think, in terms of environmental acceptability, the response is, give me a specific, rather than some kind of a gut feel about your problem. Because if we can not solve it with technology, we will stop doing it.

Our record, I think, speaks for itself, across the country. We doubled the use of coal in this country since 1976, and we have reduced all emissions, despite doubling the use of coal. We have reduced all emissions by more than 30 percent.

So our record here in this country will stand on its own. As far as any other country on the face of this earth, we have far out distanced them. We are now the standards that everybody holds themselves up to.

Mr. BARTON. Thank you, sir.

This would be for Mr. Kripowicz and also Dr. Schobert.

You talked about gasifying coal and using that in power generation, and Dr. Schobert talked about some alternative uses. If we use coal as a fuel source for power generation through this gasification process, compare that in efficiency to just using coal and burning it straight.

Is it just as efficient and you get as much of the heat, per ton of coal, by going through that process, as if you just burn the coal directly? Dr. Schobert, you may want to comment on that, also.

Mr. KRIPOWICZ. Yes, you do, Mr. Chairman. Existing coal plants operated at around 33 to 35 percent efficiency. A combined cycle gasification plant that we have operating in Tampa, Florida operates at efficiencies in the neighborhood of 43 to 45 percent, so it is a third more efficient.

If we add new technologies that we are developing to make those plants even more efficient, plus add the possibility of using fuel cells and advanced turbines, we can get efficiencies, as we project in the Vision 21 program, of up to 60 percent, which would be almost doubling the efficiency of existing coal plants.

Mr. BARTON. Dr. Schobert, do you want to comment on that?

Mr. SCHOBERT. Yes, sir, in terms of the net overall efficiency of a plant that is starting with the chemical energy and the coal, and electricity going into the bus bar at the other side, I would agree with Mr. Kripowicz's statements. I do not have the exact numbers, but certainly substantively, I agree with him.

Mr. BARTON. So environmentally, is there a downside to doing it that way? And if there is no downside in terms of efficiency, converting the coal to a gaseous state before you burn it, what kind of an emission effect is there? Does it enhance the emission effect, in terms of it being less environmentally negative, or is it worse, or about the same?

Mr. SCHOBERT. There are two concerns. First of all, during the process of gasification and subsequent use in the plant, it is possible to do some purification along the way. So one can actually capture potential pollutants before they would even be formed and emitted.

The second critical thing to bear in mind is that with the increased efficiencies that Mr. Kripowicz was referring to, you can generate the same amount of electricity by burning somewhat less coal. That is one way to look at it. That has an immediate and direct effect on carbon dioxide emissions.

Mr. BARTON. Okay, thank you. My time has expired.

The gentleman from Virginia, Mr. Boucher?

Mr. BOUCHER. Thank you very much, Mr. Chairman.

I want to commend particularly Dr. Schobert for his testimony today. I think you did a far better job than we could have expected from Karl Marks.

Mr. SCHOBERT. I would like to think that, sir.

Mr. BOUCHER. I will not compare your performance to Jerry Garcia. He made a lot of money performing, but you did quite well.

I am intrigued by your discussion of coal as potentially being the high speed aviation fuel of the future. How realistic do you think it is to suggest that some considerable volume of coal might be consumed for that purpose, and how rapidly do you think the technology will develop, so that there is any demand at all for coal for that purpose? Give us a little bit of your thinking about when this might happen, and what the volume of coal consumed for that purpose might be.

Mr. SCHOBERT. Okay, thank you, sir. In terms of the technology, I have a bottle of the prototype fuel in my briefcase, that you may have, if you wish.

Mr. BOUCHER. Thank you. I will put it in my airplane, and we will see what happens.

Mr. SCHOBERT. Well, not necessarily; that might get me back into the Karl Marks business, or Groucho, perhaps.

But let us put it this way, sir. Let us focus first on just the military aspect, without considering the commercial arena.

The United States Air Force consumes 10 percent of the jet fuel produced in America, which is 1 percent of total refinery output. Our refinery capacity today is 16 million barrels of oil a day, and 1 percent of that goes to the Air Force.

We, in our prototype fuel, can displace at least half of that with materials derived from coal. That, in turn, requires that coal be converted into those materials. I am running out of my ability to do arithmetic in my head, but the market for coal there is modest.

If that fuel then is to be transitioned into the entire commercial fleet, the market for coal in that application would be substantial.

Mr. BOUCHER. I would assume that the cost of that fuel per gallon is substantially higher than traditional aviation fuel. Therefore, one would anticipate that this fuel would only be used for high speed applications, where the different molecular composition is required. Is that accurate to say?

Mr. SCHOBERT. There are no accurate economic estimates on this fuel, at the present time.

I will say two things, however. First of all, the Air Force target is that it cost no more than five cents per gallon more than the conventional JP8 fuel.

One of the processes that is being studied at present would produce, at a bi-product material, some of these high tech carbon substances that I mentioned in my testimony. If that pays off, the profit from the high tech carbon material would virtually pay for the jet fuel.

In that case, it would be perhaps even less expensive than conventional petroleum derived fuel. However, there is much work that has to be done to make sure that comes to fruition.

Mr. BOUCHER. That is really fascinating.

Are you getting any support in developing this fuel from Mr. Kripowicz and other entities in the government, or perhaps the Department of Defense?

Mr. SCHOBERT. Presently, sir, our work is funded by the Air Force Office of Scientific Research.

Mr. BOUCHER. And Exxon.

Well, thank you very much. I appreciate your bringing that information to us today. I actually read an article in, I think it was, "Business Week" about this, about 3 months ago. I was hoping we would have some mention of this development here today.

Mr. SCHOBERT. Thank you.

Mr. BOUCHER. I would like to ask perhaps General Lawson, or maybe some of the other witnesses, who might have information on the subject, about the trends that are present today in the coal industry itself, in terms of a switch from a reliance on Eastern or Appalachian coal to coal that is mined in the West.

To what extent is that trend occurring, and if you have information about it, what is the trend in terms of the comparison between volumes of deep mined coal and surface mined coal, that are being derived at the present time?

Mr. LAWSON. I will provide the specifics on 1999 for you by note. But just roughly speaking, we are at about 55 percent/45 percent, surface to underground, across the country.

Mr. BOUCHER. With surface being the higher number?

Mr. LAWSON. Surface is the higher number.

The discussion earlier with regard to SO_2 talked about sulphur, and the amount of sulphur in coal. I think the industry has made giant strides in the blending of coal, which has permitted the Eastern coal, and especially that, plus the Illinois Basin coal, to maintain a stable or slightly declining position, vis-a-vis, say, a decade ago.

The increases are certainly coming from the Western coal fields in Wyoming and Montana; that being lower sulphur coal. Also, its expense in producing that coal is significantly below that. So it is on the increase, the Eastern coal, and Illinois Basin coal.

Mr. BOUCHER. You are not talking in terms of numbers of tons produced.

Mr. LAWSON. Yes, sir.

Mr. BOUCHER. But in terms of a percent of the overall coal market declining.

Mr. LAWSON. Yes, sir.

Mr. BOUCHER. Can you tell me what the rate of that decline is, as measured against the entire coal market?

Mr. LAWSON. It has been about 2 percent, on an annual basis. Again, I will give you the last decade, so that you can get an idea of what that looks like.

Mr. BOUCHER. Okay, Mr. Kripowicz, I have one question for you. Mr. Chairman, if you would indulge me just for a moment.

Mr. BARTON. This will have to be the last question in this round for you.

Mr. BOUCHER. It will be. Thank you.

Mr. Kripowicz, I understand that over the last couple of years, there have been two basic sources of the funding that you administer through your department for coal research and development. One of those has been the Clean Coal Technology Demonstration Program, which I think has now been terminated, or is very near its end.

The other is the basic coal research and development budget within the general fossil energy research and development budget, administered by DOE.

What has been the trend in funding for that latter component; the basic coal budget within the larger fossil energy research budget at DOE?

Mr. KRIPOWICZ. The actual coal numbers have gone up slightly in the past few years. They were on a decline until fiscal year 1999. Then they have increased slightly in both our 2000 and our 2001 request, up to a figure of about $125 million to $126 million.

Mr. BOUCHER. Do the other members of the panel think this is an adequate number, or should we be pushing for higher levels of coal research and development; Mr. Gehl?

Mr. GEHL. Thank you. The analysis that I described earlier suggests that we need, over the next 10 years, an annual average of around $400 million for coal, and another $300 million for sequestration, which would include other fossil fuels, as well as coal.

Mr. BOUCHER. Dr. Schobert?

Mr. SCHOBERT. Well, sir, I believe, without being able to give specific numbers, that a, the figure is inadequate; and b, what the Federal Government, presumably through the Department of Energy, needs to do is to ensure that there is a steady and solid base of fundamental work on coal.

Mr. BOUCHER. Okay, well thank you very much. Mr. Chairman, thank you for your indulgence.

Mr. BARTON. It is refreshing to know the Department of energy is spending some money on real energy research, though. I think, given all the other things they spend money on, it is good they are spending it on this.

Mr. Whitfield, for 5 minutes.

Mr. WHITFIELD. Thank you, Mr. Chairman.

Mr. Kripowicz, I notice in your testimony, you touched on the recent lawsuits filed by EPA against various utility companies around the country, charged with violating the new source requirements.

You said that Tampa Electric is the only company that had entered into a settlement. As a result of that, they are going to pay a $3.5 million fine, and retire significant coal capacity. I was curi-

ous, that particular facility, it is different than the Tampa Electric Polk Power station is it not?

Mr. KRIPOWICZ. Yes, sir, that emits essentially no sulphur oxide or no nitrogen oxide.

Mr. WHITFIELD. Because that is the new gasification.

Mr. KRIPOWICZ. That is correct.

Mr. WHITFIELD. And that is quite clean, I understand.

Mr. KRIPOWICZ. That is very clean.

Mr. WHITFIELD. There are, what, three of those around the country?

Mr. KRIPOWICZ. There are two in operation, and one that is in start-out; that is right. There is one in Kentucky that is doing an environmental impact statement now.

Mr. WHITFIELD. Is that the one that General Electric is involved in?

Mr. KRIPOWICZ. I am not aware of who is doing the turbines. It is Global Energy that has the gasification technology. It could be that General Electric is doing the turbines, but I am not sure.

Mr. WHITFIELD. Does your office have a working group or task force with the EPA, that you all meet on a regular basis on coal issues?

Mr. KRIPOWICZ. We do not have such an organization. But we do have quite a bit of interaction with EPA, particularly when we are trying to develop technology, prior to the formation of regulations.

We have done that several times, particularly with low NO_X burners. We provided the information that allowed them to provide a reasonable rule for low NO_X combustion.

We have done work that we have shared with EPA on air toxics, which basically allowed them to not regulate toxics, although we are working now on the possible regulation of mercury.

All of those things we do in conjunction with EPA, and EPRI has also been involved in some of those studies. We are looking at strategies for PM2.5 and particulate monitoring, also.

Mr. WHITFIELD. Mr. Lawson, in responding to a question asked by the chairman, he was talking about how coal use had doubled over the last number of years, while emissions had been reduced by 30 percent. I think everyone recognizes that significant progress has been made in the coal industry in cleaning up emissions.

But there also is the sense, that I certainly have and I think many people have, that EPA definitely does have a bias against coal. Now do you agree with that statement or not?

Mr. KRIPOWICZ. I know that they look at existing coal plants very, very strongly. But also, their regulations are regulations that can be met with existing technology. They also look at health effects.

Mr. WHITFIELD. I would just like to ask the rest of the members of the panel, do you think EPA has a bias against coal?

Mr. LAWSON. Well, let me give you one example, sir. We, the National Mining Association, own the three most sensitive air measurement devices in existence.

EPA, about 6 months ago, endeavored to put out a regulation that would have required a sensitivity that we did not have the capability to measure with the most sensitive devices existing in the world.

The people who made those devices for us said it would take another 3 years of technology improvement, before they would be able to measure to the degree that the EPA regulation was asking for, from coal-fired generation.

Mr. BAILEY. If I can add, I have been asked that question before. I am always reluctant to impart motives to people that I do not know that well.

Coal has been politically incorrect for probably a decade or two. That is the way I feel about it. Whether there is a deliberate agenda there, focused on coal-fired generation or not, the effect of that is, you feel the bias if you own a coal-fired power plant, right now.

I think one of the attachments to my written testimony shows all the regulatory programs that coal-fired power plants face, just in the next decade. Forget what has gone on in the past.

You can count probably a dozen programs that are going to regulate the same two pollutants: SO_2 and NO_X. At some point in time, those coal-fired power plants do become uneconomic, because of that.

Mr. WHITFIELD. Do you two remaining gentlemen have any comments on that subject?

Mr. GEHL. Yes, I would say that what we have tried to do is to take a look at the consequences of the various regulations. I think, along with Mr. Bailey, I am reluctant to assign motives. But the net effect of current and planned regulations would be to really make coal-fired generation an awful lot less economical than it is now.

There is a thought that we would do a lot better if the industry and the EPA collaborated more at the initial stages of developing recommendations, rather than have this analysis come in somehow in the middle of the process.

Mr. WHITFIELD. Mr. Schobert?

Mr. SCHOBERT. Well, like my previous colleagues here, I am not able to impart motives. But certainly, some of the activities undertaken by EPA have seemed wrong handed or downright bizarre; not the least of which is the recent attempt to declare coal ash as a hazardous waste.

If that were to take place, and utilities were to be faced with the cost of dealing with that as a toxic substance, the net effect to America is, the lights will go out.

Mr. WHITFIELD. Right, well, I agree. Last Fall, the EPA failed to support the policies adhered to by every Administration since 1977, regarding the application of the Clean Water Act valley fills. You could go on and on and on.

I mean, all of us are interested in cleaning up the environment. The industry has made great progress. They are reducing emission, using more coal, but EPA continues to push for standards even more strict than even the Clean Air Act calls for.

I think that they do have a bias. I hope that we can maintain a dialog with them to understand that this industry does provide about 51 percent of the electricity in the country. We are not going to get away from it. We need to work together in solving these problems, instead of adversely with each other.

Mr. BARTON. Does that conclude the gentleman's questions?

Mr. WHITFIELD. Yes, Mr. Chairman.

Mr. BARTON. Okay, the first gentleman from Ohio, Mr. Sawyer; and then we will go to the other gentleman from Ohio, Mr. Strickland.

Mr. SAWYER. Thank you, Mr. Chairman.

Secretary Kripowicz, you and others have talked a good deal about fluidized bed combustion and coal gasification. I gather from what you said that the actual applications, at this point, are at pilot or demonstration level or below.

Mr. KRIPOWICZ. Right.

Mr. SAWYER. Can you foresee for us the pathway from that level of application to widespread commercial application?

Mr. KRIPOWICZ. Yes, sir, fluidized beds are commercial, in small scale industrial plants, as well as in large scale utility boilers. So fluidized bed technology is commercial.

Mr. SAWYER. At the level of efficiency that you were talking about?

Mr. KRIPOWICZ. No, the efficiency of the fluidized bed combusters is roughly equivalent to that of pulverized coal plants.

Mr. SAWYER. I see.

Mr. KRIPOWICZ. But it does remove the vast amount of the sulphur and nitrogen oxides without scrubbers, so you have some advantage there.

For gasification, we have commercial scale demonstration plants. But what they need to do in today's market is compete with natural gas. At this point, the technology has not proven enough, and has not been replicated enough, to reduce the costs so that it will be competitive with natural gas.

We figure that that will take place over the next 10 years or so, but it is not something that is going to happen immediately. That is one of the focuses of our R&D program, to develop the technology that will produce that high efficiency and also reduce the capital costs.

Mr. SAWYER. General Lawson, Secretary Kripowicz mentioned that next week or so we are likely to be looking at a mark-up of an electric restructuring bill.

You mentioned assistance to the coal side of the industry from government. Have you given any thought to what form that should take, without upsetting the rest of the playing field, as we try to achieve a competitive restructured electrical environment?

Mr. LAWSON. We have done a good bit of work, both internally in the industry, as well as with the utilities, and some consultations with the other energies, as well.

We have a saying that we are pretty proud of. We think there is no such thing as a bad domestic energy. In an environment where you have to import 54 percent of your oil, it is quite clear that we are talking about rationalization, for the good of the country.

So we have put together a package that looks at tax incentives for certain kinds of technology introduction. We are in the process now of beginning the work on that, with the appropriate staffs. This staff will be one of the first stops in our effort.

Mr. SAWYER. If you could share materials on that with us, I would certainly appreciate it.

Mr. LAWSON. We surely will.

Mr. SAWYER. Thank you.

Dr. Schobert, you touched a subject close to my heart. I come from Akron, Ohio, where for 65 years, we have been learning how to build tires out of oil, because we knew we could not get latex during the war.

It is at the heart of what you are talking about. We use petroleum-derived feedstocks for hydrocarbon, and there are a wide range of synthetic materials that have come from this.

The kinds of materials that have been developed have just been amazing; just when you look at what things like Kevlar and Nomax have done.

Mr. SCHOBERT. Yes.

Mr. SAWYER. Those, actually, are first, earlier generation synthetic hydrocarbon materials. How would you compare the state-of-the-art with regard to the use of coal in developing similarly high performance materials, to those earlier generations of polymer-derived synthetics?

Mr. SCHOBERT. There is a tremendous opportunity to use coal in that application. It is in the early days of research and development. Basically, some of the molecular structures that can be derived from coal are in very high demand and very high price, as the building blocks to make the next generation of material.

If I could cite just one example, sir, a video tape made from this next generation would be half as thick, but twice as strong, as the existing plastic video tape. That would allow you to get 12 hours of Jerry Garcia on a cassette, instead of 6 hours.

But, again, I have to emphasize, it is in the early days. The potential is fantastic. Some figures are cited in my testimony. I could supply others, if you would like.

Mr. SAWYER. Could you have off-the-shelf materials that you could share, that I could make use of in a lay environment?

Mr. SCHOBERT. I believe so, sir.

Mr. SAWYER. I would appreciate that if you could pass them on. Thank you.

Mr. SCHOBERT. Yes, thank you, sir.

Mr. BARTON. Does that complete your questions?

Mr. SAWYER. Thank you, Mr. Chairman.

Mr. BARTON. The other gentleman from Ohio, Mr. Strickland, for 5 minutes.

Mr. STRICKLAND. Thank you, Mr. Chairman.

Mr. Bailey, one of the areas of regulatory uncertainty that utilities are facing is the NO_X SIP Call, as well as the EPA's action under Section 126 of the Clean Air Act.

The original NO_X SIP Call contained a deadline for individual sources covered by the SIP, such as electric generating units to implement the SIP's emission control requirements. That deadline was May 2003.

Legal challenges have ensured, and the situation is a little confusing and perhaps uncertain. For example, in March of this year, the DC Circuit sent certain aspects of the SIP Call back to EPA for more work. What was sent back included the very definition of electric generating unit, for example.

Nevertheless, it seems that EPA intends to require these reductions, under either Section 126 actions or the SIP Call or both, by May 2003.

I would like for you to share with us, if you would, if you think this compliance timeframe is reasonable, or if not reasonable, achievable.

In your testimony, you indicated that there could be potential for short term power supply interruptions. Could you please expand upon that concern.

Mr. BAILEY. I would be delighted to. The deadline currently is May 2003. So a number of coal-fired power plants around the country face a prospect of deciding what kind of technology to install, doing the engineering work on that, getting it constructed, and having it operating, by May 2003. Some of them have already begun that, and some of them have not.

Legally, and I am not a lawyer, so I will disqualify myself right there, but right now, as I understand it, EPA is going to ask the Court to lift the stay. Then they will talk about whether that 2003 deadline still makes sense. But that is essentially what we are facing, right now.

Do we consider that a rational deadline; no, in light of what needs to happen between that stay being lifted and in reducing NO_X emissions.

There have been a number of studies, as to whether that creates any concerns about reliability or electricity supply. Of course, several of them conflict with each other, which is the nature of this game.

We think the most definitive study on that was done by NERC recently, which put a lot of thought into it. They identified two regions of the country, ECAR and Maine, in which they saw the potential for outages.

Without getting into the all the technicalities of it, basically what they plan for is about one outage, every 10 years. That is what utilities plan for, and that is what these reliability regions plan for.

They were looking at the possibility of outages of up to one every 3½ months, in some regions of the country. So that is going from one every 10 years to one every 3½ months, depending on what kind of assumptions you make about the availability capacity.

So we are very, very concerned about that, right now. I do not know, quite frankly, how we are going to resolve it.

Mr. STRICKLAND. Thank you for that very candid answer.

The committee is going to be considering deregulation of the electric utility industry. Now we are being told that this is going to bring lower prices.

On the other hand, what seems to have been suggested, Mr. Bailey, by you and, I think, others, is that if we continue to pile environmental regulations on the industry, this could result in an increase in the electricity prices. Are we perhaps working at cross purposes?

Mr. BAILEY. We may be, if we are not very, very careful here. Again, there are a number of studies that look at the effect of environmental requirements. We have studied that, also.

Again, we are very concerned about the increase in cost. They are particularly considering what may be lack of commensurate benefits.

The studies that we have done show capital cost increases of something in the range of $22 billion. Now is without everything imposed on us. That is with most of what is in EPA's agenda, right now.

The annual costs on that are almost as high; somewhere in the range of $15 billion a year by the year 2010. So yes, if we do the wrong things environmentally, we are going to be wasting a lot of money here; that is right.

Mr. STRICKLAND. Mr. Chairman, I have one additional question.

Most of the fuel sources, Mr. Bailey, that you mentioned for electricity generation, and we are talking about nuclear and coal and hydro, are posed by one or more organizations. Nuclear, coal, and hydro, combined, account for about 86 percent of our electricity generation.

But if nuclear, coal and hydro capacity are reduced, what can replace that lost capacity? How can we replace 86 percent from the remaining possible sources? I think I see you smiling.

Mr. BAILEY. I am only smiling in response to other people on the subcommittee here.

I think nobody has the answer to that question. I have heard people from the other side try to address that. If I can say this, they seem rather uncomfortable responding to that question.

I do not know how we would provide the electricity, if we do not have all the sources. That is one of the points I am trying to make here.

We need to have a number of options in the market place. To some extent, the environmental policies will help us sort out those options. But we need to have a number of options. It is not good energy policy not to have a lot of options.

Mr. STRICKLAND. You know, that seems to be terribly important.

Mr. LAWSON. Excuse me, I was going say, on that same question, I have pressed the community very hard on that very issue. I come away with the very distinct impression that they are most willing to accept constraints on economic activity, as required in force by that kind of reduction. I am not sure the American people are willing to accept those kind of constraints, but I think they are.

Mr. STRICKLAND. Well, sir, I guess if you are living comfortably, and you have never actually been deprived, it may be easy to make those decisions for other folks.

I serve a region where one of my counties has 17.1 unemployment. We are the facing the loss of over 800 deep coal mining jobs, in the next 1½ years.

So I think these are terribly relevant questions. It seems to me that they are important enough that we ought to be trying to find answers to them.

Thank you for your comments and your opinions.

Thank you, Mr. Chairman.

Mr. BARTON. Thank you, Congressman Strickland.

We are going to have additional written questions for this panel, and we are going to conclude. I want to make just one concluding remark.

We really have not had an energy policy in the last 10 years, but we have had an environmental policy. The environmental policy has driven the energy policy.

Congressman Strickland's question kind of hit it right on the head. If we continue to allow the environmental policy to constrain the energy policy, there will be an economic consequence of that, as General Lawson pointed out, and it will not be positive. It will be negative.

So in our previous hearing, we talked about oil and gas issues. This hearing has been nuclear and coal. The next hearing we will hold will look at alternative fuel sources, conservation, and perhaps, electricity, as a stand-alone.

Then we will put our heads together, and see if we can come up with a draft legislative comprehensive energy policy to at least put out for discussion purposes, pending the next Administration.

So I want to thank you, again. I want to apologize to Dr. Schobert, if you took any personal offense at my allusion to you as Mr. Marks.

Mr. SCHOBERT. None, whatsoever.

Mr. BARTON. I certainly did not mean any personal offense.

We look forward to working with you in the months ahead, as we look at some drafts of our energy policy.

This hearing is adjourned.

[Whereupon, at 4:08 p.m., the subcommittee was adjourned.]

[Additional material submitted for the record follows:]

PREPARED STATEMENT OF THE URANIUM PRODUCERS OF AMERICA

The Uranium Producers of America is a trade organization representing the domestic uranium mining and milling industry. We respectfully submit this statement on behalf of the domestic uranium industry.

INTRODUCTION

Mr. Chairman, this hearing is extremely timely, as the domestic uranium and conversion industries face near devastation due to the introduction of overwhelming amounts of government uranium inventories into the commercial marketplace. Despite the fact that in 1999, nuclear power generated a record 23% of the electricity output for the United States, government actions have created a situation that could spell the end of the domestic nuclear fuel cycle industry. This turn of events is particularly troubling because Congress has directed the Department of Energy to assure its uranium inventory policies would be carried out in such a way as to not adversely impact the domestic uranium, conversion, and enrichment industries. As government inventories are dumped into the commercial marketplace, no producer, foreign or domestic, can produce uranium or conversion services at the current market price.

The worldwide need for energy is growing at a tremendous rate. According to a recent *Wall Street Journal* article, "[A]merica is running short of electricity."[1] The International Energy Agency of the Organization for Economic Cooperation and Development projects 65% growth in world energy demand by 2020. To meet this immense global demand for energy without damaging the environment, nuclear power must play a major role.

In the United States, nuclear safety and efficiency have improved significantly since 1990. Domestic nuclear utilities unit capacity factors have reached record levels in recent years. Despite a reduction in the number of nuclear power plants, the U.S. nuclear industry generated 9% more nuclear energy in 1999 than 1998. Average production costs for nuclear energy are now less than 2 cents per kilowatt hour,

[1] Rebecca Smith, "New Rules, Demands Put Dangerous Strains on Electricity Supply." *Wall Street Journal*, May 11, 2000.

while electricity produced from gas costs over 3 cents per kilowatt hour. Nuclear power and natural gas are the clean, secure fuels of the future.[2]

While it is evident that nuclear power should play an increasing role in meeting our nation's growing electricity requirements, the availability of a secure domestic source of fuel for the power reactors is very much at issue. I urge Congress and the Administration take an active role in crafting a solution to a predicament that threatens our national security and energy independence.

THE INTRODUCTION OF GOVERNMENT INVENTORIES HAS MATERIALLY IMPACTED THE DOMESTIC FUEL INDUSTRY

Two government initiatives have placed the future of the domestic uranium and conversion industries in peril.[3] The first was the U.S./Russian HEU Agreement (HEU Agreement) which provided for the blending down of nuclear weapons from the former Soviet Union into fuel for commercial reactors.[4] Our government has attempted to conduct this important non-proliferation policy concerning former Soviet nuclear weaponry by requiring the commercial marketplace to absorb this material. Thus, the domestic fuel industry has been required to bear the lion's share of the cost of the implementation of this program. Second, in an effort to maximize the value of the Enrichment Corporation's privatization, vast U.S. government inventories were transferred to USEC before the Corporation went public. These transfers were legitimized by a Department of Energy Secretarial Determination required to forecast the action would not adversely impact the domestic uranium and conversion industries. The Determination failed to consider numerous factors that have come to bear on the market.

Together these two initiatives have severely depressed the price of natural uranium and conversion services. The domestic industry was set to handle the market disruption caused by the HEU Agreement. However, the USEC transfers added to this program have reeked havoc on the commercial market price for uranium and conversion services. The depressed price threatens not only the viability of the domestic uranium and conversion industry, but ironically it also has negative implications on the U.S./Russian HEU Agreement because of the artificially low price for uranium feed material.

Primed with the material transferred by DOE, USEC's aggressive sale of government windfall uranium has overwhelmed the U.S. commercial fuel market. USEC is able to package this material with SWU, with little, if any, cost associated to the uranium and conversion component. This has resulted in uranium prices falling from approximately $16.50 per pound to at the time of USEC's privatization, approximately $8.00 on the spot market today. Conversion prices have plummeted in a similar fashion. DOE's determination of no adverse impact was certainly erroneous and incorrect.[5]

THE CASE FOR A SECURE DOMESTIC FUEL SUPPLY

Clearly, Congress must craft a comprehensive energy policy to respond to our nation's electricity needs crisis. We believe one component in such policy must be the assurance of a secure source of fuel for the nation's nuclear power reactors. The nuclear power industry has invested billions of dollars in capital costs. The reactors must have a secure source of fuel. While competitive priced fuel is an important factor for the nuclear utility industry, complete reliance on artificial supply, rather than competitive newly produced feed material is a recipe for disaster which will be experienced in the next three to five years when uncovered demand begins to occur in significant numbers.[6]

The question that Congress must answer is whether our nation needs secure domestic uranium and conversion industries. Our producers can compete in a realistic marketplace. However, if the Administration continues to burden the fuel industry with government inventories and non-proliferation programs that favor one part of

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[2] An extensive article highlighting the virtues of nuclear power can be found in the January/February 2000 *Foreign Affair* entitled "The Need for Nuclear Power."

[3] A comprehensive discussion of this point can be found in the testimony of Mark Stout on behalf of the Uranium Producers of America and James J. Graham on behalf of the domestic uranium conversion industry, presented to the Subcommittee on Oversight and Investigations of the Committee on Commerce, April 13, 2000.

[4] The HEU Agreement provided that the blending down of weapons grade material should be accomplished in a manner that would not adversely affect the domestic fuel industry.

[5] Exhibit 1 reflects the status of domestic uranium producers. Every U.S. producer that was in business at the date of the USEC privatization has either curtailed production or simply quit doing business.

[6] *See* Exhibit 2 (Estimated Uncovered Uranium Requirements (2000-2078)).

the fuel cycle over another, the demise of the entire industry will be a foregone conclusion.

In making this decision concerning the future of the domestic uranium and conversion industries, we believe Congress has already issued strong direction to the Department of Energy of a policy to maintain a viable domestic uranium industry.[7] The domestic industry negotiated in good faith to allow the HEU Agreement material and some U.S. government stockpiled material to enter the commercial market in a non-disruptive manner. Because DOE ignored this mandate by transferring in excess of 28,000 metric tons of uranium hexaflouride to USEC the domestic uranium producers and convertors face extinction.[8] Unfettered transfers of government inventories have effectively taken our market away. For this reason, DOE should replace the stockpiled material ill advisedly transferred to USEC, with newly mined uranium converted to UF_6. A reasonable domestic purchase program would provide sufficient material to support the nation's tritium and nuclear submarine programs. This program would allow the domestic production and conversion industries to survive until the market absorbs the artificial supply that has ruined the normal commercial marketplace.

We believe Congress and the nuclear utilities also recognize the benefit of a domestic source of production and conversion for our nation's reactors. While uranium production from foreign sources will meet a large share of the U.S. nuclear utilities needs, the existence of a viable domestic source of supply is invaluable in keeping the price of fuel competitive. Converdyn, the sole U.S. supplier of conversion services, represents approximately 60% of the conversion capacity in North America. The domestic uranium producers, given a level playing field, are capable of supplying 25% of annual reactor uranium needs. These figures are premised on competitive prices of uranium and conversion established by competitive costs of production. If the few remaining domestic producers are forced to close and reclaim their mines and the industry continues to consolidate, uranium could become a seller's market with market conditions unfavorable to U.S. utilities that would then be fully dependent on imported uranium.

This subcommittee is very familiar with the problems the American people have faced due to over reliance on foreign oil imports. The loss of the front end of the nuclear fuel cycle would likewise be injurious to electrical consumers. The domestic uranium industry has established a considerable resource that will be lost if nothing is done to resurrect this industry. An investment of approximately $6 billion dollars has been made to create our current uranium resource base. As producers close their operations, records, land positions, skilled human resources and permits will be irretrievably lost. At that point only significant price escalation would fire interest in restarting the domestic industry. Given that it can take in excess of ten years to permit a new mine and resource development may be forced to be created from ground zero, the ability of U.S. producers to create competitive uranium production when needed in the future is questionable at best regardless of a rising market price. The same would be true for the rebuilding of a new conversion facility. Permitting is an extremely time consuming process and the investment needed would require assurance that a reasonable price would be in the offing for a significant period of time. Clearly the nation's electrical needs and the utility industry would be better served to maintain the current fuel cycle infrastructure, than hoping to start it from scratch a few years in the future. The expenditure of funds today to preserve this industry from the misadventures caused by misuse of surplus government uranium stockpiles seems prudent if not essential.

We urge Congress and this subcommittee to take a strong leadership position in halting continuing programs that are exacerbating the demise of the uranium and conversion industries. Recently USEC, with at least some administrative agencies blessings, has proposed a purchase of Russian commercial SWU as a part of a larger market-based pricing arrangement under the HEU Agreement. This proposal may assist USEC, but has tremendous potential to further harm the domestic uranium and conversion industries.[9] The better course would be to bring this proposal into the light of day and determine whether it could benefit all of the front end cycle producers. For example, allowing domestic producers and the conversion supplier to

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[7] *See* 42 U.S.C. § 2297h-10(d).

[8] This equates to approximately 75 million pounds of uranium. EIA stated that USEC's inventories are sufficient to supply six-eight million pounds per year to the market over the next decade. As shown by Exhibit 2, utility uncommitted demand cannot absorb these supplies, especially when Russian HEU uranium and conventional production are interjected into the mix.

[9] Most of USEC's recent activity suggests it doesn't agree that a continuing domestic uranium and conversion industry is necessary. From the earliest date of enrichment privatization discussions, USEC has expressed interest in dominating all areas of the front end of the nuclear fuel cycle. This in itself should give rise to concerns of an anti-competitive future fuel market.

match newly produced feed material with Russian SWU could be a very inexpensive way to support the domestic industries while still achieving USEC's goal to reduce the price of HEU Agreement SWU.

To summarize, the domestic uranium industry can play an important role in fueling the clean, efficient electric power our nation demands. Given a level playing field, the domestic industry can compete economically with non-subsidized producers and assist in maintaining a competitive, secure source of fuel for our nation's nuclear power plants. Congress must do four things to assure our survival to accomplish this role. First, Congress must determine that the domestic uranium and conversion industries are worth saving. Second, Congress must insist that the Administration cease advancing programs, that while well-intended, subsidize one aspect of the front end of the nuclear fuel cycle to the detriment of the other critical players. Third, Congress and the Administration must set aside past ill-advised actions and recognize that reasonable fuel prices will benefit the domestic industries and the HEU Agreement. Finally, the domestic industry agreed to the introduction of Russian HEU material and a limited amount of U.S. stockpile inventories into the commercial market. However, because of USEC's aggressive sales of additional government transfers not anticipated in the 1996 Privatization Act, the domestic uranium and conversion markets have been devastated. Congress must redress this situation and create a program to get the producers and converter through the next three to five year period. At this time the market can work off the artificial components now experienced and fuel costs will once again reflect reasonable production costs. We would very much welcome the opportunity to work with Congress to accomplish this important task.

SUMMARY OF U.S. PRODUCTION CUTBACKS, DEFERRALS, AND WRITEDOWNS SINCE USEC PRIVATIZATION

Rio Algom Mining Corp.

Rio Algom Limited took approximately a $45 million writedown on the RAMC properties. Rio Algom Mining Corp. has indicated that it plans to decrease production from 1.8 million lbs. U_3O_8 in 1999 to around 1 million lbs. in 2000. RAMC's Wyoming Reynolds Ranch project has been deferred indefinitely pending an improvement in market conditions. RAMC's New Mexico Ambrosia Lake facility will be shut-in beginning in 2000. The Ambrosia Lake Facility produced approximately 250,000 lbs. in 1999.

Cameco/Power Resources, Inc.

In 1998, Power Resources made an announcement that they will keep Crow Butte production in Nebraska at 800,000 lbs. rather than ramp it up to the previously planned 1 million pounds. PRI also announced that its Wyoming Highland production will drop to 900,000 lbs. rather than the planned 1.5 million pounds. PRI continues to operate both facilities below maximum capacity levels.

Uranium Resources

In 1998, Uranium Resources, the only remaining producer in Texas, determined that it would operate Kingsville Dome/Rosita at minimum levels necessary to fill their sales commitments. After meeting their contractual requirements, URI shut-in their operations in the first quarter of 1999. The company also took an $18 million pretax writedown of the South Texas properties. The company relinquished its rights to the Alta Mesa deposit in Texas.

International Uranium Corp.

IUC, a Utah operator, shut-in its Sunday, GMG, and Rim mines in 1999. Their Topaz mine was also shut in recently.

Cogema, Inc.

Cogema announced plans to cease production at the Wyoming Christensen Ranch/Irigaray sometime during the fourth quarter of 2000.

U.S. Energy

In 1998, U.S. Energy announced that they had suspended development at their Jackpot uranium mine in Wyoming. The reason behind the suspension was directly related to the government's transfers of inventories to USEC. (Ux Weekly – August 3, 1998)

IMC-Agrico

IMC shut down its uranium production as a by-product of phosphate recovery at the Uncle Sam/Faustina located in Louisiana. There are no plans to restart production from these facilities.

Cotter Corporation

Cotter Corporation decided last month to shut in its Schwartzwalder mine located in Colorado.

Table C-13. Ux Uncovered Uranium Requirements Estimate, 2000-2010
(Quantities in million pounds U_3O_8)

Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
U.S. Utilities	1.5	8.5	14.2	28.4	36.7	46.4	51.0	49.0	49.8	53.4	50.6
Non-U.S. Utilities	2.3	11.8	18.2	24.5	30.3	51.7	61.3	64.6	70.2	72.0	77.1
Total Uncovered	3.8	20.3	32.3	52.9	67.0	98.0	112.3	113.6	120.0	125.3	127.7

Figure C-12. Ux Uncovered Utility Requirements, 2000-2010

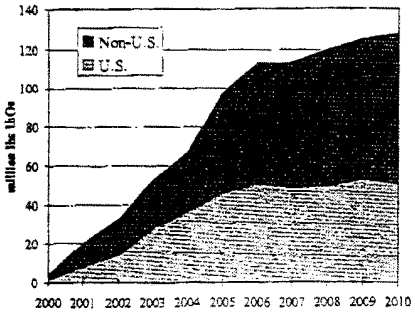

EXHIBIT
2