THE ROLE OF NUCLEAR POWER GENERATION IN A COMPREHENSIVE NATIONAL ENERGY POLICY

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND RESOURCES

OF THE

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THE ROLE OF NUCLEAR POWER GENERATION IN A COMPREHENSIVE NATIONAL ENERGY POLICY

THURSDAY, APRIL 28, 2005

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND RESOURCES,
COMMITTEE ON GOVERNMENT REFORM,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:10 a.m., in room 2247, Rayburn House Office Building, Hon. Darrell E. Issa (chairman of the subcommittee) presiding.

Present: Representatives Issa, Westmoreland, Watson, Higgins, and Kucinich.

Staff present: Larry Brady, staff director; Lori Gavaghan, legislative clerk; Dave Solan, Ph.D., Steve Cima, and Chase Huntley, professional staff members; Richard Butcher, minority professional staff; and Jean Gosa, minority assistant clerk.

Mr. ISSA. Good morning. My opening statement always says, "A quorum being present." It takes two for a quorum here, so we will skip that line. I have an opening, and I am going to put it in the record and be very brief. If the ranking member arrives before we begin testimony, that would be better. However, I don't want to abuse you of your time, and I definitely want to very much hear what you have to say and get to questioning. I can assure you we have had enough members respond that they will be here for Q&A, which seems to be the direction that Members prefer. So we will get to that as quickly as possible.

The reason for this hearing today is that our Nation's electricity demand continues to rise while, in fact, production from nuclear sources does not. According to the Department of Energy, 41 new 1,000 megawatt nuclear plants will be needed by the year 2025 just to maintain nuclear power's 20 percent share of our Nation's electricity generation. However, there hasn't been a new nuclear power plant built in three decades. There are none presently licensed to be built, and without re-licensing, or essentially extensions of their lives, a significant amount of capacity will go offline by 2025.

The growth in electricity demand, coupled with the retirement of older generation plants, means the Nation will need 281 million kilowatts, to put it in kilowatt terms, of new generation capacity—enough to power the State of California, which, of course, is the world's sixth largest economy if it were a separate nation. I always get that into every one of my opening lines, as a Californian.

I think it is important that we hear from you today about the role that nuclear power should play in America's future because we have oversight and because we are steering ourselves into a train wreck. And I think if there is any message that I would like to hear today, it would be what are the ramifications of our not acting. And as each of the distinguished individuals and I were talking about earlier, I think we also touched on the areas of global warming and our participation in it, and I hope that that will also come up.

[The prepared statement of Hon. Darrell E. Issa follows:]

COMMITTEE ON GOVERNMENT REFORM
SUBCOMMITTEE ON ENERGY AND RESOURCES

OPENING STATEMENT
CHAIRMAN DARRELL ISSA
APRIL 28, 2005

Our nation's electricity demand continues to grow as the population increases, the economy expands, and elements of our daily life become increasingly electrified. Official forecasts call for electricity use to increase 50 percent by 2025. The Department of Energy estimates that this growth in demand, coupled with the retirement of older plants, means that the nation will need 281 gigawatts of new electrical generation capacity—enough electricity to power another state the size of California. To satisfy the nation's growing appetite for electricity, the nation will need hundreds of new power plants of all types in the coming decades.

Nuclear power plants currently generate 20% of the nation's electricity. Projected growth in electricity demand, volatile fossil fuel prices, and environmental concerns have revitalized interest in nuclear generation in the U.S. and elsewhere in the world. Nuclear power is a proven, emission-free source of electricity that can contribute to the security of energy supplies and the stability of prices.

Today's operating nuclear power plants are workhorses in the U.S. electricity generation system, accounting for 20 percent of the nation's electricity, second only to coal. 103 reactors operating at 65 sites in 31 states produced more electricity in 2004 than the nation's entire electrical output in the early 1960s, when the first large-scale commercial reactors were ordered.

Nuclear power plants have a proven record of producing reliable, safe, and clean power. The nuclear industry in the U.S. can also point to decades of safe operation. Significant security upgrades introduced at all nuclear plants in the period following September 11 have gone a long way toward ensuring that nuclear power plants are among the most secure pieces of the country's civilian infrastructure. Moreover, nuclear plants operate with reliable operating costs that are relatively insulated from price fluctuations. Unlike fossil fuels, the availability and cost of uranium are stable and not likely to fall prey to cartels, embargoes, or price volatility. Perhaps most importantly, nuclear generation has also contributed considerable air quality benefits to the nation. Unlike electricity generated from coal and natural gas, nuclear energy does not result in any emissions of conventional air pollutants, such as nitrogen oxide and sulfur dioxide, nor of carbon dioxide.

Despite these projected demand increases and dramatic performance improvements, the nuclear power industry is expected to see its contribution in the nation's electricity portfolio diminish. 41 new 1,000 megawatt nuclear power plants are needed by 2025 just to maintain nuclear power's 20 percent share of the nation's electricity generation, yet the most recent new plant to come on-line did so in 1996, and no nuclear power plants have been ordered in the U.S. since 1978. Building the first new nuclear power plant in the U.S. in decades is regarded as a high-risk investment by both the nuclear power industry and the financial community, largely based on past experience.

Instead, fossil fuel-fired power plants account for almost 70 percent of the nation's electricity needs and, given current policies, are projected to continue to provide the lion's share in coming decades as additional natural gas plants are built.

Elsewhere in the world, however, nuclear power is moving ahead. Countries that once rejected nuclear power—such as Germany and Italy—are beginning to revise their policies. Moreover, as China and India develop, their electricity demand is projected to skyrocket and nuclear will play a large part in meeting that demand. China plans to commission 21 new plants between now and 2020, increasing the number of reactors in operation from 9 to 30. Furthermore, India's national energy policy calls for increasing the country's 2.5 gigawatt nuclear generating capacity one hundred-fold by 2050.

In the absence of an aggressive effort to expand the role of nuclear power, forecasts call for a rapid development of natural gas generating capacity which will require a dramatic increase in importation of natural gas from overseas sources—a market that seems likely to resemble that for petroleum in the immediate future, with prices being set in a tight world market and supplies being widely transported around the globe.

It is now clearer than ever that we must adopt a comprehensive national energy policy and establish a long-term strategy to ensure the stability of our economy and of our national interests. At the minimum, such a policy must expand domestic opportunities for production of traditional and non-traditional sources of energy while expanding conservation and efficiency efforts.

Considering whether and how to maintain or expand nuclear power's share of U.S. electricity generation in the coming decades, rather than allowing its share to shrink, is an essential component of crafting a comprehensive national energy policy. Accordingly, this hearing will attempt to identify the role of nuclear power in meeting America's electricity demand in the 21st century, the extent of the challenges faced by nuclear power generators, and determine how these issues may be addressed by a comprehensive energy policy.

We look forward to hearing testimony from our distinguished panel. We are pleased to have:

- **Dr. Donald Jones**, Vice President and Senior Economist at RCF Economic and Financial Consulting in Chicago. In 2003 and 2004, he co-directed, with George Tolley of the University of Chicago's Economics Department, the Chicago study of the future of nuclear power in the United States. Prior to joining RCF, he was a research staff member at Oak Ridge National Laboratory and served on faculty at the University of Chicago, the University of Colorado, and the University of Tennessee.

- **Mr. Marvin Fertel**, Senior Vice President for Business Operations and Chief Nuclear Officer at the Nuclear Energy Institute (NEI). Mr. Fertel is responsible for leading NEI's programs directed at increasing the value of existing nuclear energy industry assets and for developing policy initiative and industry programmatic activities that support the development of new commercial nuclear projects. Mr. Fertel has over 30 years of experience consulting to electric utilities on issues related to designing, siting, licensing and managing both fossil fuel and nuclear plants.

- **Dr. Patrick Moore** has been a leader in the international environmental field for over 30 years. He is a founding member of Greenpeace and served seven years as Director of Greenpeace International. As the leader of many campaigns Dr. Moore was a driving force shaping policy and direction while Greenpeace became the world's largest environmental activist organization. In recent years, Dr. Moore has been focused on the promotion of sustainability and consensus building among competing concerns. In 1991 Dr. Moore founded Greenspirit Strategies, a consultancy focusing on environmental policy and communications regarding natural resources, biodiversity, energy and climate change.

Mr. ISSA. Now, if I can just briefly introduce our guests. Donald Jones is vice president and senior economist at RCF Economics, a financial consulting firm in Chicago. In 2003 and 2004, he co-directed the study at the University of Chicago on the economic future of nuclear power in the United States. It couldn't have been more timely. Marvin Fertel is senior vice president of business operations and chief nuclear officer at the Nuclear Energy Institute. Mr. Fertel has over three decades experience—which means you actually remember when they last built a nuclear power plant—in consulting through electrical utilities on issues related to designing, siting, licensing, and managing both fossil fuels and nuclear power plants.

Last, and very important to me personally, and I thank you for being here, Dr. Patrick Moore has been a leader in the international environmental field for over 30 years. He is a founding member of Greenpeace and served 7 years as a director of Greenpeace International. In 1991, Dr. Moore founded Greenspirit Strategies, a consultancy focusing on environmental policy and communications.

With the indulgence of the minority staff, what we will do is return to the ranking member's opening statement upon her arrival, according to the rules.

With that, Mr. Jones, I would really appreciate if you would lead off.

For all the witnesses, your testimony will be put into the record. And as is this policy of this committee, if I could ask you each to raise your hands and be sworn, if that is acceptable.

[Witnesses sworn.]

Mr. ISSA. Please indicate that all have said I do. Thank you.

Mr. Jones.

STATEMENTS OF DONALD JONES, VICE PRESIDENT AND SENIOR ECONOMIST, RCF ECONOMIC AND FINANCIAL CONSULTING, INC.; MARVIN FERTEL, SENIOR VICE PRESIDENT FOR BUSINESS OPERATIONS, NUCLEAR ENERGY INSTITUTE; AND PATRICK MOORE, CHAIRMAN AND CHIEF SCIENTIST, GREENSPIRIT STRATEGIES LTD

STATEMENT OF DONALD JONES

Mr. JONES. Good morning, Mr. Chairman, members of the Subcommittee on Energy and Resources of the House Committee on Government Reform. I am Donald W. Jones, vice president of the RCF Economic and Financial Consulting, an economic research firm in Chicago which conducts analysis of energy and environmental issues, as well as other economic topics. Together with Dr. George S. Tolley, professor emeritus of economics at the University of Chicago, I co-directed the University of Chicago study of the economic future of nuclear power in the United States. My comments today are based on the findings of that study.

I have been asked to address the issue of policies that would be needed to foster the development of nuclear power and maintain a 20 percent nuclear share of electricity generation by 2020.

Because no construction has begun on a new nuclear plant in the United States since 1973, a number of uncertainties surround the construction of the first few new plants: the success of the new licensing procedure, the construction time, and the delivered cost of the new reactor designs. Uncertainty in an investment raises the cost of capital to a risky project so as to keep the expected rate of return at a level required by the capital market.

These uncertainties raise the cost of generating electricity from these plants above levels that would be competitive with electricity generated by coal- and gas-fired plants. Our calculations indicate that the first new nuclear plants could deliver electricity at costs of $53 to $71 dollars per megawatt hour, depending on reactor design and capital cost, while coal- and gas-fired plants would cost from $33 to $45 per megawatt hour.

The majority of these uncertainties could be resolved after the construction of the first several plants, and assuming they are resolved satisfactorily, the nuclear costs would fall well within the range of fossil-generated costs by the fourth or fifth new plant of a given design.

Table 1, to my right front, shows the progress of nuclear generation costs over the first eight plants of a reactor design with a capital cost of $1,500 per kilowatt of capacity. Learning and construction is assumed to reduce capital costs by 3 percent for each doubling of plants built, which is a conservative estimate of this learning effect according to United States and international experience. The generation costs in the right-most column of the table indicate that by the fourth or fifth new plant of this design, generation costs fall to $34 to $36 per megawatt hour, which is competitive with fossil-fired generation costs of $33 to $45 per megawatt hour. The nuclear plant's cost reductions derive from pay-off of first-of-a-kind-engineering [FOAKE], costs borne only on the first plant, shortening of construction time, investors' gaining the confidence needed to eliminate the risk premium and permit higher portions of debt financing, and learning in manufacturing and construction.

The first problem to be solved is getting from the first plant to the fourth plant. The Chicago study examined four financial assistance policies applied separately and in various combinations: a production tax credit equivalent to that currently offered to renewable energy development, an investment tax credit, accelerated depreciation, and loan guarantees. Table 2, to my left, reports the generation costs on a first plant achieved by each of these policies.

An effective combination is a 20 percent investment tax credit and a production tax credit of $18 per megawatt hour for 8 years with a cap of $125 million per plant per year. These would bring the cost of the first plants within the competitive range of coal- and gas-fired plants. Policies such as these should be needed only for the first four or five plants because of the cost reductions that can be expected after the first plant.

An important policy influencing the cost of new nuclear plants is the Nuclear Regulatory Commission's licensing procedure. The new process codified in 10 CFR Part 52 permits resolution of many of the uncertainties surrounding the construction and commissioning of a new nuclear plant prior to the times when major financial commitments must be made. Hopes are high for its successful implementation, but the system remains to be tested.

Several comparisons of generation costs illustrate the importance of this new procedure. Licensing that shortens construction time by 2 years and gives investors the confidence to reduce the risk premium on nuclear financing to the level on fossil-fired projects could reduce the generation cost of eight plants by 25 to 48 percent. Eliminating construction delays also has a significant effect on costs: a 2-year delay in the middle of a construction period would raise generation costs by 11 percent, while a similar delay at the end of construction would raise costs by 23 percent. The methodology of these calculations is reported in detail in the published report of the study, the Economic Future of Nuclear Power; A Study Conducted at the University of Chicago, dated August 2004.

Although it was not part of the formal study, our study team reviewed the subcommittee's question regarding what would be required to maintain the 20 percent contribution nuclear energy makes in meeting over electricity demand by 2020. According to projections of the growth of electricity generation capacity needed to satisfy demand growth, two to four new nuclear plants could need to come on line each year between 2015 and 2020 if the nuclear share of electricity generation is to remain at 20 percent.

This could amount to a total of 15 to 24 new plants, of 1,000 megawatts each, over a period of 6 years. One important point emerging from these numbers is that the number and pace of new plants is large enough to permit 5 to 10 percent cost reductions from learning by the fourth and fifth plants of a given type, which would be of considerable value in making those plants competitive.

Thank you very much, Mr. Chairman and subcommittee members. This concludes my written statement, and I would be happy to answer any questions you might have.

[The prepared statement of Mr. Jones follows:]

Policies to Support New Nuclear Plants in the United States

Statement of

Donald W. Jones
Vice President, RCF Economic and Financial Consulting

Subcommittee on Energy and Resources
of the
House Committee on Government Reform

April 28, 2005

Good morning, Mr. Chairman and members of the Subcommittee on Energy and Resources of the House Committee on Government Reform. I am Donald W. Jones, Vice President of RCF Economic and Financial Consulting, an economic research firm in Chicago which conducts analysis of energy and environmental issues, as well as other economic topics. Together with Dr. George S. Tolley, Professor Emeritus of Economics at The University of Chicago, I co-directed the University of Chicago study of the economic future of nuclear power in the United States. My comments today are based on the findings of that study.

I have been asked to address the issue of policies that would be needed to foster the development of nuclear power and maintain a 20 percent nuclear share of electricity generation by 2020.

Because no construction has begun on a new nuclear plant in the United States since 1973, a number of uncertainties surround the construction of the first few new plants—the success of the new licensing procedure, the construction time, and the delivered cost of the new reactor designs. Uncertainty in an investment raises the cost of capital to a risky project so as to keep the expected rate of return at a level required by the capital market. These uncertainties raise the cost of generating electricity from these plants above levels that would be competitive with electricity generated by coal- and gas-fired plants. Our calculations indicate that the first new nuclear plants could deliver electricity at costs of $53 to $71 per megawatt hour, depending on reactor design and capital cost, while coal- and gas-fired plants would cost from $33 to $45 per megawatt hour. The majority of these uncertainties could be resolved after the construction of the first several plants, and assuming they are resolved satisfactorily, the nuclear costs would fall to well within the range of fossil-generated costs by the 4th or 5th new plant of a given design. Table 1 shows the progress of nuclear generation costs over the first eight plants of a reactor design with a capital cost of $1,500 per kilowatt of capacity. Learning in construction is assumed to reduce capital costs by 3 percent for each doubling of plants built, which is a conservative estimate of this learning effect according to U.S. and international experience. The generation costs in the right-most column of the table indicate that by the 4^{th} or 5^{th} new plant of this design, generation cost falls to $34 to $36 per MWh, which is competitive with fossil-fired generation costs of $33 to $45 per MWh. The nuclear plant's cost reductions derive from pay-off of first-of-a-kind-engineering (FOAKE) costs borne only on the first plant, shortening of construction time, investors' gaining the confidence needed to eliminate the risk premium and permit higher proportions of debt financing, and learning in manufacturing and construction.

Table 1.

Generation Costs for Successive Nuclear Plants, First to Eighth Plants, for a $1,500 per kW Plant, with 3% Cost Reduction with Doubling of Plants Built due to Learning in Construction: $ per MWh, 2003 Prices

Plant	***Construction Time***	***Risk Premium on Debt and Equity***	***Debt Share of Financing***	***Generation Cost, $ per MWh***
1	*7 years*	*3%*	*50%*	62
2	*7 years*	*3%*	*50%*	51
3	*5 years*	*3%*	*50%*	45
4	*5 years*	*Gone*	*50%*	36
5	*5 years*	*Gone*	*60%*	34
6	*5 years*	*Gone*	*60%*	34
7	*5 years*	*Gone*	*70%*	32
8	*5 years*	*Gone*	*70%*	32

The first problem to be solved is getting from the first plant to the fourth plant. The Chicago study examined four financial assistance policies applied separately and in various combinations: a production tax credit equivalent to that currently offered to renewable energy development, an investment tax credit, accelerated depreciation, and loan guarantees. Table 2 reports the generation costs on a first plant achieved by each of these policies. An effective combination is a 20-percent investment tax credit and a production tax credit of $18 per megawatt hour for 8 years with a cap of $125 million per plant per year. These would bring the cost of the first plants within the competitive range of coal- and gas-fired plants. Policies such as these should be needed only for the first 4 or 5 plants because of the cost reductions that can be expected after the first plant.

Table 2.

Effectiveness of Financial Support Policies for First New Nuclear Plants

Policy for New Nuclear Plants	Generation Cost, $ per MWh, 2003 Prices		
	Nuclear with Policy	Coal-fired	Gas-fired
Production Tax Credit ($18/MWh for 8 years)	38-56	33-41	35-45
Investment Tax Credit (10 to 20 percent)	44-63		
Accelerated Depreciation (7 years or expensing)	47-67		
Loan Guarantee (25 to 50 percent)	50-67		
Combined Policies: Production Tax Credit Investment Tax Credit	31-46		

An important policy influencing the cost of new nuclear plants is the Nuclear Regulatory Commission's licensing procedure. The new process codified in 10 CFR Part 52 permits resolution of many of the uncertainties surrounding the construction and commissioning of a new nuclear plant prior to the times when major financial commitments must be made. Hopes are high for its successful implementation, but the system remains to be tested. Several comparisons of generation costs illustrate the importance of this new procedure. Licensing that shortens construction time by 2 years and gives investors the confidence to reduce the risk premium on nuclear financing to the level on fossil-fired projects could reduce the generation cost of 8^{th} plants by 25 to 48 percent. Eliminating construction delays also has a significant effect on costs: a 2-year delay in the middle of a construction period would raise generation costs by 11 percent, while a similar delay at the end of construction would raise costs by 23 percent. The methodology of these calculations is reported in detail in the published report of the study, *The Economic Future of Nuclear Power; A Study Conducted at The University of Chicago*, dated August 2004.

Although it was not part of the formal study, our study team reviewed the Subcommittee's question regarding what would be required to maintain the 20 percent contribution nuclear energy makes in meeting overall electricity demand by 2020. According to projections of the growth of electric generation capacity needed to satisfy demand growth, 2 to 4 new nuclear plants could need to come on line each year between 2015 and 2020 if the nuclear share of electricity generation is to remain at 20 percent. This could amount to a total of 15 to 24 new plants, of 1,000 Megawatts each, over a period of 6 years. One important point emerging from these numbers is that the number and pace of new plants is large enough to permit 5- to 10-percent cost reductions from learning by the 4^{th} and 5^{th} plants of a given type, which would be of considerable value in making those plants competitive.

Thank you very much, Mr. Chairman and Subcommittee members. This concludes my written statement, and I would be happy to answer any questions you might have.

Mr. ISSA. Thank you.
Mr. Fertel.

STATEMENT OF MARVIN FERTEL

Mr. FERTEL. Thank you, Chairman Issa. I am Marvin Fertel. I am senior vice president and chief nuclear officer at the Nuclear Energy Institute. And on behalf of our members, I thank you for the opportunity to be here today.

NEI is responsible for developing policy for the U.S. nuclear industry. Our organization's 270 member companies represent a spectrum of interests, including every U.S. energy company that operates a nuclear power plant.

America's 103 nuclear power plants are right now the most efficient and reliable in the world. Our nuclear energy is the largest source of emission-free electricity in the United States and our second largest source of electricity overall after coal. Nuclear power plants in 31 States currently provide electricity for one of every five U.S. homes and businesses.

Given these facts and the strategic importance of nuclear energy to our Nation's energy security and economic growth, NEI encourages Congress to maintain policies that ensure continued operation of our Nation's operating plants, and to provide an impetus required to expand emission-free nuclear energy as a vital part of our Nation's diverse energy mix.

Last week, the House of Representatives demonstrated strong support for nuclear energy's role when it passed H.R. 6.

This morning, I would like to address three major areas: first, the strategic value of nuclear power plants as a source of safe, reliable, and stable electricity; second, industry initiatives to ensure continued operation of today's nuclear plants; and, third, the importance of strong congressional oversight to ensure effective and efficient implementation of the Federal Government's responsibilities that affect nuclear energy programs.

As I mentioned, nuclear power represents 20 percent of U.S. electricity power today. It did 10 years ago also. And basically over that period we have increased demand for electricity in our country by 25 percent.

We are able to maintain our market share thanks to dramatic improvements in reliability, safety, and productivity of our current fleet of plants, which today operate at about 90 percent capacity, which means they are on line and operating 90 percent of the time, 24 hours a day, 365 days a year. Improved productivity at our plants have satisfied 20 percent of the growth in electricity demand over the last decade.

Nuclear power serves a number of other important national needs. First, nuclear power plants contribute to the fuel and technology diversity that is the core strength of the U.S. electricity supply system. Our position is that we need nuclear, coal, renewables, gas, and any other source, and you just have to have the right mix and use them for the right purposes.

Second, nuclear power plants provide future price stability that is not available from electric generating plants fueled, say, with natural gas and, in today's market, with coal. Intense volatility in natural gas prices over the last several years is likely to continue thanks partly to unsustainable demand for natural gas from the electric sector. Nuclear plants reduce the pressure on natural gas supply, thereby relieving cost pressures on other non-electric uses for natural gas where you don't have alternative fuel sources.

Third, nuclear power plays a strategic role in meeting U.S. clean air goals and the Nation's goal of reducing greenhouse gas emissions. Without our current nuclear plants, greenhouse gas emissions from the electric sector would be 30 percent higher today. New nuclear power plants reduce electricity that otherwise would be supplied by oil-, gas-, or coal-fired generating capacity, and thus avoid the emissions associated with that fossil-fueled capacity.

Overall, we believe nuclear power represents a unique value proposition. It provides large volumes of electricity cleanly, reliably and safely, and, most importantly, also affordably; it provides future price stability and serves as a hedge against price and supply volatility; and nuclear plants have valuable environmental attributes and they help preserve our Nation's energy security. These demonstrated characteristics of why nuclear power has such strategic importance in our overall U.S. energy policy.

The 103 operating plants are valuable today. The chairman mentioned renewing licenses, and what I would like to say is we are actually making very good progress on that. Two-thirds of the 103 units have either renewed their license, announced they are going to renew their license, or are in the process of getting reviewed, and our expectation is that every 1 of the 103 plants will renew their license. They are licensed for 40 years. The NRC can renew the license for another 20 years after their reviews, and, to be honest, they can renew it for 20 years after that if you wanted to do that.

Despite the dramatic gains in reliability and productivity at our operating plants, there are obvious limits to how much additional electricity they can produce, so meeting the Nation's growing demand for electricity, which according to the Energy Information Administration will require between 230,000 and 330,000 megawatts additional by 2025, we believe will require the construction of new nuclear plants in this country.

New plants would provide Americans with low-cost, safe, and reliable electricity; would bring long-term price stability to electricity; and prevent the emission of air pollutants and greenhouse gases. In addition, new plant construction would create thousands of skilled, high-tech jobs and help us rebuild our manufacturing facilities in this country, which we have lost.

A program of a new nuclear plant construction is absolutely necessary for the United States to regain its technological leadership in this high-tech field. The nuclear energy industry and the Department of Energy launched a program several years ago that will position the industry to build new nuclear plants when needed and when the business conditions are right. This is a comprehensive program designed to achieve the business issues, including licensing and regulatory issues mentioned by Dr. Jones, development of new plant designs and financing that could be roadblocks to new nuclear plant construction.

The overall objective for this joint industry-government initiative is to ensure that new nuclear plants can be operational in the 2010 to 2020 timeframe in this country. Industry and government will be prepared to meet the demands for new emission-free base load plants in that timeframe only through a sustained focus on the necessary programs and policies between now and then.

As it has in the past, strong congressional oversight will be necessary to ensure effective and efficient implementation of the Federal Government's nuclear energy programs, and to maintain America's leadership in nuclear technology development and its influence over other important diplomatic initiatives like nonproliferation.

Nowhere is this more important than with the Department of Energy's program to manage the used nuclear fuel from our nuclear power plants.

Continued progress toward a Federal used nuclear fuel repository is necessary to support nuclear energy's vital role in a comprehensive national energy policy.

Since enactment of the 1982 Nuclear Waste Policy Act, DOE's nuclear fuel management program has overcome many challenges, and challenges remain before the Yucca Mountain facility can begin operations. But as we address these issues, it is important to keep the overall progress of the program in context.

First, there is international scientific consensus that a deep geologic repository is the best solution for long-term disposition of any waste from any nuclear power facility, that is, whether you recycle it or you do a once-through fuel cycle. You still need a deep geologic repository.

Second, the Bush administration and Congress, with strong bipartisan support, affirmed the suitability of Yucca Mountain for a repository in 2002. Over the past 3 years, the Energy Department and its contractors have made considerable progress providing yet greater confirmation that Yucca Mountain is an appropriate site.

Third, during the past year, Federal courts have rejected significant legal challenges by the State of Nevada and others to the Nuclear Waste Policy Act and the 2002 Yucca Mountain suitability determination.

In the coming year, Congress will play an essential role in keeping this program on schedule by taking steps necessary to provide increased funding for the project in fiscal year 2006 and years beyond.

The industry urges the Congress to support the administration's proposal to change the funding mechanism for the Yucca Mountain program so that consumer payments to the Nuclear Waste Fund can be used only for the project and excluded from traditional congressional budget caps. Although the program should remain subject to congressional oversight, Yucca Mountain appropriations should not compete each year for funding with unrelated programs when Congress directed a dedicated funding stream for the project.

Industry also believes that it is appropriate and necessary to consider alternative approaches to the Yucca Mountain project. These alternatives could include an extended period for monitoring operation of the repository for up to 300 years or longer, other things as far as retrievability, and concepts like waste treatment and conditioning. What should be done is what is necessary to enhance safety and public confidence in the safety of the repository.

Congressional oversight can also play a key role in maintaining and encouraging the transparency and stability of the Nuclear Regulatory Commission's regulatory process. Such stability is essential for our 103 operating nuclear plants and equally critical in licensing new nuclear plants.

Congress played a key role several years ago in encouraging the NRC to move toward a new oversight process for the Nation's nuclear plants, based on quantitative performance indicators and safety significance. Today's reactor oversight process focuses industry and NRC resources on equipment, components and operational issues that have the greatest importance to safety.

The need for regulatory stability is particularly acute today in the area of nuclear plant security.

The NRC and the industry have worked hard to identify and implement new and extensive security requirements at our plants. In the 3½ years since September 11, the NRC has issued a series of requirements to increase security and enhance training for security programs. The industry has complied fully and rapidly.

The industry has spent more than $1 billion enhancing security since September 11. We have identified and addressed potential vulnerabilities. Today, 3½ years after September 11, the industry is at almost the practical limits of what a private industry can do to secure these facilities. We need to fully incorporate the new significant changes into our operations and emergency planning programs, and increase our proficiency in executing the programs to meet the high expectations of the NRC.

Both industry and the NRC need congressional oversight to support and encourage this kind of stability.

In conclusion, the public sector, including the oversight committees of the U.S. Congress, can help maintain the conditions that ensure Americans will continue to reap the benefits of nuclear energy in the years ahead.

The passage of comprehensive energy legislation that recognizes nuclear energy's contributions to meeting our growing energy demands, ensuring our energy security, and protecting our environment is an important step.

Equally important, however, is the need to ensure effective and efficient implementation of existing laws, like the Nuclear Waste Policy Act, and to provide Federal agencies with the resources and oversight necessary to discharge their statutory responsibilities.

The commercial nuclear power sector was born in the United States, and nations around the world continue to look to the United States for leadership in this technology and in the issues associated with nuclear power. Our ability to influence critical international policies in areas like nuclear nonproliferation depend on our ability to maintain a leadership role in prudent deployment, use and regulation of nuclear energy technologies here at home, and on our ability to manage the technological and policy challenges, like waste management, that arises with all advanced technologies.

This is a broad responsibility and, in the case of nuclear energy, rests equally on the shoulders of industry, government agencies like the Department of Energy and the Nuclear Regulatory Commission, and the appropriate committees of Congress.

Thank you very much for the opportunity to say this.

[The prepared statement of Mr. Fertel follows:]

TESTIMONY FOR THE RECORD

SUBMITTED BY
MARVIN S. FERTEL
SENIOR VICE PRESIDENT AND CHIEF NUCLEAR OFFICER
NUCLEAR ENERGY INSTITUTE

BEFORE THE
SUBCOMMITTEE ON ENERGY RESOURCES
COMMITTEE ON GOVERNMENT REFORM
UNITED STATES HOUSE OF REPRESENTATIVES

APRIL 28, 2005

Chairman Issa, Ranking Member Watson and distinguished members of the subcommittee, I am Marvin Fertel, senior vice president and chief nuclear officer at the Nuclear Energy Institute (NEI). NEI appreciates the opportunity to provide this testimony for the record on the role of nuclear energy in U.S. energy policy, on the value of our 103 operating nuclear power plants, and on the strategic importance of building new nuclear power plants in the years ahead.

NEI is responsible for developing policy for the U.S. nuclear industry. Our organization's 250 member companies represent a broad spectrum of interests, including every U.S. energy company that operates a nuclear power plant. NEI's membership also includes nuclear fuel cycle companies, suppliers, engineering and consulting firms, national research laboratories, manufacturers of radiopharmaceuticals, universities, labor unions and law firms.

America's nuclear power plants are the most efficient and reliable in the world. Nuclear energy is the largest source of emission-free electricity in the United States and our nation's second largest source of electricity after coal. Nuclear power plants in 31 states provide electricity for one of every five U.S. homes and businesses. Eight out of 10 Americans believe nuclear energy should play an important role in the country's energy future.[1]

Given these facts and the strategic importance of nuclear energy to our nation's energy security and economic growth, NEI encourages Congress to maintain policies that ensure continued operation of our nation's nuclear plants, and to provide the impetus required to expand emission-free nuclear energy as a vital part of our nation's diverse energy mix.

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[1] Bisconti Research Inc./NOP World, October 2004, 1,000 U.S. adults

Last week, the U.S. House of Representatives demonstrated strong support for nuclear energy's role with passage of comprehensive energy policy legislation, H.R. 6. That legislation includes a number of major policy initiatives necessary to carry this technology forward into the 21st century as a major contributor to U.S. electricity supply. Provisions supporting nuclear energy include renewal of the Price-Anderson insurance framework, which provides immediate coverage to the public in the case of nuclear reactor incident; an expanded research and development portfolio; support for universities; and updated tax treatment of nuclear decommissioning funds to reflect today's competitive electricity business.

NEI's testimony for the record will address three major areas:

1. America's nuclear power plants have a strategic value as a source of safe, reliable, clean electricity at stable prices.
2. Industry initiatives to ensure continued operation of today's nuclear plants at sustained, high levels of performance, and to prepare for construction of new nuclear power plants.
3. The importance of strong congressional oversight to ensure effective and efficient implementation of the federal government's nuclear energy programs, and to maintain America's leadership in nuclear technology development and its influence over important diplomatic initiatives like nonproliferation.

THE STRATEGIC VALUE OF NUCLEAR ENERGY

The United States has 103 nuclear reactors operating today. Nuclear power represented 20 percent of U.S. electricity supply 10 years ago, and it represents 20 percent of our electricity supply today, even though we have six fewer reactors than a decade ago and total U.S. electricity supply has increased by 25 percent in the period.

Nuclear power has maintained its market share thanks to dramatic improvements in reliability, safety, productivity and management of our nuclear plants, which today operate, at an average 90 percent capacity factor, year in and year out. Improved productivity at our nuclear plants satisfied 20 percent of the growth in electricity demand over the last decade.

The increase in output from U.S. nuclear plants in the past 10 years—from 640 billion kilowatt-hours in 1994 to 789 billion kilowatt-hours in 2004—is approximately equivalent to bringing 18 new 1,000-megawatt power plants (operating at a 90 percent capacity factor) into service.

Nuclear energy serves a number of important national needs.

First, nuclear power plants contribute to the fuel and technology diversity that is the core strength of the U.S. electric supply system. This diversity is at risk because today's business environment and market conditions in the electric sector make investment in large, new capital-intensive technologies difficult, particularly in the advanced nuclear power plants and advanced coal-fired power plants best suited to supply baseload electricity. More than 90 percent of all new electric generating capacity added over the past five years is fueled with natural gas. Natural gas has many desirable characteristics and should be part of our fuel mix, but over-reliance on any one fuel source leaves consumers vulnerable to price spikes and supply disruptions.

Second, nuclear power plants provide future price stability that is not available from electric generating plants fueled with natural gas. Intense volatility in natural gas prices over the last several years is likely to continue, thanks partly to unsustainable demand for natural gas from the electric sector, and such price volatility subjects the U.S. economy to potential damage. The operating costs of nuclear power plants are stable and can dampen volatility of consumer costs in the electricity market.

Third, nuclear plants reduce the pressure on natural gas supply, thereby relieving cost pressures on other users of natural gas that have no alternative fuel source.

Fourth, nuclear power plants play a strategic role in meeting U.S. clean-air goals and the nation's goal of reducing greenhouse gas emissions. Nuclear power plants produce electricity that otherwise would be supplied by oil-, gas- or coal-fired generating capacity, and thus avoid the emissions associated with that fossil-fueled capacity.

The emissions avoided by U.S. nuclear power plants are essential in meeting clean-air regulations. In 2003, U.S. nuclear power plants avoided the emission of about 3.4 million tons of sulfur dioxide (SO_2) and about 1.2 million tons of nitrogen oxide (NOx). To put these numbers in perspective, the requirements imposed by the 1990 Clean Air Act amendments reduced SO_2 emissions from the electric power sector between 1990 and 2001 by about 5 million tons per year and NOx emissions by about 2 million tons year.[2] Thus, in a single year, nuclear

[2] "EPA Acid Rain Program: 2001 Progress Report," U.S. Environmental Protection Agency, November 2002.

power plants avoid nearly as much in emissions as was reduced over an 11-year period by other sources.

The NOx emissions avoided by U.S. nuclear plants are equivalent to eliminating NOx emissions from six out of 10 passenger cars in the United States. The carbon emissions avoided by U.S. nuclear power plants are equivalent to eliminating the carbon emissions from nine out of 10 passenger cars in the United States. Without our nuclear power plants, greenhouse gas emissions from the electric power sector (which represents approximately one-third of U.S. greenhouse gas emissions) would be approximately 30 percent higher

Finally, nuclear energy is a secure domestic source of energy, and the United States is not alone in recognizing its importance to national security. The decision to employ nuclear power as a major energy source in countries such as France and Japan was based on energy security. The governments of both countries recognize that nuclear energy would protect their nations' energy supplies from disruptions resulting from political instability and protect consumers from price fluctuations resulting from market volatility. Today, France depends on nuclear energy to meet more than three-quarters of its electricity demand, and Japan for more than one-quarter.

Despite the strong international commitment to nuclear power, evidenced by the 26 nuclear reactors under construction today around the world, the U.S. nuclear energy sector remains by far the world's largest in terms of electricity production—larger than the nuclear sectors of France and Japan combined.

In summary, nuclear energy represents a unique value proposition. Nuclear power plants provide large volumes of electricity—cleanly, reliably, safely and affordably. They provide future price stability and serve as a hedge against price and supply volatility. Nuclear plants have valuable environmental attributes. And they help preserve our nation's energy security. These characteristics demonstrate why nuclear energy has such strategic importance in U.S. energy policy.

Thanks to excellent plant performance and growing awareness of nuclear energy's benefits, public support for nuclear energy is at an all-time high. The industry has monitored public opinion closely since the early 1980s, and two key trends are clear: First, public favorability to nuclear energy has never been higher. Second, the spread between those who support the use of nuclear energy and those opposed is widening steadily—80 percent of Americans think nuclear power is important for our energy future, and 67 percent favor the use of nuclear energy. Seventy-one percent favor keeping the option to build more nuclear power plants. Six in 10 Americans agree that "we should definitely build more nuclear power plants in the future." And 62 percent said it would be acceptable to build new plants next to a nuclear power plant already operating.[3]

INDUSTRY INITIATIVES TO INCREASE NUCLEAR ENERGY PRODUCTION AND PREPARE FOR NEW NUCLEAR POWER PLANT CONSTRUCTION

The 103 operating nuclear plants are such valuable electric generating assets that virtually all companies are planning to renew the operating licenses for these plants, as allowed by law and Nuclear Regulatory Commission regulations, and operate for an additional 20 years beyond their initial 40-year license terms. Seventy U.S. reactors have now renewed their licenses, filed their formal applications, or indicated to the NRC that they intend to do so. We believe that virtually all U.S. nuclear plants will renew their licenses and operate for an additional 20 years.

In order to maintain safety and reliability, and to prepare the plants for an additional 20 years of operation, the industry is investing substantial sums in large capital improvement projects, including installation of new steam generators, new reactor vessel heads and other modifications to increase plant generating capacity.

These capital improvement projects position the plants for many years of operation in the future at high levels of reliability and safety, and they demonstrate the industry's commitment to making the capital investments necessary to maintain safety and reliability.

Although it has not yet started to build new nuclear plants, the industry continues to achieve small but steady increases in generating capacity—either through power uprates or the restart of shutdown nuclear capacity. An uprate increases the flow of steam from the nuclear reactor to the turbine-generator so that the plant can produce more electricity. Uprates can increase a plant's capacity up to 20 percent, depending on plant design and how much capital a company is prepared to invest. Over the past several years, the NRC has authorized power uprates that represent approximately 2,000 megawatts of additional generating capacity. Over the next five years, the NRC anticipates that companies will apply for approximately 30 power uprates, which could add an additional 2,000 megawatts of new capacity.

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[3] Bisconti Research Inc./NOP World, October 2004, 1,000 U.S. adults.

In addition, the Tennessee Valley Authority is restarting Unit 1 at its Browns Ferry site in northern Alabama. This is a very complex project—fully as challenging as building a new nuclear plant—and it is on schedule and within budget at the midpoint of the project.

However, there are obviously limits on how much additional electricity output the existing 103 nuclear power plants can produce. Meeting the nation's growing demand for electricity—which will require between 229,000 megawatts and 334,000 MW by 2025, depending on assumptions about electricity demand growth—will require construction of many new nuclear power plants in the years ahead. [4]

The factors that make operating nuclear power plants a strategic national asset also justify a systematic, disciplined program to build new nuclear power plants in the years ahead to help meet growth in electricity demand. New nuclear plants would provide Americans with low-cost, safe and reliable electricity; bring long-term price stability to electricity markets; and prevent emission of air pollutants and greenhouse gases. In addition, new nuclear plant construction would create thousands of skilled, high-tech jobs—to design and build the plants, manufacture the equipment and fuel, and operate the plants when built. A program of new nuclear plant construction would maintain U.S. technological leadership in this high-tech field.

The nuclear energy industry and the Department of Energy launched a program several years ago that will position the industry to build new nuclear capacity when it is needed, by creating the business conditions under which companies can order new nuclear plants.

This is a comprehensive program designed to address the business issues—including licensing and regulatory issues, development of new plant designs, and financing—that could be roadblocks to new nuclear plant construction.

The United States has a new licensing process created by the 1992 Energy Policy Act. Under this process, we obtain all necessary regulatory approvals from the NRC before significant capital is committed. Sites can be approved in advance. Reactor designs can be approved in advance. And new nuclear plants will receive a single license for construction and operation—not the separate proceedings that created excessive delay in the period between construction and operation of many of today's plants.

This approach should limit the regulatory risks that impacted the construction and licensing of many of our operating plants. This process also allows meaningful input from the

[4] "Annual Energy Outlook 2005," Energy Information Administration.

public and other stakeholders early on, before the plant is built, at a time when such input can influence plant design and licensing issues. This should avoid the costly delays common to the old way of licensing a nuclear plant. Because the old licensing process was a two-step process and did not require all the design and engineering to be complete when the construction permit was issued, it often resulted in extensive public hearings and public input after the plant was built and before it was allowed to operate.

The industry is now in the process of validating this new licensing process. In 2003, three companies—Dominion, Exelon and Entergy—initiated a three-year effort to obtain NRC approval for early site permits. Basically, the companies will be "banking" those sites for possible future use, deferring their decision to build reactors until later.

Three industry consortia, consisting of 16 energy companies, construction firms, architect/engineers, fuel companies and equipment suppliers, have responded to a DOE request for proposals to share the cost of obtaining a combined construction/operating license (COL). (Obtaining a COL will require a substantial investment of design and engineering work on new nuclear reactor designs.)

The design, engineering and licensing work that must be completed before new nuclear plants can be built and ordered is a substantial investment. It will cost $400 million to $500 million to complete the licensing demonstrations and the first-of-a-kind design and engineering for one reactor design. The industry would expect to share that cost with the federal government under DOE's Nuclear Power 2010 program. The private sector would therefore commit the equivalent of $200 million to $250 million to the effort. To carry two new designs forward, the private sector commitment would be $400 million to $500 million.

It is critically important, therefore, that the government provide adequate funding for the DOE Nuclear Power 2010 program.

The overall objective for this industry initiative is to ensure new nuclear plants can be operational between 2010 and 2020. This will require an aggressive program of design, engineering and licensing work that must be completed before companies can place orders and invest in construction.

At that time, three factors—growth in electricity demand, increasingly stringent environmental controls on coal-fired and gas-fired generating capacity, and continued pressure on natural gas supply and prices—will make construction of new nuclear generation an imperative.

THE IMPORTANCE OF STRONG CONGRESSIONAL OVERSIGHT

Industry and government will be prepared to meet the demand for new emission-free baseload nuclear plants in the 2010 to 2020 time frame only through a sustained focus on the necessary programs and policies between now and then.

As it has in the past, strong Congressional oversight will be necessary to ensure effective and efficient implementation of the federal government's nuclear energy programs, and to maintain America's leadership in nuclear technology development and its influence over important diplomatic initiatives like nonproliferation. Such efforts have provided a dramatic contribution to global security, as evidenced by the U.S.-Russian nonproliferation agreement to recycle weapons-grade material from Russia for use in American reactors. Currently, more than 50 percent of U.S. nuclear power plant fuel depends on converted Russian warhead material.

Nowhere is continued congressional oversight more important than with DOE's program to manage the used nuclear fuel from our nuclear power plants.

Continued progress toward a federal used nuclear fuel repository is necessary to support nuclear energy's vital role in a comprehensive national energy policy and to support the remediation of DOE defense sites.

Since enactment of the 1982 Nuclear Waste Policy Act, DOE's federal repository program has repeatedly overcome challenges, and challenges remain before the Yucca Mountain facility can begin operation. But as we address these issues, it is important to keep the overall progress of the program in context.

- There is international scientific consensus that a deep geologic repository is the best solution for long-term disposition of used military and commercial nuclear power plant fuel and high-level radioactive byproducts.
- The Bush administration and Congress, with bipartisan support, affirmed the suitability of Yucca Mountain for a repository in 2002. Over the past three years, the Energy Department and its contractors have made considerable progress providing yet greater

confirmation that this is the correct course of action and that Yucca Mountain is an appropriate site for a national repository.

- During the past year, federal courts have rejected significant legal challenges by the state of Nevada and others to the Nuclear Waste Policy Act and the 2002 Yucca Mountain site suitability determination. These challenges questioned the constitutionality of the Yucca Mountain Development Act and DOE's repository system, which incorporates both natural and engineered barriers to contain radioactive material safely.

In the coming year, Congress will play an essential role in keeping this program on schedule, by taking the steps necessary to provide increased funding for the project in fiscal 2006 and in future years.

Meeting DOE's schedule for initial repository operation requires certainty in funding for the program. This is particularly critical in view of projected annual expenditures that will exceed $1 billion beginning in fiscal 2007. Meeting these budget requirements calls for a change in how Congress provides funds to the project from monies collected for the Nuclear Waste Fund. The history of Yucca Mountain funding is evidence that the current funding approach must be modified.

Consumer fees (including interest) committed to the Nuclear Waste Fund since its formation in 1983 total more than $24 billion. Consumers are projected to pay between $750 million to $800 million to the fund each year, based on electricity generated at the nation's 103 reactors. This is more than $2 million per day. Although about $8 billion has been used for the program, the balance in the fund is nearly $17 billion. In each of the past several years, there has been a gap between the annual fees paid by consumers of electricity from nuclear power plants and disbursements from the fund for use by DOE at Yucca Mountain.

Since the fund was first established, billions of dollars paid by consumers of electricity from nuclear power plants to the Nuclear Waste Fund—intended solely for the federal government's used fuel program—in effect have been used to decrease budget deficits or increase surpluses.

The industry believes that Congress should change the funding mechanism for Yucca Mountain so that payments to the Nuclear Waste Fund can be used only for the project and be excluded from traditional congressional budget caps. Although the program should remain subject to congressional oversight, Yucca Mountain appropriations should not compete each year for funding with unrelated programs when Congress directed a dedicated funding stream for the project.

The industry also believes that it is appropriate and necessary to consider an alternative perspective on the Yucca Mountain project. This alternative would include an extended period for monitoring operation of the repository for up to 300 years after spent fuel is first placed underground. The industry believes that this approach would provide ongoing assurance and greater confidence that the repository is performing as designed, that public safety is assured, and that the environment is protected. It would also permit DOE to apply evolving innovative technologies at the repository.

Through this approach, a scientific monitoring program would identify additional scientific information that can be used in repository performance models. The project then could update the models, and make modifications in design and operations as appropriate.

Congressional committees like this one can help ensure that DOE does not lose sight of its responsibility for used nuclear fuel management and disposal, as stated by Congress in the Nuclear Waste Policy Act of 1982. The industry fully supports the fundamental need for a repository so that used nuclear fuel and the byproducts of the nation's nuclear weapons program are securely managed in an underground, specially designed facility. World-class science has demonstrated that Yucca Mountain is the best site for that facility. A public works project of this magnitude will inevitably face challenges. Yet, none is insurmountable. DOE and its contractors have made significant progress on the project and will continue to do so as the project enters the licensing phase.

Congressional oversight also can play a key role in maintaining and encouraging the stability of the NRC's regulatory process. Such stability is essential for our 103 operating nuclear plants and equally critical in licensing new nuclear power plants.

Congress played a key role several years ago in encouraging the NRC to move toward a new oversight process for the nation's nuclear plants, based on quantitative performance indicators and safety significance. Today's reactor oversight process is designed to focus industry and NRC resources on equipment, components and operational issues that have the greatest importance to, and impact on, safety.

The need for regulatory stability is particularly acute today in the area of nuclear plant security.

The NRC and the industry have worked hard to identify and implement realistic security requirements at nuclear power plants. In the three-and-a-half years since 9/11, the NRC has issued a series of requirements to increase security and enhance training for security programs. The industry complied—fully and rapidly.

In the days and months following Sept. 11, quick action was required. Orders that implemented needed changes quickly were necessary. Now, we should return to the orderly process of regulating through regulations.

The industry has spent more than $1 billion enhancing security since September 2001. We've identified and fixed vulnerabilities. Today, the industry is at the practical limit of what private industry can do to secure our facilities against the terrorist threat. NRC Chairman Nils Diaz and other commissioners have said that the industry has achieved just about everything that can be reasonably achieved by a civilian force.

The industry now needs a transition period to stabilize the new security requirements. We need time to incorporate these dramatic changes into our operations and emergency planning programs and to train our employees to the high standards of our industry—and to the appropriately high expectations of the NRC.

Both industry and the NRC need congressional oversight to support and encourage this kind of stability.

CONCLUSION

Electricity generated by America's nuclear power plants over the past half-century has played a key part in our nation's growth and prosperity. Nuclear power produces over 20 percent of the electricity used in the United States today without producing air pollution. As our energy demands continue to grow in years to come, nuclear power should play an even greater role in meeting our energy and environmental needs.

The nuclear energy industry is operating its reactors safely and efficiently. The industry is striving to produce more electricity from existing plants. The industry is also developing more efficient, next-generation reactors and exploring ways to build them more cost-effectively.

The public sector, including the oversight committees of the U.S. Congress, can help maintain the conditions that ensure Americans will continue to reap the benefits of our operating plants, and create the conditions that will spur investment in America's energy infrastructure, including new nuclear power plants.

One important step is passage of comprehensive energy legislation that recognizes nuclear energy's contributions to meeting our growing energy demands, ensuring our nation's energy security and protecting our environment.

Equally important, however, is the need to ensure effective and efficient implementation of existing laws, like the Nuclear Waste Policy Act, and to provide federal agencies with the resources and oversight necessary to discharge their statutory responsibilities in the most efficient way possible.

The commercial nuclear power sector was born in the United States, and nations around the world continue to look to this nation for leadership in this technology and in the issues associated with nuclear power. Our ability to influence critical international policies in areas like nuclear nonproliferation, for example, depends on our ability to maintain a leadership role in prudent deployment, use and regulation of nuclear energy technologies here at home, in the United States, and on our ability to manage the technological and policy challenges—like waste management—that arise with all advanced technologies.

That is a broad responsibility and, in the case of nuclear energy, it rests equally on the shoulders of industry, government agencies like DOE and the NRC, and the appropriate committees of Congress.

Mr. Chairman, on behalf of NEI, I thank you for the opportunity to discuss nuclear energy's significant role in providing electricity to our nation today, and its vital importance as a clean, reliable and safe energy source for the future.

Mr. ISSA. Thank you.

And, as promised, our ranking member and others have arrived, so we will go to opening statements before Dr. Moore.

I would like to recognize Representative Westmoreland from Georgia, who has arrived. Representative Kucinich had to apologize, he has left his opening statement, and it will be put in the record. He had another conflict and will try to return.

[The prepared statement of Hon. Dennis J. Kucinich follows:]

"The Role of Nuclear Power Generation in a Comprehensive National Energy Policy"

Energy Policy Subcommittee 2247 Rayburn HOB 10:00A.M.

Statement of Dennis Kucinich

Committee on Government Reform 4/28/05

Obviously,

The idea that nuclear power can solve our climate change and clean air challenges is akin to smoking crack to help one quit cigarettes. That's absolute nonsense. You don't solve one problem by creating another.

Nuclear power is a threat to our local communities and creates highly radioactive waste that remains so for over a million years. The current political interest in nuclear power stems from the free flow of political contributions more than good business sense or science. In the Energy Policy Act of 2005, passed last week, Congress continues to subsidize nuclear power far more than it subsidizes renewable energy, the only sustainable approach to good energy policy. Once again politics overcomes those pesky issues of safety, the environment, and sustainability.

The first case in point is Davis Besse, a nuclear reactor downwind from my hometown Cleveland, Oh. This nuclear reactor was shut down 4 years ago because a large cavity, the size of a football, was discovered in the top of the reactor wall. The utility, First Energy, knowingly avoided mandatory inspection and cleanings, which would have prevented this near miss. Instead, First Energy chose to protect their profits and run the reactor dangerously close to a disaster.

The Nuclear Regulatory Commission, the agency charged with protecting the public, instead chose to protect the financial interests of First Energy. They repeatedly took minimal actions to prevent this near disaster, punish the utility for its negligence, and reform its own operations to place safety first.

The NRC Inspector General has found that the NRC chose to protect the "financial impact on FENOC" rather than force compliance with safety regulations. After the shutdown of Davis Besse, the NRC released a report that documented its "Lessons Learned." The report made a few recommendations as to how NRC might avoid future incidents like the corrosion problems at Davis Besse. Since the release of the final report, a draft "lessons learned" report surfaced that contained several far reaching recommendations that would in fact make a real difference in nuclear power plant safety. But to avoid costly regulations on the industry, those recommendations did not make the final report.

If this is the track record of the safety of nuclear power, then lets do the right thing and phase out the use of nuclear power.

Nuclear reactors produce highly radioactive waste that the U.S. is attempting to bury in Yucca Mountain, Nevada. No matter how deep you bury it, and no matter where you bury it, this waste will reemerge. Basic geology dictates that over a million years the earth shifts and water moves, and this waste will reemerge into our environment.

I need not remind this committee that only a few weeks ago, another subcommittee of Government Reform held a hearing that revealed a U.S. Geologic Survey employee falsified documents to make Yucca Mountain appear to met the requirements for disposal. The bottom line is that Yucca Mountain will never contain this waste.

If the Department of Energy does attempt to bury nuclear waste in Yucca Mountain, the transportation of this waste would require over 96,000 truck shipments over four decades. Nationally, 11 million people reside within one- half mile of a truck or rail route. This never-before-attempted radioactive materials transportation effort would bring with it a constellation of hazards and risks, including accidents that lead to serious economic damage in cities and communities along shipping routes. I cannot support any plan that places this many people at risk.

If sending nuclear waste down our roads and rails with limited safeguards doesn't bother you, then maybe placing this deadly waste on barges in our rivers, lakes, and oceans will. Because of a lack of rail facilities to several reactors, The Department of Energy will use barge shipments to move this waste to a port cable of transferring the 120 ton cask to a train.

Some of these shipments will occur on the Great Lakes; the world's largest source of fresh water. Over 35 million people living in the Great Lakes basin use it for drinking water, and I will venture to guess they will not be appreciative of nuclear waste shipments across their drinking water. I cannot support any plan that even contemplates shipping highly radioactive waste in the Great Lakes.

If this is the track record to resolve the waste problem, then lets do the right thing and phase out the use of nuclear power.

Mr. ISSA. With that, I would like to recognize our ranking member, Ms. Watson, for her opening remarks.

Ms. WATSON. I want to thank the Chair for holding this very important subcommittee hearing on the role of nuclear power. Most importantly, I have with me a young student. It is bring your daughter or son to work with you day. Megan Tarr is in the back. And it is important for these young people—and I have some interns from my office—to hear a discussion on power use for the future; how we can generate it, how we can care for it, how we can maintain it. So the subject of this hearing, the nuclear power generation, is a comprehensive national energy policy that is so essential, and I am very pleased that these young people will start getting themselves informed.

No nuclear plants have been ordered in the United States since 1978 and more than 100 reactors have been canceled. However, the rising costs of electricity generated from natural gas and coal-fired power plants may make nuclear power and renewable energy sources relatively more competitive.

It has been argued that expanded nuclear generation could help substitute for some of the demand for natural gas. Electricity is a major contributing source to the increased demand for natural gas. In contrast to oil, uranium, the key fuel source for nuclear reactors, is domestically available and supplies are not vulnerable to disruption by political instability overseas. Is this a reasonable viewpoint?

In addition, a significant aspect of reduced fossil fuel consumption is a reduction in carbon dioxide emission. Nuclear energy does not produce substantial air pollution; therefore, it could help reduce air pollution problems such as smog, particulate matter, and global warming. The United States is responsible for about one-fourth of the world's total greenhouse gas emissions. Americans must do better. How much fossil fuel electric generation must be replaced to make a difference? Is nuclear generation the answer? I am hoping that we will have the input so we can continue that dialog.

Nuclear power generation has many downsides. Nuclear power produces large quantities of waste that remain highly radioactive for thousands of years. The Nuclear Waste Policy Act of 1982, as amended in 1987, requires the Department of Energy to manage Yucca Mountain, NV, as a permanent repository for high-level waste.

The United States must commit the scientific manpower and monetary resources needed to educate the public and provide the appropriate protection to the Nation's environmental and physical health. If the Government develops a high-level nuclear waste disposal site, then the proper precautions must be in place to safeguard the transportation of spent fuel from across the country and to protect the area surrounding the repository from radiation exposure. What is the status of Yucca Mountain?

The over-arching issue of nuclear proliferation has been around for decades. The United Nations and other world organizations have been vigilant and aggressive in monitoring non-civil applications of nuclear energy. The United States should remain responsible and conscientious in this regard.

On another thought, this is an issue regarding uranium and plutonium in domestic use. What about the accidents that could come about or a terrorist attack? The potential catastrophic nature of an accident at a nuclear power plant makes this a very serious concern and needs much debate. The last major accident in the United States was at Three Mile Island, Pennsylvania, in 1979.

The general feeling of improved safety and acceptable standards in current operations is commendable. However, in March 2002, leaking boric acid produced a large hole in the nuclear reactor vessel head at the Davis-Besse nuclear plant in Ohio. The corrosion left only a quarter-inch-thick stainless steel inner liner to prevent a potentially dangerous loss of reactor cooling water. The Nuclear Regulatory Commission must hold the nuclear industry to the highest standards in order to prevent such problems. How safe is the industry, especially with no new construction in the last 30 years? These are issues that have to be debated.

All commercial nuclear power plants licensed by the NRC have a series of physical barriers to accessing the nuclear reactor area and are required to maintain a trained security force to protect them. America presents a prime terrorist target on a site that contains radioactive materials. Following the terrorist attack of September 11, 2001, the NRC began a review to improve defenses against terrorist attack. What has been done to prevent terrorism? And is it enough?

So, Mr. Chairman, it is very foresighted of you to call this hearing today, and I look forward to hearing from the rest of the witnesses. I am sorry I was late, but I am sure that you can address some of the questions that I raise. Thank you very much.

[The prepared statement of Hon. Dianne E. Watson follows:]

Opening Statement
Congresswoman Diane E. Watson
Subcommittee on Energy and Natural Resources - Ranking Member
Hearing: The Role of Nuclear Power Generation in a Comprehensive National Energy Policy.
April 28, 2005

Mr. Chairman, thank you for convening today's hearing. This Subcommittee is systematically investigating each of the major energy issues that our constituents are concerned about. I want to commend the Chair for his selection of nuclear energy, and the next topic of gas pricing. Each subject is of critical importance to Southern California, where both our District's rest, and to the entire country.

The subject for this hearing is nuclear power generation in a comprehensive national energy policy. In the United States, nuclear power faces an uncertain long-term future. No nuclear plants have been ordered in the United States since 1978 and more than 100 reactors have been cancelled. However, the rising costs of electricity generation from natural gas and coal-fired power plants may make nuclear power and renewable energy sources relatively more competitive.

It has been argued that expanded nuclear generation could help substitute for some of the demand for natural gas. Electricity is a major contributing source to the increased demand for natural gas. In contrast to oil, uranium, the key fuel source for nuclear reactors, is domestically available, and supplies are not vulnerable to disruption by political instability overseas. Is this a reasonable viewpoint?

In addition, a significant aspect of reduced fossil fuel consumption is a reduction in carbon dioxide emission. Nuclear energy does not produce substantial air pollution; therefore, it could help reduce air pollution problems such as smog, particulate matter, and global warming. The United States is responsible for about one-fourth of the world's total greenhouse gas emissions. America must do better. How much fossil fuel electric generation must be replaced to make a difference? Is nuclear generation the answer?

Nuclear power generation has many downsides. Nuclear power produces large quantities on waste that remain highly radioactive for thousands of years. The Nuclear Waste Policy Act of 1982, and as amended in 1987, requires the Department of Energy to manage Yucca Mountain, Nevada, as a permanent repository for high-level waste. The United States must commit the scientific manpower and monetary resources needed to educate the public and provide the appropriate protection to the nation's environmental and physical health. If the government develops a high-level nuclear waste disposal site, then the proper precautions must be in place to safeguard the transportation of spent fuel from across the country, and to protect the area surrounding the repository from radiation exposure. What is the status of Yucca Mountain?

The over-arching issue of nuclear proliferation has been around for decades. The United Nations and other world organizations have been vigilant and aggressive in monitoring non-civil applications of nuclear energy. The United States should remain responsible and conscientious in this regard.

On another related thought, a thought provoking issue regarding uranium and plutonium is domestic accidents and terrorist attacks. The potentially catastrophic nature of an accident at a nuclear power plant makes this a very serious concern. The last major accident in the United States was at Three Mile Island, Pennsylvania in 1979. The general feeling of improved safety and acceptable standards in current operations is commendable. However, in March 2002, leaking boric acid produced a large hole in the nuclear reactor vessel head at the Davis –Besse nuclear plant in Ohio. The corrosion left only a quarter-inch-thick stainless steel inner liner to prevent a potentially dangerous loss of reactor cooling water. The Nuclear Regulatory Commission must hold the nuclear industry to the highest standards in order to prevent problems. How safe is the industry, especially with no new construction in the last 30 years?

All commercial nuclear power plants licensed by the NRC have a series of physical barriers to accessing the nuclear reactor area, and are required to maintain a trained security force to protect them. America presents a prime terrorist target on a site that contains radioactive materials. Following the terrorist attacks of September 11, 2001 the NRC began a review to improve defenses against terrorist attack. What has been done to prevent terrorism? And is it enough?

Mr. Chairman, thank you for convening today's hearing. I look forward to hearing the witnesses' testimony and the answers to some of my questions.

Mr. ISSA. Thank you.

And I would note that Representative Brian Higgins of New York has joined us, and each has said that they will incorporate their opening statements into the round of questioning.

So with that, Dr. Moore, we look forward to hearing your remarks.

And I will remind all the members, I guess for the next panel, too, your entire written statement will be put into the record, so you may use it or abbreviate it or add to it as you see fit. We know that your wealth of knowledge is not on that piece of paper, but in your years of experience.

Thank you, Dr. Moore.

STATEMENT OF PATRICK MOORE

Mr. MOORE. Thank you, Mr. Chairman and members of the subcommittee. I am a Canadian citizen born and raised on Northern Vancouver Island, in a tiny fishing and logging village, and was sent off to boarding school in Vancouver at age 14, where I soon learned city ways, and ended up at the University of British Columbia eventually, studying the life sciences. I studied biology, biochemistry, genetics, forestry, agriculture. But then I discovered ecology, a subject that not many people knew about at that time, in the late 1960's, and I realized that I had discovered something that was going to change my life. And, as I put it, I became a born again ecologist, because it taught me how all living things are interrelated and how we are related to them.

While doing my Ph.D. in ecology in 1971, I joined a small group of people in a church basement in Vancouver, and we planned a protest voyage against U.S. hydrogen bomb testing in Alaska. The United States was conducting underground hydrogen bomb tests at Amchitka Island in the Aleutians.

We sailed a leaky old boat across the North Pacific and provided a focal point for media attention to opposition to the tests. When that H-bomb was detonated in November 1971 at Amchitka, it was the last hydrogen bomb the United States exploded. There were more atomic tests after that, but President Nixon, at the height of the cold war and the height of the Vietnam War, canceled the remaining tests in the series due to overwhelming public opposition. This was the birth of the organization Greenpeace.

I spent the next 15 years full-time in the top committee of Greenpeace, as we took on campaigns around the world: against French atmospheric nuclear testing in the South Pacific; we confronted the Soviet factory whaling fleets in the North Pacific; we confronted the Canadian seal slaughter off the East Coast of Canada; we took on toxic wastes and nuclear wastes; and uranium mining; and kangaroo slaughtering; an amazing number of issues over a 15-year period, at the end of which, of the 15 years I was in Greenpeace, we had grown from the church basement to a group with $100 million a year coming in and offices in 21 countries. I felt we had largely accomplished our task by this time, the mass public awareness of the importance of the environment, and for me it was time to make a change. I had been against about three or four things every day of my life for 15 years. I decided I would like to be in favor of something for a change.

I made the transition from the politics of confrontation, telling people what they should stop doing, to trying to figure out what we should do instead, because, after all, over 6 billion of us wake up every morning on this planet with real needs for food, energy, and materials. Sustainability, which I believe is the next logical step after environmental activism, is about continuing to provide for those needs, maybe even getting some more things for the people in the developing countries, while at the same time reducing our negative environmental impact. I believe this is one of the most important points around how we move forward in continuing to provide our civilization with the things it needs to survive every day: that we can continue to have civilization and reduce negative impacts.

A lot of environmental thinkers, Paul Ehrlich and his school of thought, they contend that automatically the more people there are and the more stuff they use everyday, the more negative impact there will be on the environment. This is not the case. It is possible to change the way we obtain the material and energy we need, while at the same time reducing our negative impact. That is basically the definition of sustainable development in many ways.

Back in the mid-1980's, not all my former colleagues saw things that way as I moved into sustainability and consensus. Environmental extremism arose at that time for two distinct reasons. First, because most of the public now agreed with all of the reasonable things we were saying in the environmental movement, the only way to remain adversarial and anti-establishment was to adopt ever-more unreasonable positions, eventually abandoning science and logic altogether in zero tolerance policies that we see today, nuclear energy being one of them, genetically modified foods being another one. Policies of zero tolerance in areas where there is actually tremendous potential for environmental and human welfare improvement.

So I diverged from this approach, which ended up, in my estimation, with a movement that is, to a considerable extent, just plain anti-civilization. They are anti-globalization; they are basically anti-capitalist; they are anti-business, anti-science, anti-technology. There is too many antis for me. As I say, I was against things for a long enough time that I wanted to be in favor of something.

There is this kind of naive vision of returning to some kind of utopian Garden of Eden, that actually never existed in the first place, conveniently forgetting that just 100 years ago the average person's life was 35 years in this world. And the tremendous advances that have been made in all areas since then is why our life span is so much longer now, and one of those, of course, is in energy.

What does environmental extremism have to do with nuclear energy? I believe the majority of environmental activists—and I would include Greenpeace, the Sierra Club, the Rainforest Action Network, the NRDC, and many of the others—have now become so blinded by their extremist policies that they fail to consider the enormous and obvious benefits of harnessing nuclear power to meet and secure America's growing energy needs. I believe these benefits far outweigh the risks.

As mentioned earlier, nuclear supplies 20 percent of U.S. electrical energy today. If no more nuclear plants are built, that will be cut in half just in the next few years. And it is virtually certain that the only technically feasible path, if nuclear is not built, is greater reliance on fossil fuels than we have today. I can't see any analysis that shows any other way than that we would have more reliance on coal, oil, and natural gas in the future than we do today, and I believe it is becoming a rather untenable position even at the present time.

In a "business as usual" scenario, that is, no more nukes, a significant reduction in greenhouse gas emissions would be impossible. An investment in nuclear energy could go a long way to reducing this reliance on fossil fuels, and could actually result in reduced CO_2 emissions.

According to the Clean Air Council, annual fossil fuel-fired power plant emissions are responsible for 36 percent of all the CO_2 emitted in the United States, and coal-fired plants account for 88 percent of the CO_2 being emitted from the entire power industry.

One of the most interesting events that is occurring now is that a number of prominent environmentalists are changing their position on nuclear energy.

I have to say, Mr. Chairman, in my whole time in Greenpeace, and since then to date, over 30 years, I have never changed my position on a single major policy area other than nuclear energy. I am portrayed sometimes as someone that has gone over to the other side, the dark side or whatever. It is not as if I am advocating the resumption of hydrogen bomb testing or whale slaughtering. I still hold true to all the positions I held when I was in Greenpeace. Those positions that I disagree with them on today are either ones that they have adopted since I left, in 1986, or they are nuclear issues like this; it is the only one I really changed.

But I am not the only one who is changing their opinion. Stewart Brand, a prominent philosopher and thinker, the founder of the Whole Earth Catalog that we all used as a bible when we went back to the land in the 1970's, has come out with a very important essay in the May 2005 issue of Technology Review, in which he says the environmental movement has to change their position on nuclear energy, among other things.

My acquaintance and friend, James Lovelock, the Gaia theorist, has also come out saying that nuclear is the only solution to reducing CO_2 emissions. He says, "Civilization is in imminent danger and has to use nuclear, the one safe available energy source, or suffer the pain soon to be inflicted by our outraged planet."

While I might not be so strident as my friend, Lovelock, it is clear that whatever risk there is from increased CO_2 levels in the atmosphere—and there may be considerable risk—it can be offset by an emphasis on nuclear energy.

Nuclear energy is a proven alternative and now provides over 75 percent of the U.S.' emission-free generation. The bulk of the other emission-free generation is hydroelectric.

Again, back to environmental extremism. If you poll many of these environmental groups, including Greenpeace, you will find that they are against coal-fired power plants, they are against nuclear plants, and they are against building new hydroelectric projects, and are even proposing to tear some of the existing ones down. If you take coal, nuclear, and hydro, and add them together, you have nearly the whole energy supply for the United States. So, therefore, it is completely unrealistic to be against all of these things. We do have to choose winners.

I must say, just in concluding, that even though I have said and have been quoted on numerous occasions, I believe this: "Nuclear energy is the only non-greenhouse gas emitting energy source that can effectively replace fossil fuels and satisfy global demand." That said, however, I want to make it very clear that there should also be a much greater emphasis on renewable energy production.

I believe the two most important of these, along with hydro, which is already established as an important source, are wind energy, which actually has far more potential than hydro on a global basis for electrical production; and ground source heat pumps, also known as geothermal or GeoExchange. In particular, when non-CO_2-emitting electrical sources, such as wind, hydro, or nuclear, are tied with ground source heat pumps for heating and cooling and providing hot water in all of our buildings, tremendous reduction of CO_2 and fossil fuel consumption can be realized.

A combination of nuclear, geothermal, and wind could actually bring the United States in line with the Kyoto Protocol, whether or not the United States signs that treaty.

I think that concludes my remarks.

Oh, just one more thing, if I may, Mr. Chairman.

Mr. ISSA. Absolutely.

Mr. MOORE. Just on the issue of accidents. It is true that Chernobyl was a terrible accident, but I characterize it as the exception that proves the rule that nuclear energy is generally safe. There are 434 reactors operating around the world as we speak. Chernobyl is the only really bad accident that has ever happened, and it was an accident waiting to happen. It had no containment structure, it was badly designed, it was badly operated, and badly maintained.

And Three Mile Island, which has been mentioned, I actually consider a success story, because the radiation was contained even in the event of what was nearly the worst possible thing that could happen in there, which was a partial meltdown of the reactor core. The radiation from the core was contained in that reaction and did not come out like it did in Chernobyl. Of course, since Three Mile Island we have learned even more. So I don't think the safety issue is an obstacle to moving ahead.

One other point: the nuclear proliferation point. These have to be taken as two separate issues, the issues of nuclear energy and the issues of nuclear proliferation. It is apparent that actually the main technologies that have resulted in the most combat deaths in this world in recent years are machetes, rifles, and car bombs. No one would seriously suggest banning machetes, guns, cars, or the fertilizer and diesel oil that are used to make the explosives in car bombs. These have to be looked at as separate issues; we can't simply say no nuclear power because the byproducts of it can be made into deadly weapons.

Thank you very much, Mr. Chairman.

[The prepared statement of Mr. Moore follows:]

Statement to the Congressional Subcommittee on Energy & Resources

"Nuclear energy is the only non-greenhouse gas-emitting energy source that can effectively replace fossil fuels and satisfy global demand."

Patrick Moore, Ph.D.
Chair and Chief Scientist
Greenspirit Strategies Ltd.

Introduction

Mr. Chairman and members of the Subcommittee, thank you for inviting me here today to testify about why nuclear energy is a vital component for America's energy future.

First, let me say a few words about who I am and where I've come from.

Founding Greenpeace

I was born and raised in the tiny fishing and logging village of Winter Harbour on the northwest tip of Vancouver Island, in the rainforest by the Pacific. I didn't realize what a blessed childhood I'd had, playing on the tidal flats by the salmon spawning streams in the rainforest, until I was sent to boarding school in Vancouver at age fourteen.

I eventually attended the University of British Columbia studying the life sciences: biology, biochemistry, genetics, forestry; but it was when I discovered ecology that I realized that through science I could gain an insight into the mystery of the rainforest I had known as a child.

I became a born-again ecologist, and in the late 1960's, was soon transformed into a radical environmental activist.

I found myself in a church basement in Vancouver with a like-minded group of people, planning a protest campaign against US hydrogen bomb testing in Alaska. We proved that a somewhat rag-tag looking group of activists could sail a leaky old halibut boat across the North Pacific Ocean and change the course of history.

President Nixon cancelled the remaining hydrogen bomb tests in the series due to overwhelming public opposition, which we had helped to generate. In retrospect this was a major turning point in the global arms race.

This was the birth of Greenpeace.

Activism in Action

In 1975 we set sail deep-sea into the North Pacific against the Soviet Union's factory whaling fleets that were slaughtering the last of the sperm whales off California. We put ourselves in front of the harpoons in little rubber boats and made Walter Cronkite's evening news.

That really put Greenpeace on the map.

In 1979 the International Whaling Commission banned factory whaling in the North Pacific and soon it was banned in all the world's oceans.

From Confrontation to Consensus

By the mid-1980's Greenpeace had grown from that church basement into an organization with an income of over US$100 million per year, offices in 21 countries and over 100 campaigns around the world, now tackling toxic waste, acid rain, uranium mining and drift net fishing as well as the original issues.

We had won over a majority of the public in the industrialized democracies. Presidents and prime ministers were talking about the environment on a daily basis.

For me it was time to make a change. I had been against at least three or four things every day of my life for 15 years; I decided I'd like to be in favor of something for a change.

I made the transition from the politics of confrontation to the politics of trying to build a consensus for environmental reform.

After all, when a majority of people decide they agree with you it is probably time to stop hitting them over the head and sit down and talk to them about finding solutions to our environmental problems.

Sustainable Development

The term sustainable development was adopted to describe the challenge of taking the new environmental values we had popularized, and incorporating them into the traditional social and economic values that have always governed public policy and our daily behavior.

We cannot simply switch to basing all our actions on purely environmental values.

Every day 6 billion people wake up with real needs for food, energy and materials. The challenge for sustainability is to continue to provide for those needs, maybe even provide more for people in the developing countries, while at the same time reducing our negative impact on the environment. These two goals are not mutually exclusive as many activists claim today.

But any changes made must also be socially acceptable and technically and economically feasible. It is not always easy to balance environmental, social, and economic priorities.

Compromise and co-operation with the involvement of government, industry, academia and the environmental movement are required to achieve sustainability.

It is this effort to find consensus among competing interests that has occupied my time for the past 20 years.

Environmental Extremism

Not all my former colleagues saw things that way. They rejected consensus politics and sustainable development in favor of continued confrontation and ever-increasing extremism. They ushered in an era of zero tolerance and left-wing politics. Some of the features of this environmental extremism are:

Environmental extremists tend to be anti-human. Humans are characterized as a cancer on the Earth. To quote eco-extremist Herb Hammond, "of all the components of the ecosystem, humans are the only ones we know to be completely optional". Isn't that a lovely thought? It isn't even true.

They are anti-science and technology. Science is invoked to justify positions that have nothing to do with science. Unfounded opinion is accepted over demonstrated fact. You don't need to look any farther than the zero-tolerance policies against genetically enhanced food crops and nuclear energy to see that this is true.

They are anti-business. All large corporations are depicted as inherently driven by greed and corruption. Profits are definitely not politically correct. The liberal democratic, market-based model is rejected even though no viable alternative is proposed to provide for the material needs of 6 billion people. As expressed by the Native Forest Network, "it is necessary to adopt a global phase out strategy of consumer based industrial capitalism."

I think they mean civilization.

And they are just plain anti-civilization. In the final analysis, eco- extremists have a naive vision of returning to a utopian Garden of Eden, which never actually existed, conveniently forgetting that just 100 years ago people lived to an average age of 35, and there were not enough doctors or dentists to go around. In their Brave New World there will be no more chemicals, no more airplanes, and certainly no more nuclear plants.

The Case for Nuclear Energy

What does environmental extremism have to do with nuclear energy?

I believe the majority of environmental activists, including those at Greenpeace, have now become so blinded by their extremist policies that they fail to consider the enormous and obvious benefits of harnessing nuclear power to meet and secure America's growing energy needs.

These benefits far outweigh the risks.

There is now a great deal of scientific evidence showing nuclear power to be an environmentally sound and safe choice.

The Current Situation

Today nuclear energy supplies 20 per cent of US electrical energy.

Yet demand for electricity continues to rise and in the coming decades may increase by 50 per cent over current levels.

If nothing is done to revitalize the US nuclear industry, the industry's contribution to meeting US energy demands could drop from 20 per cent to 9 per cent.

What sources of energy would make-up the difference?

It is virtually certain that the only technically feasible path is an even greater reliance on fossil fuels.

Fossil Fuels

In a 'business as usual' scenario a significant reduction in greenhouse gas emissions (GHG) seems unlikely given our continued heavy reliance on fossil fuels. An investment in nuclear energy would go a long way to reducing this reliance and could actually result in reduced CO2 emissions from power generation.

According to the Clean Air Council, annual power plant emissions are responsible for 36% of carbon dioxide (CO2), 64% of sulfur dioxide (SO2), 26% of nitrogen oxides (NOX), and 33% of mercury emissions (Hg).

These four pollutants cause significant environmental impact, including acid rain, smog, respiratory illness, mercury contamination, and are the major contributors to GHG emissions.

Among power plants, old coal-fired plants produce the majority of these pollutants. By contrast, nuclear power plants produce an insignificant quantity of these pollutants.

According to the Clean Air Council, while 58% of power plant boilers in operation in the U.S. are fueled by coal, they contribute 93% of NOX, 96% of SO2, 88% of Co2, and 99% of the mercury emitted by the entire power industry.

Prominent environmentalists see nuclear energy as solution

Prominent environmental figures like Stewart Brand, founder of the *Whole Earth Catalog*, Gaia theorist James Lovelock, and Hugh Montefiore, former Friends of the Earth leader, have now all stated their strong support for nuclear energy as a practical means of reducing greenhouse gas emissions while meeting the world's increasing energy demands.

I too place myself squarely in that category.

UK environmentalist James Lovelock, who posited the Gaia theory that the Earth operates as a giant, self-regulating super-organism, now sees nuclear energy as key to our planet's future health. "Civilization is in imminent danger," he warns, ``and has to use nuclear—the one safe, available energy source—or suffer the pain soon to be inflicted by our outraged planet."

While I may not be quite so strident as my friend James Lovelock it is clear that whatever risk there is from increased CO2 levels in the atmosphere, and there may be considerable risk, can be offset by an emphasis on nuclear energy.

In a recent edition of the Massachusetts Institute of Technology's *Technology Review*, Stewart Brand writes that nuclear energy's problems can be overcome and that:

> "The industry is mature, with a half-century of experience and ever improved engineering behind it. Problematic early reactors like the ones at Three Mile Island and Chernobyl can be supplanted by new, smaller-scale, meltdown-proof reactors like the ones that use the pebble-bed design. Nuclear power plants are very high yield, with low-cost fuel. Finally, they offer the best avenue to a "hydrogen economy," combining high energy and high heat in one place for optimal hydrogen generation."

Nuclear energy: a proven alternative

Indeed, nuclear power is already a proven alternative to fossil fuels.

The United States relies on nuclear power for some 20% of its electricity production, and produces nearly one-third of global nuclear energy.

Despite its current limited supply, nuclear energy now provides the vast majority (76.2 per cent) of the US's emission-free generation. (Others include hydroelectric, geothermal, wind, biomass, and solar.

In 2002, the use of nuclear energy helped the US avoid the release of 189.5 million tons of carbon into the air, if this electricity had been produced by coal.

In fact, the electric sector's carbon emissions would have been 29 per cent higher without nuclear power.

And while hydro, geothermal and wind energy all form an important part of reducing our reliance on fossil fuels, without nuclear energy that reliance will likely not diminish. In 2002, carbon emissions avoided by nuclear power were 1.7 times larger than those avoided by all renewables combined.

But let me make it clear at this point that I believe there should also be a much greater emphasis on renewable energy production. I believe the two most important renewable energy technologies are wind energy, which has great potential, and ground-source heat pumps, known as geothermal or GeoExchange. Solar panels will not be cost effective for mass application until their cost is reduced by 5-10 times. I would not be inclined to support an energy policy that focused exclusively on nuclear but would rather insist that an equal emphasis be placed on renewables, even though it is not possible, given present technologies, that renewables could produce the same quantity of power as nuclear plants.

The impact of additional nuclear energy generation

Nuclear energy has already made a sizeable contribution to the reduction of GHG emissions in the US.

But more must be done and nuclear energy is pointing the way.

A revitalized American nuclear energy industry, producing an additional 10,000 MW from power plant upgrades, plant restarts and productivity gains could assist the electric sector to avoid the emission of 22 million metric tons of carbon per year by 2012, according to the Nuclear Energy Institute – that's 21 per cent of the President's GHG intensity reduction goal.

A doubling of nuclear energy production would make it possible to significantly reduce total GHG emissions nation-wide.

While current investment in America's nuclear energy industry languishes, development of commercial plants in other parts of the world is gathering momentum.

In order to create a better environmental and energy secure future, the US must once again renew its leadership in this area.

Safety

As Stewart Brand and other forward-thinking environmentalists and scientists have made clear, technology has now progressed to the point where the activist fear mongering about the safety of nuclear energy bears no resemblance to reality.

The Chernobyl and Three Mile Island reactors, often raised as examples of nuclear catastrophe by activists, were very different from today's rigorously safe nuclear energy technology. Chernobyl was actually an accident waiting to happen, bad design, shoddy construction, poor maintenance and unprofessional operation all combined to cause the only terrible accident in reactor history. In my view the Chernobyl accident was the exception that proves the rule that nuclear reactors are generally safe. Three Mile Island was actually a success story in that the radiation from the partially melted core was contained by the concrete containment structure, it did the job it was designed to do.

Today, approximately one-third of the cost of a nuclear reactor is dedicated to safety systems and infrastructure.

The Chernobyl reactor, for example, was not outfitted with the fully automated, multiple levels of safety and redundancy required for North American reactors.

As we speak there are over 100 nuclear reactors in the US and over 400 worldwide that are producing electricity every day without serious incident.

Nuclear Waste

The fact that reactors produce nuclear waste is often used to support opposition to them. First, there is no technical obstacle to keeping nuclear waste from entering the environment at harmful levels. Second, this is already being accomplished at hundreds of nuclear power sites around the world. It is simply an issue of secure containment and maintenance. Most important, the spent fuel from reactors still has over 95% of its potential energy contained within it. Therefore spent fuel should not be disposed of, it should be stored securely so that in the future we can use this energy productively.

Nuclear Proliferation

Nuclear reactors produce plutonium that can be extracted and manufactured into nuclear weapons. This is unfortunate but is not in itself justification for eliminating nuclear energy. It appears that the main technologies that have resulted in combat deaths in recent years are machetes, rifles, and car bombs. No one would seriously suggest banning machetes, guns, cars or the fertilizer and diesel that explosives are made from. Nuclear proliferation must be addressed as a separate policy issue from the production of nuclear energy.

Other benefits from nuclear energy

Besides reductions in GHG emissions and the shift away from our reliance on fossil fuels, nuclear energy offers two important additional and environmentally friendly benefits.

First, nuclear power offers an important and practical pathway to the proposed "hydrogen economy." Unfortunately there are no hydrogen mines where we can source this element directly. It must be manufactured, from fossil fuels, biomass, or by splitting water into hydrogen and oxygen. Splitting water is the only non-greenhouse gas emitting approach to manufacturing hydrogen.

Hydrogen, as a fuel, offers the promise of clean, green energy for our automobiles and transportation fleets.

Automobile manufacturers continue to improve hydrogen fuel cells and the technology may, in the not-to-distant future, become feasible for mass application.

By using electricity, or by using heat directly from nuclear reactors to produce hydrogen, it may be possible to move from fossil fuels for transport energy to using clean hydrogen, thus virtually eliminating smog caused by autos, trucks, and trains.

A hydrogen fuel cell-powered transport fleet would not only virtually eliminate CO2 emissions but would eliminate the energy security problem posed by reliance on oil from overseas.

Second, around the world, nuclear energy could be used to solve another growing crisis: the increasing shortage of fresh water available for human consumption and crop irrigation.

By using nuclear energy, seawater could be desalinized to satisfy the ever-growing demand for fresh water without the CO2 emissions caused by fossil fuel-powered plants.

Conclusion

I want to conclude by emphasizing that nuclear energy – combined with the use of renewable energy sources like wind, geothermal and hydro – remains the only practical, safe and environmentally-friendly means of reducing greenhouse gas emissions and addressing energy security.

If the US is to meet its ever-increasing demands for energy, while reducing the threat of climate change and reliance on overseas oil, then the American nuclear industry must be revitalized and permitted to grow.

The time for common sense and scientifically sound leadership on the nuclear energy issue is now.

Thank you.

Mr. ISSA. Thank you, Dr. Moore.

As is my policy, I will waive my opening questions until all the other panel members have theirs, but I will tee up the discussion with just two items: one, in concert with yours, Dr. Moore, no person in the United States has ever died in a civilian nuclear power accident, period, including Three Mile Island, which cannot be said, obviously, for everyone driving gasoline, oil, and all the other petrochemicals down the road; nor can it be said either of liquified natural gas or refineries, all of which have had fairly spectacular loss of lives over the years.

Last, it is estimated that had the United States built all the nuclear power plants which were on order in the late 1970's, when they all became canceled directly as a result of Three Mile Island, we would presently be in Kyoto compliance. And I personally strongly suggest that had we already been in Kyoto compliance, the willingness of Congress to ratify Kyoto might have been dramatically greater than when we were on a collision course for no such opportunity.

With that, I would recognize the ranking member for her questions.

Ms. WATSON. Dr. Moore, I certainly appreciate your viewpoint and your input. There are several questions that come up in my mind. We certainly are interested in alternative energy power and fuels. I just returned from Qatar a few weeks ago, the emir told us that we have enough natural gas to furnish every single home in America for the next 100 years. And I thought if they have our natural resources, they have the power. And their question, the week-long that we were there, was we want to be treated like equals; and they were talking about democracy and so on and so forth.

But what strikes me is that our energy needs rest in other places. So I am very interested in what we can develop as energy sources here that would not pollute our environment and destroy our planet. I believe in global warming; I have seen the climate change in Los Angeles, my home. We had the largest rainfall ever in the last few months, larger than what we have in a cumulative 15 years or so.

In saying all that, I heard you speak of your background with Greenpeace. I think what they do is one thing; what they believe in is another. I don't like their tactics; I don't think you have to destroy to get the point over. I am hoping that you can share with us what they believe are other sources of energy, rather than the fossil fuel that we have been so dependent on that comes from the Middle East, where we are having tremendous problems at the current time, at a tremendous cost. What is it that we can use?

I heard you talk about wind power and so on. I really am looking at nuclear energy and, as you say, it has been a real tsunami of a change with you, and just by the fact that I am saying this it is a real change with me too. But we are going to have to have some source of energy where we don't have to go change a whole nation's politics to get what we need. Then I look at Greenpeace, who is trying to save the environment and save the planet.

What is it that you see, what is it that they see, what is it that we can see as sources of fuel for the future? Can you go into that?

What are their winning proposals? I don't like their destructive ones. What are their winning proposals?

Mr. MOORE. Thank you. Unfortunately, one of the great distractions in the debate around renewable energy is the focus on solar voltaic panels, the solar panels that go on a roof. They are all show and no go in many ways. They are very techy looking, they give the impression that you are a green person. They show up because they are on top of your roof.

Whereas, just to give a couple of facts, $20,000 invested in solar panels in this part of the world brings about $100 to $120 worth of electricity into your house per year. So you get a $120 return per year on a $20,000 investment. This is why they have to be so heavily subsidized before anybody will put them on the roof.

If you invest that same $20,000 in a ground source heat pump for your home, you get $1,300 equivalent worth of energy. But it is in your basement, where nobody can see it, and the pipes that it uses to get the energy out of the ground are buried in the ground where no one can see them, so it is not a symbol of your commitment to renewable energy and it doesn't have the same appeal. It is sort of the same thing as with automobiles, where 90 percent of it is psychological about what kind of car you want to drive.

So solar has really distracted people. I have a solar system in a little place I go to down in Mexico because there is no electricity into this little town, and it does make sense, when you are off the grid, to use solar energy. But it costs about 10 times as much as normal electrical power does; whereas, wind energy is now becoming reasonably close, in terms of competitiveness, with conventional electrical production. So we should be focusing on wind.

Between the two of them, Germany and Denmark produce 50 percent of the world's wind energy. Now, they certainly don't have 50 percent of the world's wind in those two little countries.

Now, some people would argue that they put too much of it in, that it is not cost-effective, but General Electric is now making 5 megawatt wind turbines, individual turbines that produce 5 megawatts each. It doesn't take that many of them to start producing a substantial amount of power. And a lot of coal-fired generation companies are actually investing in wind as a way of diversifying their energy portfolio. So there is tremendous potential there.

Back to ground source heat pumps. This is the key to making our electricity more efficient in terms of heating and cooling our homes, and getting rid of the peaks and valleys in our electrical requirements so you don't need so much base load. See, ground source heat pumps could heat, cool, and provide the hot water for every single structure in the world. You can get heat out of permafrost in Alaska in order to heat a building. This is stored solar energy that is in the top of the earth.

Ms. WATSON. How far down do you have to go?

Mr. MOORE. You put pipe in the ground 8, 10 feet deep; sometimes, if you drill down, you go 50 feet or more. But basically you put pipe in the ground, circulate water through it, and bring the heat of the ground into your house and magnify it with a heat pump. It is actually the same technology as is used in refrigeration and freezing. Your refrigerator is a heat pump. I don't know if you notice, when you put your hand at the back of it, there is hot air coming out of it.

Most people don't know where that hot air is coming from, they think it is coming from the motor. It is actually coming from inside the fridge. That is how the fridge gets the heat out of the inside, is by pumping it out and pumping it into the room.

Whereas, if you think of your house as a big fridge, with ground source heat pumps, you can take the heat out of the ground and pump it into your house, or you can take the heat out of your house and pump it back into the ground. It is available technology. Actually, many military bases are being retrofitted with this under the mandate for the 10-year payback. Lots of people are installing it, but it is nowhere near as large a program as it could or should be.

And combined with nuclear energy, wind energy, hydro energy, and all the other non-CO_2-emitting sources of energy, both renewables and nuclear, combined with that, we could cut CO_2 emissions by so much more than even Kyoto would require. And none of this is pie-in-the-sky. There are two factories producing over 100 million—a conglomerate. Two factories, one in Fort Wayne, IN, which is Water Furnace International, and one in Oklahoma City, Climate Master, producing these heat pumps on a mass scale in factories, and people are installing them.

I understand President Bush and Vice President Cheney both have ground source heat pump systems in their homes. President Bush's ranch in Texas, I believe. I am told this by the heat pump people, so I assume it is true.

I wish more emphasis would be put on these technologies which are actually feasible, rather than so much emphasis—California nearly passed a mandate for solar panels to be required on all new residential construction. At least that got beat back. It is just a big waste of money if you are on the grid. There are so many other things you can do, whether it is insulating your home or putting in a ground source heat pump. There are so many better ways to invest that money—that is a real waste.

Instead, California has now got, what is it, the million solar homes program? Now they are subsidizing putting the solar panels on to such an extent that people will do it. You practically have to buy these things for people to get them to want to put them on their roofs. And that is the route they are going, instead of going in a more cost-effective way.

As I say, solar panels are great for niche applications off-grid, but I call them the world's most expensive roofing tiles, and I believe that is a fair description.

Mr. ISSA. Thank you.

Ms. WATSON. Thank you.

Mr. ISSA. With that, I recognize Mr. Westmoreland for his round of questioning.

Mr. WESTMORELAND. Thank you, Mr. Chairman. I would like to thank you for holding this hearing. It is very timely that we just got through passing the energy bill.

Let me say that, being from Georgia, we get 27 percent of our power from nuclear plants, and it is not near that percentage of the coal-fired, fossil fuel plants that we have in Georgia. And I hope that 1 day, starting today, that we can look at—because our needs are going to be great. Our economy is growing, our State is growing. Our needs are going to greatly increase, and I hope that we can look at doing some more nuclear facilities in Georgia.

Mr. Chairman, I would like to submit my opening remarks, if I could, for the record.

Mr. ISSA. Without objection.

[The prepared statement of Hon. Lynn A. Westmoreland follows:]

Westmoreland

Opening statement for April 28, 2005 Government Reform Subcommittee on Energy Oversight hearing on "The Role of Nuclear Power Generation in a Comprehensive National Energy Policy"

- **Thank you Mr. Chairman for holding this hearing**
- **And I must say perfect timing with the passage of the energy bill last week**
- **I also want to thank all the witnesses for their willingness to testify today and I look forward to hearing what ya'll have to say**
- **I think we can all agree that the benefits of nuclear power are obvious – it's reliable, it's safe, AND it's emission free for crying out loud!**
- **Nuclear power generates about 20 % of the electricity that we use in this Nation.**
- **I know Georgia has about 27 % of its energy supplied by nuclear power plants**
- **And with the projected population growth in Georgia over the next decade I want to take a hard look at how we can build some new nuclear power plants**
- **To keep Georgia's economy growing and the Nation's, we are definitely going to need new sources of power**

- **Unfortunately there are parts of the state – and my district for that matter – and the rest of the U.S. - that are dealing with some air quality issues**

- **As the power companies start looking at how they are going to grow with the population increases and help keep the economy strong, I think nuclear has to be an option to provide the folks back home an emissions free, safe, reliable – and let's not forget affordable power**

- **Can we take a moment revel in the passage of the energy bill…**

- **I know the provisions related to nuclear power are a step in the right direction, but I want to find out today what else we can be doing**

- **We all know the U.S. faces a critical need for investment in emission-free, next generation nuclear power plants**

- **The evidence is overwhelming and the justification is there:**
  - **to relieve pressure on natural gas supply**
  - **to help preserve fuel and technology diversity**
  - **to help make our air cleaner**
  - **And not to mention - to strengthen U.S. energy security**

- **Countries around the world are building new nuclear power plants to meet their growing demand for electricity – but the U.S. – the global leader in nuclear energy technology – is not and I think it's high time we get on the ball**

- **Let's work together and figure out ways to encourage construction of new nuclear power plants**

- **Thank you and let's get this thing started**

Mr. WESTMORELAND. Mr. Moore, I want to compliment you for the things that you have said today about the nuclear power. I am in the building business, and I do agree with you on the geothermal. But I promise you that before long the environmentalists will be saying something about having that much pipe in the ground. Trust me.

And I know we didn't want to get into a geothermal discussion, but you are dead on with that because of the energy savings, but heat pumps are becoming more and more efficient. You can get an 17 to 23 SAER rating now on some of those heat pumps.

But the windmill, you know, they need to come up with some other kind of design rather than the windmill type of design, because I don't know that they would ever be aesthetically pleasing to have as many as you would need to create the electricity to supply a neighborhood. I understand that they are doing it in other countries, but I just don't know if that would ever be possible, at least in my area, coming from where I am from.

You are dead on on the solar panels also. That was a big thing when we were in the building business 20 years ago, and it just caused a lot of roof leaks is basically what those solar panels caused.

But I would like to see us look at not only this nuclear option, but look at doing, on a State-to-State basis—and it might be something for you to do—giving tax credits for people who will seal up and use envelope type insulation packages, geothermal higher SAER rating equipment to cool and heat these houses, because it takes a tremendous amount of energy.

Mr. Chairman, my last comment is that I have been looking over the cost of these nuclear plants, but with the amount of demand that is going to be on electricity and the amount of increase it is going to take in the infrastructure of our grid system right now—because I think our grid systems are not in the best shape that they could be, as evidenced by some of the blackouts that we had up in the northeast—that when you look at the amount of work and the new grid that would have to be put on, I think that we are not that far out of line with the nuclear additions. And as you have here, as the plants that we build, we become more and more competitive with them.

Also, the ranking member was talking about the safety aspects of it. We can learn a lot from the European countries as far as what they are doing, but I think our technology is so far advanced now from where it was when we built the original nuclear plants that it is definitely something we need to do, and I hope, by the chairman having this hearing, that we will not only sit here and talk about these things, but we will actually do something to further the building of these nuclear power plants.

Thank you, Mr. Chairman.

Mr. ISSA. Thank you.

I have good news and bad news. The good news is it is only one vote. The bad news is we will stand adjourned for about 15 minutes, until we go over and come back and renew questioning. I know our committee structure will support any cost of coffee or soft drinks you would like to have while we are gone.

With that, we stand recessed.

[Recess.]

Mr. ISSA. One nice thing about being chairman, if you can be patient to get your questions in, you will get your questions in. I will now recognize myself for as much time as I will consume—there will be Members coming back here shortly—and I have a list of them.

First of all, Mr. Jones, would it be all right for us to include your entire study in the record? You have no objections? I would like to have it submitted in the record.

[The information referred to follows:]

THE ECONOMIC FUTURE OF NUCLEAR POWER

A Study Conducted at The University of Chicago

August 2004

STUDY PARTICIPANTS

George S. Tolley, Professor Emeritus at The University of Chicago, and Donald W. Jones, Vice President of RCF Economic and Financial Consulting, Inc., directed the study.

The study was carried out in cooperation with the Department of Economics, the Graduate School of Business, and the Harris School of Public Policy of The University of Chicago. Graduate students and advanced undergraduate students coauthored the study as follows:

Name	Topic	Affiliation
Martin Castellano	Nonproliferation	Harris School of Public Policy
William Clune	Nuclear Waste Disposal Nuclear Fuel Cycle Nuclear Regulation	Harris School of Public Policy
Philo Davidson	Future Electricity Capacity	Economics
Kant Desai	Nuclear Technologies Hydrogen, Gas, and Coal Technologies Environmental Policies	Harris School of Public Policy
Amelia Foo	Hydrogen	Economics
Adrian Kats	Energy Security	Economics
Minghao Liao	Levelized Costs of Electricity	Economics
Emil Iantchev	Energy Security	Economics
Nathan Ilten	International Comparisons	Economics
Wei Li	Financing Issues	Graduate School of Business
Mark Nielson	Financing Issues	Economics
Ashwin Rode	Fuel Prices	Economics
James Taylor	Nuclear Technologies Hydrogen	Harris School of Public Policy
Walter Theseira	Electricity Futures	Economics
Stephanie Waldhoff	Environmental Policies	Harris School of Public Policy
Daniel Weitzenfeld	Learning by Doing	Economics
Jie Zheng	Financing Issues Nuclear Scenarios: 2015	Graduate School of Business

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TABLES(contd.)

PREFACE

In 2003, the U.S. Department of Energy (DOE), acting through Argonne National Laboratory (ANL), requested a study of the economic factors affecting the future of nuclear power in the United States. The study was carried out at The University of Chicago.

The present report gives the results of the study. Intended to be a white paper, it is a systematic review of the economics of nuclear power that can serve as a reference for future studies. It does not take a position on policy subjects. Rather, it reviews and evaluates alternative sources of information bearing on the nuclear power industry, and presents scenarios encompassing a reasonable range of future possibilities.

Part I considers factors affecting the competitiveness of nuclear power. Topics include (1) levelized costs, (2) comparisons with international nuclear costs, (3) capital costs, (4) effects of learning by doing, and (5) financing issues.

Part II analyzes gas-fired and coal-fired technologies as the major baseload competitors to nuclear generation. Topics include technologies that could reduce the costs of gas- and coal-fired electricity, future fuel price changes, and the potential economic impact of greenhouse gas control policies and technology.

Part III analyzes several federal financial policy alternatives designed to make nuclear power competitive in the next decade and beyond.

The Appendix provides comprehensive background information underpinning the body of the study. Previous nuclear energy studies were less comprehensive. The demand for new electricity generating capacity in the United States is estimated. A major concern is the viability of new nuclear plants as a way to meet growing electrical demand during the next decade. The study focuses on baseload electrical capacity. Appendices A1 through A9 address the major factors that affect the desirability and the viability of nuclear power. Conclusions include the following:

- Waste disposal issues remain to be settled.
- U.S. policy regarding nonproliferation goals will affect future fuel cycle decisions.
- Regulatory simplification shows promise of reducing plant construction times.
- A transition from oil-based to hydrogen-based transportation could, in the longer run, increase the demand for nuclear power as a non-polluting way to produce hydrogen.
- If gas imports increase, nuclear power could substitute for gas and contribute to energy security.

DOE NUCLEAR POWER 2010 PROGRAM *

In FY 2003, the U.S. Department of Energy (DOE) initiated a University of Chicago study on the economic viability of new nuclear power plants in the United States. This report describes the results of that study. According to DOE's Fiscal Year 2005 Budget Report, "the information obtained from this study is used to focus the program's activities on issues of the greatest impact" (DOE 2004, p. 397).

The Nuclear Power 2010 program is a joint government-industry cost-shared effort involved with identifying sites for new nuclear power plants, developing advanced nuclear plant technologies, evaluating the business case for building new nuclear power plants, and demonstrating untested regulatory processes. These efforts are designed to pave the way for an industry decision by the end of 2005 to order a new nuclear power plant. The regulatory tasks include demonstration of the Early Site Permit (ESP) and combined Construction and Operating License (COL) processes to reduce licensing uncertainties and minimize attendant financial risks to the licensee.

The Nuclear Power 2010 program continues to evaluate the economic and business case for building new nuclear power plants. This evaluation includes identification of the economic conditions under which power generation companies would add new nuclear capacity. In July 2002, DOE published a draft report, "Business Case for New Nuclear Power Plants in the United States," which provided recommendations for federal government assistance. DOE continues to develop and evaluate strategies to mitigate specific financial risks associated with deployment of new nuclear power plants identified in that report.

Recently, DOE solicited proposals from teams led by power generation companies to initiate new nuclear plant licensing demonstration projects. Under a cost-sharing arrangement, power companies will conduct studies, analyses, and other activities necessary to select an advanced reactor technology and prepare a site-specific, technology-specific COL application. DOE has already received responses from several utility consortia.

DOE has also initiated a technology assessment of nuclear power plant construction, which is being conducted in cooperation with the power generation companies. That study has assessed schedules and construction methods for the nuclear power plant designs most likely to be built in the near term.

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*Source: U.S. Department of Energy (DOE). (2004). "FY 2005 DOE Budget Request, Energy and Water Development Appropriations," Vol. 3, Nuclear Energy, pp. 395-398. http://www.mbe.doe.gov/budget/05budget/content/es/nuclear.pdf.

ACKNOWLEDGEMENTS

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ABSTRACT

Developments in the U.S. economy that will affect the nuclear power industry in coming years include the emergence of new nuclear technologies, waste disposal issues, proliferation concerns, the streamlining of nuclear regulation, a possible transition to a hydrogen economy, policies toward national energy security, and environmental policy. These developments will affect both the competitiveness of nuclear power and appropriate nuclear energy policies. A financial model developed in this study projects that, in the absence of federal financial policies aimed at the nuclear industry, the first new nuclear plants coming on line will have a levelized cost of electricity (LCOE, i.e., the price required to cover operating and capital costs) that ranges from $47 to $71 per megawatt-hour (MWh). This price range exceeds projections of $33 to $41 for coal-fired plants and $35 to $45 for gas-fired plants. After engineering costs are paid and construction of the first few nuclear plants has been completed, there is a good prospect that lower nuclear LCOEs can be achieved and that these lower costs would allow nuclear energy to be competitive in the marketplace. Federal financial policies that could help make early nuclear plants more competitive include loan guarantees, accelerated depreciation, investment tax credits, and production tax credits. In the long term, the competitiveness of nuclear power could be further enhanced by rising concerns about greenhouse gas emissions from fossil-fuel power generation.

EXECUTIVE SUMMARY

Context

Developments in the U.S. economy that will affect the nuclear industry in the future include the emergence of new nuclear technologies, decisions about nuclear fuel disposition, proliferation concerns, regulatory reform, a potential transition to a hydrogen economy, national energy security policies, and environmental policies. A successful transition from oil-based to hydrogen-based transportation could, in the long run, increase the demand for nuclear energy as a nonpolluting way to produce hydrogen.

The U.S. Department of Energy (DOE) currently supports research on designs for advanced nuclear power plants that can produce hydrogen as well as increase the sustainability and proliferation-resistance of nuclear energy and help lower nuclear energy costs. DOE also supports the certification of new nuclear reactor designs and the early site permitting process that will help make the licensing of new nuclear plants more predictable. Such predictability promises to lower financial risk by reducing the time required to construct and license new plants.

This study analyzes the economic competitiveness of nuclear, gas-fired, and coal-fired electricity.

Summary of Economic Findings

Economics of Deploying Plants during the Next Decade

- Capital cost is the single most important factor determining the economic competitiveness of nuclear energy.
- First-of-a-kind engineering (FOAKE) costs for new nuclear designs could increase capital costs by 35 percent, adversely affecting nuclear energy's competitiveness.
- The risk premium paid to bond and equity holders for financing new nuclear plants is an influential factor in the economic competitiveness of nuclear energy. A 3 percent risk premium on bonds and equity is estimated to be appropriate for the first few new plants.
- Without federal financial policy assistance, new nuclear plants coming on line in the next decade are projected to have a levelized cost of electricity (LCOE) of $47 to $71 per megawatt-hour (MWh). This study provides a full range of LCOEs for first nuclear plants for alternative construction periods, plant lives, capacity factors, and overnight cost estimates. LCOEs for coal- and gas-fired electricity are estimated to be $33 to $41 per MWh and $35 to $45 per MWh, respectively.

- With assistance in the form of loan guarantees, accelerated depreciation, investment tax credits, and production tax credits, new nuclear plants could become more competitive, with LCOEs reaching $32 to $50 per MWh.

Economics of Deploying the Next Series of Nuclear Plants

- With the benefit of the experience from the first few plants, LCOEs are expected to fall to the range of $31 to $46 per MWh; no continued financial assistance is required at this level.

Future Greenhouse Gas Policies

- If stringent greenhouse policies are implemented and advances in carbon capture and sequestration prove less effective than hoped, coal-fired electricity's LCOE could rise as high as $91 per MWh and gas-fired electricity's LCOE could rise as high as $68 per MWh. These LCOEs would fully assure the competitiveness of nuclear energy.

SUMMARY

Background

The focus of this study is baseload electricity as supplied by nuclear, coal-fired, and gas-fired technologies. Baseload power is power that a utility generates continuously, year round, in anticipation of the minimum customer demand that will occur, regardless of daily and seasonal fluctuations. Nuclear energy, coal, and gas are the major baseload fuel alternatives. Renewables are not considered since they are used minimally to meet baseload demand. While hydroelectric facilities supply baseload generation in some parts of the United States, the major opportunities for hydroelectric projects have already been taken. Table 1 presents the shares of generation furnished by various technologies in the United States. This study synthesizes the current understanding of the factors affecting the economic viability of nuclear power and estimates its viability under a range of future scenarios.

Table 1: Shares of Total U.S. Electricity Generation, by Type of Generation, 2003[a]

Energy Source	Net Generation, Percent
Coal	50.1
Nuclear	20.2
Natural Gas	17.9
Hydroelectric	6.6
Petroleum	2.5
Non-hydro Renewables	2.3
Other Sources	0.4
Total	**100**

[a]Identical to Table A1-1.

Part One: Economic Competitiveness of Nuclear Energy

This study first develops a pre-tax levelized cost of electricity (LCOE) model and uses it to calculate LCOEs for nuclear, coal, and gas generation based on values from recent plant models and data developed for use in those models. The LCOE is the price at the busbar needed to cover operating costs plus annualized capital costs. Table 2 summarizes these results.

Table 2: Summary Worksheet for Busbar Cost Comparisons, $ per MWh, with Capital Costs in $ per kW, 2003 Prices[a]

Technology	Sandia Model GenSim		SAIC Model Power Choice			Scully Capital Report			EIA – AEO 2004	
	r=10%	r=15%	Debt r = 8%; Disc r = 8%	Debt r =10%; Disc r = 8%	Debt r =10%; Disc r = 10%	r = 8%	r = 10%	r = 10%	Debt r =10%; Eq = 15%; Disc r = 10%	Debt r =8%; Eq = 10%; Disc r = 10%
Nuclear (capital cost)	51 (1,853)	83 (1,853)								
Legacy Nuclear (capital cost)			65 (2,000)	70 (2,000)	77 (2,000)					
EIA Reference Case, New Nuclear (capital cost)									63 to 68 (1,752 to 1,928)	
EIA Advanced Technology Case, New Nuclear (capital cost)									43 to 53 (1,080 to 1,555)	
ABWR (capital cost)			53 (1,600)	50 (1,600)	55 (1,600)					
AP 1000 (capital cost)			49 (1,365)	46 (1,365)	51 (1,365)	36 (1,247)	40 (1,247)	44 (1,455)		
Pebble Bed Modular Reactor (PBMR) (capital cost)			40 (1,365)	41 (1,365)	45 (1,365)					
Gas Turbine Modular Helium Reactor (GT-MHR) (capital cost)			39 (1,126)	39 (1,126)	43 (1,126)					
Advanced Fast Reactor (AFR) (capital cost)			57 (1,126)	57 (1,126)	64 (1,126)					
Coal (capital cost)	37 (1,094)	48 (1,094)	43 (1,350)	44 (1,350)	49 (1,350)					38 (1,169)
Gas Turbine Combined Cycle (capital cost)	35 (472)	40 (472)	38 (590)	38 (590)	40 (590)					41 (466)
Gas Combustion Turbine (capital cost)	56 (571)	68 (571)								
Solar-Photovoltaic	202	308								
Solar-Thermal	158	235								
Wind	55	77								

[a]Identical to Table 1-1.

To illuminate the reasons for the ranges of LCOEs estimated in prior studies, this study calculates LCOEs using the cost and performance assumptions used in three plant models identified in Appendix A2 (Table A2-1) and in the National Energy Modeling System (NEMS), as reported in the Energy Information Administration's (EIA's) *Annual Energy Outlook*. The Sandia model, GenSim, does not specify a particular nuclear technology; rather, it adopts EIA's specifications from the 2003 *Annual Energy Outlook* (AEO 2003). At a base capital cost of $1,853 per kW, increasing the discount rate from 10 to 15 percent raises the GenSim busbar nuclear cost from $51 to $83 per megawatt-hour (MWh). GenSim's estimates for competitors to nuclear are: $37 to $48 per MWh for coal, $35 to $40 per MWh for gas turbine combined cycle, and $56 to $68 per MWh for gas combustion turbines. The SAIC model, Power Choice, considers several nuclear technologies; cost estimates range from $39 per MWh for the Gas Turbine Modular Helium Reactor (GT-MHR) to $77 per MWh for existing nuclear technology. Coal-fired costs are on a par with the Pebble Bed Modular Reactor (PBMR) costs, at $43 to $49 per MWh. Gas turbine combined cycle costs are in the range of $35 to $48 per MWh. The Scully model compares alternative financing plans for a technology that broadly corresponds to the AP1000. The busbar cost range is $36 to $44 per MWh. The reference case in EIA's recent *Annual Energy Outlook* (AEO 2004) considers future construction of historical designs. Its assumptions regarding capital costs and interest rates result in a nuclear busbar cost of $63 to $68 per MWh, which is higher than most other studies. However, its cost for coal generation is $38 per MWh. Its advanced technology case lowers capital costs, partly to reflect learning effects in construction, which produces LCOEs of $43 to $53 per MWh.

Worldwide Cost Estimates

This study compares U.S. nuclear busbar costs with those in other countries that use electricity generated from nuclear energy, coal, and gas. U.S. nuclear busbar costs are estimated to be somewhat below the middle of the worldwide range for countries not reprocessing spent fuel, i.e., $36 to $65 per MWh. LCOEs of new nuclear plants in the United States compare favorably to prospective costs for new nuclear plants in France. Table 3 reports the nuclear busbar costs for various countries; separate estimates are provided for fuel cycles that dispose of spent fuel directly and those that reprocess spent fuel.

Table 3: Organization for Economic Co-operation and Development (OECD) Busbar Costs, 75 Percent Capacity Factor, 40-Year Plant Life, $ per MWh, 2003 Prices[a]

Plant Type	Country	Discount Rate (To Derive Net Present Value) 8 Percent	10 Percent
		$ per MWh	
Nuclear, Spent Fuel Disposal	Finland, new SWR 1000	36	42
	Canada	39 to 45	48 to 53
	China	44	54
	United States	45	53
	Russia	45	55
	Romania	49	59
	Korea	49	59
	India	52	64
	Turkey	53	64
	Finland	58	68
	Spain	65	78
Nuclear with Reprocessing	China	39 to 50	47 to 61
	France	50	60
	Japan	83	97
Gas Turbine Combined Cycle	OECD average	30 to 66	38 to 65
Advanced Gas Turbine Combined Cycle	United States	26	27
Pulverized Coal Combustion	OECD average	36 to 74	43 to 84
Coal Circulating Fluidized Bed	Canada	56	63
Coal Integrated Gasification Combined Cycle (IGCC)	OECD average	36 to 66	42 to 74

[a] From Tables 2-5 and 2-6.

Overnight Capital Cost Estimates

Capital costs, the single most important cost component for nuclear power, are analyzed in detail. For the Advanced Boiling Water Reactor (ABWR), already built in Asia, and the AP1000, a smaller scale version of which has been certified by the U.S. Nuclear Regulatory Commission (NRC), overnight capital costs, or undiscounted capital outlays, account for over a third of LCOE; interest costs on the overnight costs account for another quarter of the LCOE. Overnight cost estimates from different sources have ranged from less than $1,000 per kilowatt (kW) to as much as $2,300 per kw. This study examines the reasons for the differences in these estimates, with the aim of estimating a narrower plausible range.

One reason that early plants are more expensive is the impact of first-of-a-kind engineering (FOAKE) costs. Several hundred million dollars may be expended to complete the engineering design specifications for Generation III or III+ reactors. Such costs are incurred for early nuclear plants built of any type. Although building a reactor of a particular design in one country may enable transfer of part of the engineering that will be used in another country, some partial FOAKE costs may still be incurred for the first construction in any given country.

FOAKE costs are a fixed cost of a particular reactor design. How a vendor allocates FOAKE costs across all the reactors it sells can affect the overnight cost of early reactors considerably. A vendor may be concerned about its ability to sell multiple reactors and therefore want to recover all FOAKE costs on its first plant. FOAKE costs could raise the overnight cost of the first plant by 35 percent.

This study uses the Advanced Boiling Water Reactor (ABWR), the CANDU ACR-700, the AP1000, and the Framatome SWR 1000 as reasonable candidates for deployment in the United States by 2015.

- An overnight cost of $1,200 per kW is assumed for a generic class of mature designs.
- An overnight cost of $1,500 per kW is assumed for a generic class of designs that require payment of FOAKE costs.
- An overnight cost of $1,800 per kW is assumed for a generic class of more advanced designs that also require FOAKE costs.

Consideration of the four reactor types contributes to the choice of $1,200, $1,500, and $1,800 per kW for overnight costs, a range consistent with estimates identified in EIA's 2004 advanced technology case. (See AEO 2004.)

Learning by Doing

The study finds that reductions in capital costs between a first new nuclear plant and some n^{th} plant of the same design can be critically important to eventual commercial viability. In building the early units of a new reactor design, engineers and construction workers learn how to build the plants more efficiently with each plant they build. A case can be made that the nuclear industry will start with very little learning from previous experience when the first new nuclear construction occurs in the United States. The paucity of new nuclear construction over the past twenty years in the United States, together with the entry of new technologies and a new regulatory system, has eliminated much of the applicable U.S. experience. On the other hand, participation in overseas construction may have given some U.S. engineers experience that is transferable to construction in the United States.

This study uses a range of 3 to 10 percent for future learning rates in the U.S. nuclear construction industry, where learning rate is the percent reduction in cost resulting from doubling the number of plants built. Table 4 summarizes the conditions associated with different learning rates.

Table 4: Conditions Associated with Alternative Learning Rates[a]

Learning Rate (Percent for Doubling Plants Built)	Pace of Reactor Orders	Number of Reactors Built at a Single Site	Construction Market	Reactor Design Standardization	Regulation Impacts
3	Spread apart 1 year or more	Capacity saturated; no multiple units	Not highly competitive; can retain savings from learning	Not highly standardized	Some construction delays
5	Somewhat more continuous construction	Somewhat greater demand for new capacity; multiple units still uncommon	More competitive; most cost reductions from learning passed on to buyers	Narrower array of designs	Delays uncommon
10	Continuous construction	High capacity demand growth; multiple units common	Highly competitive; all cost reductions passed on	Several designs; sufficient orders for each to achieve standardization learning effects	Construction time reduced and delays largely eliminated

[a]Identical to Table 4-6.

The Financial Model

This study employs a financial model for businesses that is based on the following equation:

PRESENT VALUE OF EQUITY INVESTMENT DURING THE CONSTRUCTION PERIOD
= PRESENT VALUE OF NET REVENUE EARNED BY EQUITY OVER THE LIFE OF THE PLANT

where

NET REVENUE = EARNINGS FROM LCOE REVENUE BEFORE INTEREST AND TAXES (EBIT) – INTEREST EXPENSE – TAX EXPENSE + DEPRECIATION – REPAYMENT OF DEBT

Because risk is a major consideration for investors, its treatment in the financial model is an important factor in deriving the required net revenue. The perceived risk of investments in new nuclear facilities contributes to the risk premium on new nuclear construction. Principal sources of risk are the possibilities that construction delays will escalate costs and that new plants will exceed original cost estimates for other reasons. This study uses guidelines from the corporate finance literature, previous nuclear studies, and opinions of investment analysts to specify likely relationships between project risk and risk premiums for corporate bonds and equity capital. Risks associated with building a new nuclear plant are estimated to raise the required rate of return on equity to 15 percent, compared to 12 percent for other types of facilities, and debt cost to rise to 10 percent from 7 percent.

Table 5 specifies the parameter values for LCOE calculations under the assumption that no financial policies benefiting nuclear power are in effect. In using the financial model to study sensitivities, overnight costs of $1,200, $1,500, and $1,800 per kW are used. Table 6 summarizes the "no-policy" LCOEs for the three nuclear capital costs, each under 5-year and 7-year anticipated construction times. These construction times are expected values perceived by investors, based on both previous nuclear construction experience and new information. This study assumes investors will conservatively expect a 7-year construction period for the first few new plants. If actual construction times prove to be 5 years, investors will revise their expectations downward accordingly for subsequent plants.

Table 5: Parameter Values for No-Policy Nuclear LCOE Calculations[a]

Item	Parameter Value
Overnight Capital Cost	$1,200 per kW $1,500 per kW $1,800 per kW
Plant Life	40 years
Construction Time	7 years
Plant Size	1,000 MW
Capacity Factor	85 percent
Hours per Year	8,760 hours
Cost of Debt	10 percent
Cost of Equity	15 percent
Debt Term	15 years
Depreciation Term	15 years
Depreciation Schedule	MACRS[b]
Debt Finance	50 percent
Equity Finance	50 percent
Tax Rate	38 percent
Nuclear Fuel Cost	$4.35 per MWh
Nuclear Fixed O&M Cost	$60 per kW
Nuclear Variable O&M Cost	$0.45 per MWh
Nuclear Incremental Capital Expense	$10.50 per kW per year
Nuclear Decommissioning Cost	$350 million
Nuclear Waste Fee	$1 per MWh

[a]Identical to Table 5-1.
[b]Modified Accelerated Cost Recovery System.

Table 6: First-Plant LCOEs for Three Reactor Costs, 5- and 7-Year Construction Periods, $ per MWh, 2003 Prices[a]

Construction Period	Mature Design FOAKE Costs Paid, $1,200 per kW Overnight Cost	New Design FOAKE Costs Not Yet Paid, $1,500 per kW Overnight Cost	Advanced New Design FOAKE Costs Not Yet Paid, $1,800 per kW Overnight Cost
5 years	47	54	62
7 years	53	62	71

[a]Identical to Table 5-3.

Table 7 presents a full range of LCOEs for first nuclear plants, for alternative construction periods, plant lives, and capacity factors and for each of the three overnight costs specified in Table 5. The table shows the relative importance of the various characteristics for generation cost. Overnight capital cost is clearly most important, but the two-year difference in construction period is nearly as important. If investors were convinced of the likelihood of a 5-year construction period, they would estimate the generation cost of the $1,800 per kW plant to equal that of the $1,500 per kW plant built in 7 years; similarly, the $1,500 per kW plant anticipated to be built in 5 years would have a generation cost nearly that of the $1,200 per kW plant anticipated to be built in 7 years. Capacity factor also exerts a significant influence on generation cost. However, the effect of longer plant life is relatively minor because these benefits occur in the distant future and are discounted.

Table 7: Effects of Capacity Factor, Construction Period, and Plant Life on First-Plant Nuclear LCOE for Three Reactor Costs, $ per MWh, 2003 Prices[a]

Capacity Factor, Percent	Overnight Cost					
	$1,200 per kW		$1,500 per kW		$1,800 per kW	
5-year construction period						
	Plant Life		Plant Life		Plant Life	
	40 years	60 years	40 years	60 years	40 years	60 years
85	47	47	54	53	62	61
90	44	43	51	50	58	58
95	42	41	49	48	56	55
7-year construction period						
	Plant Life		Plant Life		Plant Life	
	40 years	60 years	40 years	60 years	40 years	60 years
85	53	53	62	61	71	70
90	50	49	58	58	67	66
95	47	47	56	55	64	63

[a]Identical to Table 5-6.

Table 8 presents LCOEs for coal and gas alternatives. Given the capital cost range, the LCOE of new nuclear plants in the absence of federal financial policies is from $53 to $71 per MWh with a 7-year construction time. The range is from $47 to $62 per MWh with a 5-year construction time. Costs remain above the range of competitiveness with coal and gas generation, which have LCOEs ranging from $33 to $45 per MWh. For the $1,500 and $1,800 per kW plants, FOAKE costs of roughly $300 per kW are assumed to be paid off with the first plant, which lowers the LCOE for the second plants by 13 to 15 percent.

Table 8: LCOEs for Pulverized Coal and Gas Turbine Combined Cycle Plants, $ per MWh, 2003 Prices[a]

Coal	33 to 41
Gas	35 to 45

[a]From Tables 5-4 and 5-5.

Part Two: Outlook for Nuclear Energy's Competitors

Gas and Coal Technologies

This study examines the near-term prospects for improvements in gas- and coal-fired electricity generation that would affect their costs relative to nuclear power. Table 9 summarizes the cost estimates, construction times, and thermal efficiencies of fossil-fired electricity generation. Some modest thermal efficiency improvements are foreseen in the near term for gas technologies, but similar improvements for coal technologies appear to be farther in the future. The most common combustion technology used in coal plants recently built in the United States is pulverized coal combustion. Fluidized bed combustion is a cleaner alternative, and the thermal efficiency of most fluidized beds used for power generation is similar to that of pulverized coal. However, the cost competitiveness of fluidized bed combustion remains a question. Integrated coal gasification combined cycle, while attractive from the perspective of thermal efficiency and emissions, is likely to be too expensive to enter the U.S. market in the near term. More advanced coal-fired technologies are still in early R&D stages.

Since fuel costs are generally two-thirds of the levelized cost of gas-generated power, a 5 percentage point increase in efficiency in gas turbine combined cycle plants could decrease the cost of gas-generated electricity by approximately 8 percent.

Table 9: Cost Characteristics of Fossil-Fired Electricity Generation[a]

	Pulverized Coal Combustion	Coal, Circulating Fluidized Bed	Coal, Integrated Gasification Combined Cycle	Gas Turbine Combined Cycle
Capital Cost ($ per kW)	1,189	1,200	1,338	590
Fuel Cost ($ per MWh)	11.26	12.04	9.44	23.60
Total Operations and Maintenance Cost (O&M) ($ per MWh)	7.73	5.87	5.19	2.60
Construction time (years)	4	4	4	3
Current Thermal Efficiency (percent)	30 to 35	30 to 35	40 to 45	55 to 60
R&D Thermal Efficiency Targets (percent)	45	45	60	65

[a] Identical to Table 6-6.

Fuel Prices

This study examines forecasts for three fuels: coal, natural gas, and uranium.

Coal and Gas

Coal supplies worldwide are expected to be sufficiently price elastic that even a doubling of demand would not increase price appreciably. Previous forecasts generally agree that coal production will increase 35 to 50 percent over the next 25 years. Forecasts for the U.S. coal price to utilities uniformly predict a decline of about 10 percent.

Forecasts for natural gas prices are mixed (see Table 10). EIA's forecasts have changed sharply as prices experienced during the base years of 2000 to 2003 have fluctuated considerably. Expressed in 2003 prices, the Lower 48 wellhead price rose from $3.93 per 1000 cu. ft. in 2000 to $4.24 in 2001, then fell to $3.02 in 2002. The 2003 price of $5.01 was the highest in recent years. EIA's 2003 forecast for 2020, in 2003 prices, was $3.75, but its 2004 forecast for the same date is $4.34. The 2002 price of $3.02 was below both 2020 forecasts, but the 2003 price of $5.01 was well above both. As Table 10 shows, EIA's 2004 forecast for 2020 was for an 11 percent increase over 2000 prices, equivalent to a 40 percent increase over 2002 prices but a 13 percent decrease from 2003 prices.

Table 10: Natural Gas Price Projections[a]

Year	2000[b]	2005	2010	2015	2020
NEMS[c], Lower 48 U.S. Wellhead Price, AEO 2003	100[d]	75	86	93	96
NEMS[c], Lower 48 U.S. Wellhead Price, AEO 2004	100[d]	92	88	109	111

[a]Abridged version of Table 7-2, Year 2000=100.
[b]Year 2000=100.
[c]National Energy Modeling System (NEMS).
[d]$3.93 per 1,000 cu. ft.

Sensitivity analyses for gas-fired LCOEs use three alternative time paths for natural gas prices. One is an average of the 2001and 2002 gas price, which results in forecasts for 2010 to 2015 of $3.39 per MMBtu, assumed constant over the plant life. Another uses the 2003 gas price forecast for 2010 to 2015 of $4.30, also assumed constant over the plant life. The third uses EIA's 2004 forecast of gas prices from 2015 through the end of the plant life, which begins at $4.25 in 2015, peaks at $4.51 in 2021, falls to $4.48 by 2025, and remains at that level for the remainder of the plant life. All prices are in 2003 dollars.

Uranium

The supply elasticity of uranium is estimated by several sources to be between 2.3 and 3.3, which should be sufficiently large to keep uranium prices down in the range of $15 per pound over the next several years. Since fuel cost accounts for only about 10 percent of total nuclear generation cost, variation in uranium prices will have only a limited effect on the overall cost of nuclear generation of electricity.

Environmental Policies

As opposed to technology advances and possible fuel price decreases that could reduce coal- and gas-fired costs, environmental considerations could raise the cost of these sources because they emit air pollutants. This study assesses potential cost increases from more stringent environmental compliance for coal- and gas-generated electricity.

- Despite global climate concerns, carbon remains an important but largely uncontrolled emission that could be subject to future controls through carbon capture and sequestration.

- Although the technologies of carbon capture, transport, injection, and sequestration are not yet commercialized, estimates of current and future costs are available.

Assuming 100 km transportation by pipeline, this study reports the following costs per MWh generated:

- $36 to $65 per MWh for pulverized coal, including an energy penalty of 16 to 34 percent
- $17 to $29 per MWh for gas turbine combined cycle, including an energy penalty of 10 to 16 percent
- $20 to $44 per MWh for integrated gasification combined cycle, including an energy penalty of 6 to 21 percent

- An alternative measurement of the future costs of carbon control can be obtained by examining permit markets. In particular, prices generated through permit market trading can be interpreted as the approximate future cost of reducing present emissions. This study uses a carbon price range of $50 to $250 per ton to construct upper and lower bounds of the electricity cost impact. For coal-fired electricity, the cost impact is likely to be between $15 and $75 per MWh; for gas-fired electricity, the cost impact is likely to be between $10 and $50 per MWh. These estimates are subject to significant uncertainty, particularly because of uncertainty about the overall amount of carbon that will be controlled.

Part Three: Nuclear Energy in the Years Ahead

Nuclear Energy Scenarios: 2015

The year 2015 is chosen as a reasonable year for the first new nuclear plants to come on line, allowing for time lags required for design certification, site selection and planning, licensing, and construction. This study considers the effects of several possible federal policies targeting the first plants.

Individual Federal Financial Policies Considered for the First Plants

- According to this study's financial model, a loan guarantee of 50 percent of construction loan costs would reduce the nuclear LCOE for the lowest-cost reactor from $53 to $49 per MWh (see Table 11).
- Accelerated depreciation would reduce the LCOE for the lowest-cost reactor to $47 per MWh (see Table 12).
- An investment tax credit of 20 percent, refundable so as to be applicable as an offset to a utility's non-nuclear activities, would reduce the nuclear LCOE to $44 per MWh for the lowest-cost reactor (see Table 13).

- A production tax credit of $18 per MWh for the first 8 years (as proposed in 2004 legislation) would reduce the LCOE of the lowest-cost reactor to $38 per MWh, which is within the required competitive range (see Table 14).

This study uses a 7-year construction schedule because the financial community is likely to assume that duration for the first plants constructed, for financial planning purposes. If shorter construction times are proven with early experience, the construction period used for financial planning would be reduced accordingly for subsequent plants.

Table 11: Nuclear LCOEs with Loan Guarantees, $ per MWh, 2003 Prices[a]

Loan Guarantee Policy	Mature Design $1,200 per kW	New Design $1,500 per kW	Advanced New Design $1,800 per kW
0 (no policy)	53	62	71
25 percent of loan	50	58	67
50 percent of loan	49	57	65

[a]From Table 9-3.

Table 12: Nuclear LCOEs with Accelerated Depreciation Allowances, $ per MWh, 2003 Prices[a]

Depreciation Policy	Mature Design $1,200 per kW	New Design $1,500 per kW	Advanced New Design $1,800 per kW
15 years (no policy)	53	62	71
7 years	50	58	67
Expensing (1 year)	47	54	62

[a]From Table 9-4.

Table 13: Nuclear LCOEs with Investment Tax Credits, $ per MWh, 2003 Prices[a]

Tax Credit Policy	Mature Design $1,200 per kW	New Design $1,500 per kW	Advanced New Design $1,800 per kW
0 percent (no policy)	53	62	71
10 percent	47	55	63
20 percent	44	51	58

[a]From Table 9-5.

Table 14: Nuclear LCOEs with Production Tax Credits, $18 per MWh, 8-Year Duration, $ per MWh, 2003 Prices

Tax Credit Policy	Mature Design $1,200 per kW	New Design $1,500 per kW	Advanced New Design $1,800 per kW
0 (no policy)	53	62	71
$18 per MWh, 8-year duration	38	47	56

[a]From Table 9-6.

Combination of Federal Financial Policies and Streamlined Licensing

While the most of the individual financial policies considered in this study appear to be insufficient to enable nuclear power to enter the marketplace competitively, the financial model indicates that a combination of policies at reasonable levels could do so. As shown in Table 15, an $18 per MWh production tax credit for 8 years together with a 20 percent investment tax credit could bring the LCOE of the lower-cost reactors ($1,200 and $1,500 per kW) within the competitive range with a 7-year anticipated construction time. This policy package would bring the LCOE of the $1,800 per kW reactor close to the anticipated competitive range with the 7-year construction time and well within it with a 5-year construction period.

Table 15: Effects of Combined $18 per MWh 8-Year Production Tax Credits and 20 Percent Investment Tax Credits on Nuclear Plants' LCOEs, $ per MWh, 2003 Prices

Mature Design $1,200 per kW		New Design $1,500 per kW		Advanced New Design $1,800 per kW	
Construction Time		Construction Time		Construction Time	
5 years	7 years	5 years	7 years	5 years	7 years
No policies:					
47	53	54	62	62	71
With combination of policies:					
26	31	31	38	37	46

[a]Identical to Table 9-7.

N^{th} Plants and Nuclear Competitiveness

Under aggressive assumptions regarding learning by doing, the LCOE for the fifth plant, when most learning has been achieved, is $44 per MWh for the lowest-cost nuclear reactor, assuming that for the first plant the business community anticipates a construction period of 7 years and uses a 3 percent risk premium on debt and equity interest rates (see Table 16).

Table 16: LCOEs for the Fifth Nuclear Plant, with No Policy Assistance, 7-Year Construction Time, 10 Percent Interest Rate on Debt, and 15 Percent Rate on Equity $ per MWh, 2003 Prices[a]

Learning Rate (Percent for Doubling Plants Built)	Initial Overnight Cost, $ per kW	
	1,200 and 1,500	1,800
3	50	58
5	48	56
10	44	52

[a]From Table 9-8.

This study goes on to report LCOEs for the fifth plant assuming that, with favorable regulatory experience, the business community comes to expect a 5-year construction period and more favorable risks, comparable to gas and coal. Under these conditions, the fifth-plant LCOEs for nuclear reactors reach the required range of competitiveness. The two lower-cost nuclear reactors have LCOEs of about $35 per MWh even under the most pessimistic learning rate (see Table 17). If the reduced risk encourages a higher ratio of debt to equity in financing, LCOEs would be further reduced: by nearly 3 percent with 60 percent debt instead of 50 percent or by 8.5 percent with 70 percent debt instead of 50 percent.

This study found that, even under pessimistic learning assumptions, nuclear power could become self-sufficient in the market after cessation of initial policy assistance if overnight costs were $1,200 or $1,500 per kW and a 5-year construction schedule was maintained. Depending on where fossil LCOEs emerge within the ranges calculated here, the $1,800 per kW nuclear plant could become self-sufficient as well.

Table 17: LCOEs for the Fifth Nuclear Plant, with No Policy Assistance, 5-Year Construction Time, 7 Percent Interest Rate on Debt, and 12 Percent Rate on Equity $ per MWh, 2003 Prices[a]

Learning Rate (Percent for Doubling Plants Built)	Initial Overnight Cost, $ per kW	
	1,200 and 1,500	1,800
3	35	40
5	34	39
10	32	36

[a]From Table 9-11.

Robustness of Conclusions

The results of this study are sensitive to assumptions about overnight costs and plant construction times, but are not very sensitive to assumptions about plant life and capacity factors.

Environmental Policies for Fossil Generation

Stringent measures to control greenhouse gases would raise costs for both gas- and coal-fired plants, making nuclear energy easily competitive in the market place, as shown in Table 18.

Table 18: Fossil LCOEs with and without Greenhouse Policies, $ per MWh, 2003 Prices[a]

	Under Current Environmental Policies	Under Greenhouse Policy
Coal-Fired	33 to 41	83 to 91
Gas-Fired	35 to 45	58 to 68

[a]Identical to Table 9-12.

2025 and Beyond

The long gestation periods involved in nuclear energy research and the long lags entailed in gearing up the nuclear industry to construct new power plants make it prudent to look several decades ahead when making decisions about nuclear energy policy.

Nuclear Energy Technology. The importance of cost reductions from first-of-a-kind-engineering (FOAKE) costs and learning by doing beyond FOAKE has been documented in this study. If presently available Generation III technologies are deployed for several years beginning in 2015, as contemplated in this study, significant cost reductions from their replication could extend to 2025 and beyond. Research and development on Generation III and IV designs is expected to allow commercialization of lower-cost reactors in later years.

Global Warming. The longer the time horizon, the more likely the United States will place an increased priority on global warming, leading to an urgent need to replace coal- and gas-fired electricity generation. In view of the time it takes to gear up the nuclear industry, the prospect of this need is one of the reasons for national concern with maintaining a nuclear energy capability. If environmental policies greatly restrict carbon emissions in the period after 2025, fossil-fired LCOEs could increase by 50 to 100 percent over current levels. Nuclear power would then acquire an unquestioned cost advantage over its gas and coal competitors.

Hydrogen. The widespread introduction of hydrogen-powered vehicles to replace gasoline-powered vehicles would greatly increase the demand for energy to produce hydrogen. Some impacts could occur by 2015, but this study is conservative and does not consider those impacts when projecting demand for nuclear energy in the 2015 timeframe. If the expressed national commitment to developing a commercially viable hydrogen vehicle proves successful, nuclear power could become a major producer of this transportation fuel. A full analysis of the implications of increased demand for hydrogen is beyond the scope of this study.

Despite the many uncertainties in the future beyond 2025, the findings in this study suggest the likelihood of an increased demand for nuclear energy beyond 2025.

APPENDIX

Background

Purpose and Organization of Study

This study aims to synthesize what is known about the factors affecting the economic viability of nuclear power and to estimate its viability under a range of future scenarios. The focus is on generating baseload electricity—nuclear, coal-fired, and gas-fired technologies. Renewables are not considered because they are rarely used to meet baseload demand. While hydroelectric facilities supply baseload generation to some parts of the United States, the major opportunities for hydroelectric projects have already been taken.

Electricity Futures

This study uses two principal types of models to investigate electricity futures:

- *Plant models* calculate the cost of electricity generation from a specific type of power plant. Costs are calculated on a levelized basis (LCOE), combining operating and capital costs to arrive at a cost per megawatt-hour (MWh), that must be recouped in the price of electricity. Costs are calculated at the busbar level in order to focus on electricity generation costs and abstract from locally varying distribution costs.

- *Market models* forecast the demand for electricity and the mix of electricity generating capacity that will come online to meet future levels of expected demand. Aggregate demand and supply functions are estimated and brought together to simulate market behavior, often at the regional level.

Table A-1 summarizes the characteristics of the various plant and market models that are reviewed in this study. The table distinguishes the plant types, forecast horizons, treatments of environmental costs, and nuclear power data sources that have been used.

Table A-1: Plant and Market Model Summary[a]

Model Identification	Plant Type	Forecast Horizon	Treatment of Environmental Costs	Source of Nuclear Power Data
		Plant Models		
Scully Capital-DOE (Nuclear Energy)	Nuclear (AP1000)	Up to 2010	No	Vendor, 2002
Electricity Generation Cost Simulation Model (GenSim)/Sandia	Wide spectrum of energy sources	Current year	Has capability	Energy Information Administration (EIA) and Platt's (McGraw-Hill) Database, 2003
MIT Study	Nuclear, coal, gas	Up to 2050	Carbon tax	EIA, 2003
		Market Models		
National Energy Modeling System (NEMS)-EIA	Wide spectrum of energy sources	20 years from present	No	EIA, 2003
NEMS-Electric Power Research Institute (EPRI)	Nuclear, coal, gas	Up to 2050	Carbon tax	Vendors, 2002
All Modular Industry Growth Assessment Modeling System (AMIGA)/ Pew Charitable Trust	Wide spectrum of energy sources	Up to 2035	Yes	Argonne National Laboratory, Vendors, 2001
Integrated Planning Model (IPM)/Environmental Protection Agency (EPA)	Nuclear, coal, gas	20 years from present	Yes	EIA
		Hybrid Models		
Science Applications International Corporation (SAIC) Power Choice Model	Nuclear, coal, gas	80 years from present	Carbon tax	DOE and Vendors, 2001

[a]Identical to Table A2-1.

Within each model category, different underlying numerical assumptions cause the principal differences in electricity cost projections. The most significant of these are differences in capital costs and interest rates for nuclear capacity, capital costs for coal generation, and fuel costs for gas generation. The market models are sufficiently complex that reasons for differences in their projections frequently are difficult to pinpoint. Plant models are better suited for studying the economic viability of nuclear energy. However, while the plant model structures are straightforward, documentation of underlying data is not always sufficient to allow detailed economic analysis. Four of the plant models, identified in bold font in Table A-1, are used for comparison purposes later in this study: the Scully model, GenSim, NEMS, and SAIC's Power Choice model.

Need for New Generating Capacity in the United States

This study analyzes future electricity demand and compares it with existing capacity to estimate a future time range when construction of added capacity must start. Projections by EIA and the North American Electric Reliability Council (NERC) are compared with projections based on historical relationships between electricity demand growth and gross domestic product (GDP) growth. The historical relationships estimated for this study imply electricity demand growth rates that are roughly one percentage point higher than EIA's forecasts and a half percentage point above NERC's forecasts. From a national perspective, even with an annual growth rate in electricity demand of 2.7 percent, which is above the EIA and NERC forecasts, new capacity will not be needed before 2011. On a regional basis, new capacity may be required as early as 2006. (See Appendix A3, "Need for New Generating Capacity in the United States.")

Major Issues Affecting the Nuclear Power Industry in the U.S. Economy

Technologies for New Nuclear Facilities

The nuclear reactors currently in use in the United States, denoted as Generation II, were deployed in the 1970s and 1980s. They include boiling water reactors and pressurized water reactors. Advanced modular reactor designs are denoted as Generation III. Some have passive safety features, and all have been developed to be more cost competitive. Generation III designs include the ABWR design and the pressurized water reactor, both of which use passive safety systems; they also include the AP600/AP1000 and the light-water-cooled heavy-water-moderated CANDU ACR-700. The nuclear industry has continued to develop yet more innovative Generation III+ designs. Generation III+ designs may have lower generating costs than Generation III designs, but the U.S. Nuclear Regulatory Commission (NRC) has not yet certified them, and their cost estimates have greater uncertainty. DOE is developing Generation IV nuclear energy systems that use even more advanced designs intended to further reduce life cycle costs.

Table A-2 summarizes the characteristics and NRC certification status of the reactor designs reviewed in this study.

Table A-2: Summary of New Reactor Designs[a]

Design	Supplier	Size and Type	U.S. Deployment Prospects and Overseas Deployment	NRC Certification Status
ABWR	General Electric	1,350 MW BWR	Operating in Japan, under construction in Taiwan.	Certified in 1996.
AP1000	Westinghouse	1,090 MW PWR	Additional design work to be done before plant ready for construction.	Design certification expected September 2005.
SWR 1000	Framatome Advanced Nuclear Power (ANP)	1,013 MW BWR	Under consideration for construction in Finland, designed to meet European requirements.	Submission of materials for pre-application review to begin in mid-2004. Pre-application review completion expected 2005.
CANDU ACR-700	Atomic Energy Company, Limited (AECL)Technologies Inc., U.S. subsidiary of AECL	753 MW HWR	Deployed outside Canada in Argentina, Romania, South Korea, China, and India.	Pre-application review scheduled to be completed by NRC, June 2004.
AP600	Westinghouse	610 MW PWR	Additional design work to be done before plant ready for construction.	Design is certified, but actual construction will be superseded by AP1000.
Simplified Boiling Water Reactor (ESBWR)	General Electric	1,380 MW BWR	Commercialization plan not likely to support deployment by 2010.	Pre-application review completion expected in early 2004. Application for design certification to be submitted mid-2005.
PBMR	British Nuclear Fuels (BNFL)	110 MW Modular pebble bed	No plan beyond completion of South African project.	Pre-application review closed September 2002 with departure of Exelon.
GT-MHR	General Atomics	288 MW Prismatic graphite	Licensed for construction in Russia.	Design certification application would begin by end of 2005.
International Reactor Innovative and Secure (IRIS) Project	Westinghouse	100 to 300 MW PWR	Plans to deploy between 2012 and 2015.	Design certification review to begin 2006.
European Pressurized Water Reactor (EPR)	Framatome-ANP	1,545 to 1,750 MW PWR	No decision on U.S. market.	Ordered for deployment in Finland.
System 80+	Westinghouse	1,300 MW PWR	Plants built in Korea. Design not planned to be marketed in United States.	Certified May 1997.
Advanced Fast Reactor; Power Reactor Innovative Small Module (AFR; PRISM)	General Electric, Argonne National Laboratory	300 to 600 MW, sodium-cooled	Began certification in the 1990s.	No action taken.

[a]Identical to Table A4-2.

Nuclear Fuel Cycle and Nuclear Waste Disposal

This study analyzes the economic costs of nuclear power contributed by the nuclear fuel cycle. It also considers two options for spent fuel disposition: (1) on-site storage followed by centralized disposal and (2) on-site storage and reprocessing, followed by centralized disposal. Recycle of mixed-oxide fuel was not considered. The front-end costs of nuclear fuel are relevant regardless of which disposition alternative is used. As shown in Table A-3, these costs amount to $3.50 to $5.50 per MWh or 5 to 12 percent of the cost of nuclear power generation. In the United States, the direct method of spent fuel disposal has been used to date, without reprocessing of spent fuel. The costs of disposal consist of on-site storage costs while awaiting permanent storage, plus a charge levied to pay for eventual permanent storage or disposal at a centralized site. The back-end costs are about $1.10 per MWh, as shown in Table A-4, which is about 2 percent of the overall LCOE. Plausible differences in fuel cycle costs are not a major factor in the economic competitiveness of nuclear power.

Table A-3: Components of Front-End Nuclear Fuel Costs, $ per kg U, 2003 Prices[a]

Process Step	Direct Outlays	Interest Cost	Total Cost
Ore Purchase	222 to 353	94 to 150	316 to 503
Conversion	40 to 94	15 to 35	55 to 129
Enrichment (per kg SWU)	606 to 951	197 to 306	804 to 1,259
Fabrication	193 to 250	54 to 69	246 to 319
Total			**1,420 to 2,209**
$ per MWh			**3.56 to 5.53**

[a]Abridged version of Table A5-1.

Table A-4: Disposal Costs, $ per MWh, 2003 Prices[a]

Fuel Cycle Component	No Reprocessing
Temporary on-site storage	0.09
Permanent disposal at Yucca Mountain	1.00
Total	1.09

[a]Identical to Table A5-2.

Nuclear Regulation

Federal Regulation 10 CFR Part 52 was adopted in the 1990s. It provides for combined construction and operation permitting and is aimed at streamlining the permitting process. The combined Part 52 license is designed to allow investors to resolve many historically important uncertainties before committing large amounts of money to a nuclear facility. This study analyzes the economic advantages that such regulatory streamlining can provide, both directly by reducing construction delays, and indirectly by reducing the risk premium necessary to compensate investors for possible delays or cancellations due to regulatory difficulties. For example, as more new nuclear plants are built well beyond 2015, this study finds that mature designs already in operation could generate energy that could be competitive with gas-fired electricity, if the nuclear licensing period could be reduced to five years (see Table 17 above).

Nonproliferation Goals

This study reviews international arrangements aimed at preventing nuclear proliferation. Some countries have chosen direct disposal of spent nuclear fuel, while others have chosen recycling of spent fuel. In the United States, policy decisions regarding direct disposal versus recycling must be reviewed when DOE considers a second repository. By statute, DOE must report to Congress on or after January 1, 2007, but not later than January 1, 2010, on the need for a second repository. (See Sec. 161(b), P.L. Law 97-425.) The uranium extraction (UREX) process was developed as a variant of plutonium-uranium extraction (PUREX). DOE is currently conducting R&D on further recycling technologies, including pyrometallurgical processing. In the future, an innovative fuel cycle that strongly resists nuclear proliferation, such as pyrometallurgical processing, will be pursued. The President recently announced a policy to cap the deployment of new reprocessing technologies outside a select group of countries. Nevertheless, the future economic viability of nuclear power does not depend on decisions about direct disposal versus reprocessing. As Appendix A6 shows, differences in the cost of nuclear waste handling between these two alternatives is too small to materially affect the economic viability of nuclear power.

Hydrogen

This study reviews the prospects of hydrogen as a transportation fuel that would reduce U. S. dependence on foreign oil and could have potentially large environmental benefits. Mass production costs need to be reduced by roughly one-half to two-thirds to achieve widespread adoption of hydrogen vehicles. The environmental benefits of hydrogen would be tempered to the extent that fossil fuels, with their attendant carbon emissions, were used to produce the hydrogen. Carbon emissions from oil would then simply be replaced by emissions from fossil-fuel power generation or steam methane reforming. Nuclear energy, on the other hand, would provide a pollution-free input to hydrogen production. A hydrogen economy, accompanied by more stringent control of carbon emissions, could greatly expand the demand for nuclear power.

Energy Security

This study considers the energy security benefits of nuclear power as a potential source of hydrogen to replace oil in the transportation sector and more generally as a substitute for gas-generated electricity. Energy security has been analyzed primarily in connection with oil and the political instability of the Middle East. A direct link to electricity is limited by the small amount of electricity produced using oil. However, nuclear energy could help ease oil security concerns if hydrogen is cogenerated for transportation. Currently, the United States imports about 4 percent of its natural gas consumption in the form of liquefied natural gas (LNG), but that percentage could grow if many new gas-fired electricity generating plants are built and if North

American gas production expands only sluggishly. As international trade in LNG becomes more extensive and the United States imports increase, this energy security linkage could become more important, if nuclear electricity substitutes directly for gas-generated electricity.

This study considers potential supply and demand shocks from environmental, national security, and other risks affecting choices among electricity generation technologies. Maintaining some nuclear capacity now could avoid a costly and lengthy adjustment of gearing up a nuclear industry that might otherwise be in a run-down condition. This study uses a decision-making model to develop a numerical example of a portfolio of fossil and nuclear electrical generating capacity. In this example, 25 percent of new capacity would be nuclear. Further research is needed to refine this analysis.

Mr. ISSA. Additionally, I would like to have yesterday's remarks by President Bush put in the record, since he helped set up our meeting with his efforts.

[The information referred to follows:]

For Immediate Release
Office of the Press Secretary
April 27, 2005

President Discusses Energy at National Small Business Conference

Washington Hilton Hotel
Washington, D.C.

2:16 P.M. EDT

THE PRESIDENT: Thanks for the warm welcome. I appreciate such a generous welcome. Marianne, thank you for your introduction, and congratulations on being the Small Business Person of the Year. You had some pretty stiff competition. (Laughter.) I appreciate the courage that Marianne has shown and her determination to succeed. She is proof that the entrepreneurial spirit in America is really strong.

I want to thank Hector Barreto, the SBA Administrator. I appreciate the fine job he's done. (Applause.) It was my honor to meet some of the state Small Business Person of the Year honorees. Congratulations. I appreciate the ambassadors who are here. Embajadores, thank you for coming. And I appreciate you all giving me a chance to come by and visit with you. (Laughter and applause.)

I appreciate the fact that our small business owners are taking risks and pursuing dreams, and as a result, you're creating jobs for millions of our citizens. A vibrant small business sector is important for the economic health of our country. I appreciate the fact that the small business entrepreneurs are some of the great innovators in our nation. After all, men and women who run small businesses have a vision to see beyond what is, and the courage to pursue what might be.

From Thomas Edison's light bulb to Alexander Graham Bell's telephone, to Henry Ford's Model T, most Americans -- most of America's great inventions began with the innovative spirit of entrepreneurs. And today a new generation of entrepreneurs is leading a technological revolution that will transform our lives in incredible ways. I'm going to spend a little time talking about how technology can help us.

One of the roles of an administration is to set an agenda, a clear agenda. I've laid out an agenda that I believe will unleash the innovative spirit of our small business entrepreneurs. We can't make you successful, but we can create an environment in which people can dream big dreams and in which people are willing to risk capital. We need to keep your taxes low. We need to protect you from needless regulation and the burden of junk lawsuits. (Applause.) We'll continue to work to open up new markets for your products. The House of Representatives and the United States Senate needs to pass CAFTA legislation, free-market agreement with Central America. (Applause.)

We'll continue to work to lower the cost of health care by insisting that health care modernize itself through electronic records and helping to spread health savings accounts-- they're particularly good for small businesses -- and to work with the United States Congress to finally pass medical liability reform. (Applause.) I look forward to working with the Congress to create association health plans, so small businesses can buy insurance, can pool risk across jurisdictional boundaries so they can buy insurance at the same discount that big businesses can.

As small business owners, you know that a dollar should be spent wisely, or not at all. That same standard ought to apply to the federal government when it comes time to spending your money. (Applause.) I've submitted a disciplined budget to the Congress that meets our priorities, that restrains federal spending and keeps us on track to cut the deficit in half by 2009. I appreciate the fact that the Senate has passed a version of the budget; and the House has passed a version of the budget. Now it's time for them to together and pass a budget resolution this week.

By restraining federal spending, by keeping taxes low, we'll keep this economy growing and keep the innovative spirit strong. But in order to make sure our economy grows, in order to make sure people are still able to find opportunity, in order to encourage small business sector growth and vitality, we need to address a major problem facing our country -- and that is our nation's growing dependence on foreign sources of energy. (Applause.)

Technology is allowing us to better use our existing energy resources. And in the years ahead, technology will allow us to create entirely new sources of energy in ways earlier generations could never dream. Technology is the ticket, is this nation's ticket to greater energy independence. And that's what I want to talk about today. I fully understand that many folks around this country are concerned about the high price of gasoline. I know small business owners are.

I went to Fort Hood the other day -- it's right around the corner from Crawford. (Laughter.) And sat down with some of our troops and we had dinner -- lunch, in Texas they call dinner (laughter) -- the noon meal, and supper the evening meal. (Laughter and applause.) I'm trying to standardize the language. (Laughter.) We sat down for lunch. (Laughter.)

And I was asking the soldiers, you know, what was on your mind -- what was on their mind. And a fellow said, why don't you lower gas prices -- gasoline prices, Mr. President? Obviously, gasoline prices were on his mind. I said, I wish I could; if I could, I would. I explained to him that the higher cost of gasoline is a problem that has been years in the making. To help in the near-term, we'll continue to encourage oil-producing countries to maximize their production, to say to countries that have got some excess capacity, get it on the market so you do not destroy the consumers that you rely upon to buy your energy.

We're doing everything we can to make sure our consumers are treated fairly, that there is no price gouging. Yet, the most important thing we can do today is to address the fundamental problem of our energy situation. That's the most important thing we can do. And the fundamental problem is this: Our supply of energy is not growing fast enough to meet the demands of our growing economy.

Over the past decade our energy consumption has increased by more than 12 percent, while our domestic production has increased by less than one-half of 1 percent. A growing economy causes us to consume more energy. And, yet, we're not producing energy here at home, which means we're reliant upon foreign nations. And at the same time we've become more reliant upon foreign nations, the global demand for energy is growing faster than the growing supply. Other people are using more energy, as well. And that's contributed to a rise in prices.

Because of our foreign energy dependence, our ability to take actions at home that will lower prices for American families is diminishing. Our dependence on foreign energy is like a foreign tax on the American people. It's a tax our citizens pay every day in higher gasoline prices and higher costs to heat and cool their homes. It's a tax on jobs and it's a tax that is increasing every year.

The problem is clear. This problem did not develop overnight, and it's not going to be fixed overnight. But it's now time to fix it. See, we got a fundamental question we got to face here in America: Do we want to continue to grow more dependent on other nations to meet our energy needs, or do we want to do what is necessary to achieve greater control of our economic destiny?

I made my decision. I know what is important for this country to become less dependent on foreign sources of energy, and that requires a national strategy. Now, when I first got elected, I came to Washington and I said, we need a national strategy. And I submitted a national strategy to the United States Congress. And it has been stuck. And now it's time for the Congress to pass the legislation necessary for this country to become less dependent on foreign sources of energy. (Applause.)

And the most important component of our strategy is to recognize the transformational power of technology. Over the last quarter century, technology has radically changed the way we live and work. Think about this: Just 25 years ago -- for a guy 58 years old, that doesn't seem all that long ago -- (laughter) -- if you're 24 years old, it's a heck of a long time ago. (Laughter.) In the 1980s, most Americans used typewriters, instead of computers. We used pay phones, instead of cell phones. We used carbon paper, instead of laser printers. We had bank tellers, instead of ATMs. (Laughter.) We had Rolodexes, instead of PDAs. And for long family trips, we played the "license plate" game -- (laughter and applause) -- instead of in-car DVDs. (Laughter.) We've seen a lot of change in a quick period of time, haven't we?

I believe the next 25 years the changes are going to be even more dramatic. Our country is on the doorstep of incredible technological advances that will make energy more abundant and more affordable for our citizens. By harnessing the power of technology, we're going to be able to grow our economy, protect our environment, and achieve greater energy independence. That's why I'm so optimistic about our future here in America.

The first essential step toward greater energy independence is to apply technology to increase domestic production from existing energy resources. And one of the most promising sources of energy is nuclear power. (Applause.) Today's technology has made nuclear power safer, cleaner, and more efficient than ever before. Nuclear power is now providing about 20 percent of America's electricity, with no air pollution or greenhouse gas emissions. Nuclear power is one of the safest, cleanest sources of power in the world, and we need more of it here in America.

Unfortunately, America has not ordered a new nuclear power plant since the 1970s. France, by contrast, has built 58 plants in the same period. And today, France gets more than 78 percent of its electricity from safe, clean nuclear power.

It's time for America to start building again. That's why, three years ago, my administration launched the Nuclear Power 2010 Initiative. This is a seven-year, $1.1 billion effort by government and industry to start building new nuclear power plants by the end of this decade. One of the greatest obstacles we face to building new plants is regulatory uncertainty which discourages new plant construction. Since the 1970s, more than 35 plants were stopped at various stages of planning and construction because of bureaucratic obstacles. No wonder -- no wonder -- the industry is hesitant to start building again. We must provide greater certainty to those who risk capital if we want to expand a safe, clean source of energy that will make us less dependent on foreign sources of energy.

To do so, I've asked the Department of Energy to work on changes to existing law that will reduce uncertainty in the nuclear plant licensing process, and also provide federal risk insurance that will protect those building the first four new nuclear plants against delays that are beyond their control. A secure energy future for America must include more nuclear power. (Applause.)

A secure energy future for America also means building and expanding American oil refineries. Technology has allowed us to better control emissions and improve the efficiency and environmental performance of our existing refineries. Yet there have been no new oil refineries built in the United States since 1976. And existing refineries are running at nearly full capacity. Our demand for gasoline grows, which means we're relying more on foreign imports of refined product.

To encourage the expansion of existing facilities, the EPA is simplifying rules and regulations. I will direct federal agencies to work with states to encourage the building of new refineries -- on closed military facilities, for example -- and to simplify the permitting process for such construction. By easing the regulatory burden, we can refine more gasoline for our citizens here at home. That will help assure supply and reduce dependence on foreign sources of energy. (Applause.)

Advances in technology will also allow us to open up new areas to environmentally responsible exploration for oil and natural gas, including the Arctic National Wildlife Refuge. (Applause.) Technology now makes it possible to reach ANWR's hydrocarbons by drilling on just 2,000 acres of the 19 million acres of land. That's just one-tenth of 1 percent of ANWR's total area. Because of the advances in technology, we can reach the oil deposits with almost no impact on land or local wildlife. (Applause.) Developing this tiny section of ANWR could eventually yield up to a million barrels of oil per day. That's a million barrels less that we've depended on from foreign sources of energy.

Listen, the more oil we can produce in environmentally sensitive ways here at home, the less dependent our economy is, the less reliant we are on other -- on other parts of the world. Technology is allowing us to make better use of natural gas. Natural gas is an important source of energy for industries like agriculture or manufacturing or power production. The United States is the sixth-largest proven reserves of natural gas in the world, and we'll do more to develop this vital resource. That's why I signed into law a tax credit to encourage a new pipeline to bring Alaskan natural gas to the rest of the United States. (Applause.)

Technology is also helping us to get at reserves of natural gas that cannot be reached -- easily reached by pipelines. Today, we're able to super cool natural gas into liquid form so it can be transported on tankers and stored more easily. Thanks to this technology, our imports of liquefied natural gas nearly doubled in 2003. Last year, imports rose another 29 percent. But our ability to expand our use of liquefied natural gas is limited, because today we have just five receiving terminals and storage facilities around the United States.

To take advantage of this new -- this technology, federal agencies must expedite the review of the 32 proposed new projects that will either expand or build new liquefied natural gas terminals. In other words, there's projects on the books, and we're going to get after the review process. Congress should make it clear to the Federal Energy Regulatory Commission its authority to choose sites for new terminals, so we can expand our use of liquefied natural gas.

Technology also allows us to use our most abundant energy source in a smart way. America as enough coal to last for 250 years. But coal presents an environmental challenge. To make cleaner use of this resource, I have asked Congress for more than $2 billion over 10 years for my coal research initiative. It's a program that will encourage new technologies that remove virtually all pollutants from coal-fired power plants. My Clear Skies initiative will result in more than $52 billion in investment in clean coal technologies by the private sector. To achieve greater energy dependence, we must put technology to work so we can harness the power of clean coal.

The second essential step toward greater energy independence is to harness technology to create new sources of energy. Hydrogen is one of the most promising of these new sources of energy. Two years ago my administration launched a crash program called the Hydrogen Fuel initiative. We've already dedicated $1.2 billion over five years to this effort to develop hydrogen-powered fuel cells. We know that when hydrogen is used in the fuel cell it has the power to -- potential to power anything from a cell phone to a computer to an automobile; that it emits pure water, instead of exhaust fumes.

I've asked Congress for an additional $500 million over five years to help move advanced technology vehicles from the research lab to the dealership lot. See, I want the children here in America -- you two are sitting there -- to be able to take your driver's test in a completely pollution-free car that will make us less dependent on foreign sources of energy. (Applause.) To help produce fuel for these cars, my administration has also launched a Nuclear Hydrogen Initiative, an effort to develop advanced nuclear technologies that can produce hydrogen fuels for cars and trucks. My budgets have dedicated $35 million over the past three years and will continue this effort.

In other words, we're developing new technologies that will change the way we drive. See, I know what we're going to need to do for a generation to come. We need to get on a path away from the fossil fuel economy. If we want to be less dependent on foreign sources of energy, we must develop new ways to power automobiles. My administration is committed to finding those news ways, and we're working with industry to do so.

Ethanol is another promising source of energy. I like the idea of people growing corn that gets converted into fuel for cars and trucks. Our farmers can help us become less dependent on foreign oil. (Applause.) Technology is now under development that may one day allow us to get ethanol from agricultural and industrial waste.

We can produce another renewable fuel, bodies, from leftover fats and vegetable oils. I mean, we're exploring a lot of alternatives. Ethanol and biodiesel have got great potential. And that's why I've supported a flexible, cost-effective renewable fuel standard as part of the energy bill. This proposal would require fuel producers to include a certain percentage of ethanol and biodiesel in their fuel and would increase the amount of these renewables in our nation's fuel supply. Listen, more corn means more ethanol, which means less imported oil.

Technology can also help us tap into a vital source that flows around us all the time and that is wind. That's why I've asked Congress to provide $1.9 billion over 10 years for tax incentives for renewable energy technologies like wind, as well as residential solar heating systems and energy produced from landfill gas and biomass. (Applause.)

An energy strategy must be comprehensive, all aimed at making us less dependent. A third essential step toward greater energy independence is to harness the power of technology so we can continue to become better conservers of energy. Already, technology is helping us grow our economy while using less energy. For example, in 1997, the U.S. steel industry used 45 percent less energy to produce a ton of steel than it did in 1975. The forest and paper industry used 21 percent less energy to produce a ton of paper. In other words, we're making advances in conservation. And in the years ahead, if we're smart about what we do, we can become even more productive while conserving even more energy.

Technological advances are helping develop new products that give our consumers the same and even better performance at lower cost by using less energy. Think about this, you can buy a refrigerator that uses the same amount of power as a 75-watt light bulb. It's a remarkable advance when it comes to helping consumers save money on energy.

Advances in energy-efficient windows keep hot and cold air in and prevent your dollars from flowing out. (Laughter.) High efficiency light bulbs last longer than traditional ones, while requiring less electricity.

These and other technological advances are saving our consumers a lot of money, and there's more to be done. Let me tell you this, in 2001, the average American family spent about half as much to heat his home as it did in 1978. Think about what's possible over the next 25 years. We can imagine a day when technologies like solar panels, high-efficiency appliances, and advanced installation will allow us to build zero-energy homes that produce as much energy as they consume. That's the promise that technology holds for us all.

And as we make our homes more energy efficient, we're doing the same for our automobiles. Hybrid vehicles are one of the most promising technologies immediately available to consumers. These cars are powered by a combination of gasoline and electricity. They provide better fuel efficiency, ultra-low emissions and exceptional performance. And their electronic systems are paving the way for tomorrow's hydrogen-powered vehicles.

We're encouraging automakers to produce a new generation of modern, clean diesel cars and trucks. My administration has issued new rules that will remove more than 90 percent of the sulfur in diesel fuel by 2010. Clean diesel technology will allow consumers to travel much farther on each gallon of fuel, without the smoke and pollution of past diesel engines. We've proposed $2.5 billion over 10 years in tax credits that will encourage consumers to buy energy-efficient hybrid cars and trucks, and we need to expand these incentives to include clean diesel vehicles, as well. (Applause.)

As we conserve energy at home and on the road, technology will help us deliver it more efficiently. New technologies such as superconducting power lines can help us bring our electrical grid into the 21st century, and protect American families and businesses from damaging power outages. Some of you who live in the Midwest and on the East Coast know what I'm talking about -- damaging power outages. We have modern interstate grids for our phone lines and our highways. It's time for America to build a modern electricity grid. (Applause.) The electricity title is an important part of the energy bill. As a matter of fact, a lot of which I've discussed so far is an important part of the energy bill that needs to get passed by the United States Congress before August of this year. (Applause.)

The House acted, and I appreciate the leadership in the House. Now it's time for the United States Senate to act. And then it's time for them to get together and iron out their differences and get me a bill so I can sign.

The fourth essential step toward greater energy independence is to make sure other nations can take advantage in advances -- take advantage of the advances in technology to reduce their own demand. Listen, we need to remember that the market for energy is a global one, and we're not the only large consumer. Much of the current projected rise in energy prices is due to rising energy consumption in Asia. As Asian economies grow, their demand for energy is growing. And the demand for energy is growing faster than the supply of energy is increasing. And as small business people, you understand what happens when demand is larger than supply -- you hope that's the case for the products you produce. (Laughter.) Our costs -- our prices are going up. It is in our interest to help these countries become more energy self-sufficient; that will help reduce demand, which will help take pressure off price, and at the same time help protect the environment.

I'm looking forward to going to a G8 meeting in July in Great Britain. And there I'm going to work with developed nations, our friends and allies to help developing nations, countries like China and India to develop and deploy clean energy technology. Like us, some of these countries have got substantial coal reserves. We need to find practical ways to help these countries take advantage of clean coal technology.

As well, we will explore ways we can work with like-minded countries to develop advance nuclear technologies that are safe, clean and protect against proliferation. With these technologies, with the expansion of nuclear power, we can relieve stress on the environment and reduce global demand for fossil fuels. That would be good for the world, and that would be good for American consumers, as well. (Applause.)

This strategy will work for our children and our grandchildren. We should have put this in place several decades ago. We haven't had a national energy strategy in this country for a long period of time. I tried to get the Congress to pass it four years ago. Now is the time for them to act. For the sake of this country, for the sake of a growing economy, and for the sake of national security, we've got to do what it takes to expand our independence. We must become less dependent.

And there's no doubt in my mind that technology is going to help us achieve that objective.

One reason why I believe this so strongly is because free societies are able to adjust to the times. And we're the freest of free societies. We're a society where it doesn't matter where you were raised or where you're from; if you've got a dream, you can pursue it and realize your dream. (Applause.)

Our country has always responded to challenges because we've got people with such great imaginations and such drive and such determination. Twenty-five years from now, people are going to look back and say, I like my hydrogen-powered automobile -- (laughter) -- and I produced a little extra energy this year from my home. Our farmers are going to be saying, you know, the crops up, and we're less dependent.

Now is the time to put that strategy in place. Now is the time to do the right thing for America. Now is the time to set aside political differences and focus on what is good for the United States of America. And with your help, we'll achieve that. (Applause.)

God bless you all. Thanks for coming. (Applause.)

END 2:51 P.M. EDT

Mr. ISSA. I am not sure that officially we coordinated, but it certainly was timely.

With that, I would like to lead off with my first question. And probably, Dr. Moore, I suspect I have a lot of questions for you, but I am going to go to our other two from the standpoint of equal time. You are looking a little lonely there. This is both for Fertel and Jones.

The blend of financial incentives that you talked about in your study that is up here, the President's proposal was for four nuclear power plants to be funded. When I look at the eight, I can certainly see where you get down to eight, you are down to 3.2 cents per kilowatt hour, to put it in the ratepayer's terms, which means it is competitive with fossil fuel, without accounting for the advantages to zero emissions generation.

It seems your study concluded that you needed to get to eight. Are you and the President talking essentially two different visions of the same thing, getting us through those what we used to call non-recurring expenses?

Can you characterize where there may be common ground or whether there is a difference of four power plants between the proposals?

Mr. JONES. Yes, sir. The President and I seem to be speaking off the same page. In Table 1, right here to my right, your left, by the time we get down to the fourth or fifth plant, we are well within the competitive range with fossil generation. So the President and the Chicago study are in perfect agreement on that number.

Mr. ISSA. Mr. Fertel.

Mr. FERTEL. I think, Mr. Chairman, first of all, the President's discussion yesterday, which we welcome—and this is about the fifth time since the State of the Union he has spoken out positively on nuclear energy, which is clearly very encouraging to us.

Mr. ISSA. The first time he did it timely for my hearing, though.

Mr. FERTEL. We thought he did it intentionally for your hearing. We thought you had orchestrated that, and really appreciated the timing.

What the President said yesterday, he actually talked less incentives for these four plants than a risk insurance, which is something that the chief executive officers, because of the experience they had in the previous licensing process, have raised with Secretary Bodman and with the White House a number of times now as something that they felt was very important. And to be honest, if you demonstrated the licensing process worked on four plants—put aside the economic incentives—we think that you would have a track record that would give both the financial community and the boards of directors the confidence that the licensing process is disciplined.

We are actually pretty optimistic the licensing process, as it is being reshaped, will be not only protective of health and safety, but actually pretty reasonable in how you implement it. But it hasn't been demonstrated. So I think that four plants for that is clearly a very adequate demonstration. And I think that as Don pointed out, we think you get pretty economic pretty fast these days.

Mr. ISSA. Excellent. I will also ask that a poll done in my own district, at government expense, which shows approximately 80 percent of my constituents favor adding an additional reactor where we have two working reactors at San Onofre. And I will provide that in the next 5 days so it gets in the record. That doesn't mean that there aren't 20 percent who didn't say yes, but certainly I don't get 80 percent in my district, so I always assume it is an awfully good sign when something is more popular than I am.

Sticking to our nuclear experts, per se, on production, the President yesterday seemed to be talking about Generation 3.5, and not Gen 4. Could you characterize the differences and the advantages? Because I think you are talking Gen 3.5 here too.

[The information referred to follows:]

Congressman Darrell Issa
Constituent Survey Site

1) There are several different proposals being considered in Congress to address the California energy crisis. What do you feel should be the first step in solving this crisis.

Increasing the supply of electricity to lessen the likelihood of blackouts.	3089	28.7%
Implementing price caps to limit the electricity costs.	2144	19.9%
Investigating price fixing by utilities and electric generators.	3428	31.8%
Adopting a long-range plan to diversify our energy supply and meet future energy needs.	2106	19.6%

2) Reactor one at San Onofre Nuclear Power Plant, which is in our congressional district, was retired recently and is being dismantled. Building a new, replacement reactor would generate enough power to meet the needs of nearly a million Californians.

Support the construction of a replacement reactor at San Onofre.	8313	80.9%
Oppose the construction of a replacement reactor at San Onofre.	1968	19.1%

3) Earlier this year, I sponsored the Energy Self-Reliance Act. This bill includes a tax credit to promote new technologies and alternative energy sources. Do you support this approach to meeting our nation's energy needs?

Support the Issa Plan	7997	80.2%
Prefer another approach.	1970	19.8%

4) I recently asked Congress to investigate price fixing and market manipulation by utilities and generators. If found that Californians have been charged unjust and unreasonable rates generators may be ordered to pay refunds to California consumers.

Support the Issa Plan	9109	92.6%
Prefer another approach.	729	7.4%

5) To avert blackouts, I have co-sponsored legislation to authorize businesses and institutions with backup generators to bring them on line before blackouts occur. This reduces demand at critical times and makes electricity available for other users.

Support the Issa Plan	8689	89.4%
Prefer another approach.	1029	10.6%

Mr. FERTEL. Our current reactors, if you sort of just baselined them and said that the 103 operating reactors we have today are Gen 3, if you just took that as a baseline—and let me go first out to Gen 4, which is a program that the Department of Energy has ongoing right now, and has been ongoing for probably about 5 or 6 years. It is looking at both new advanced fuel cycles, liquid metal fuel cycles, high temperature gas fuel cycles, and reactors that will be commercial. It may vary in people's minds, but their commercial timing is probably in the 2030, 2040 timeframe, for really commercializing the reactors.

So, for instance, our Nation is looking to move ahead in Gen 4 space to build a very high temperature gas reactor, helium being the gas that they are talking about. And it has some very significant advantages if you make it work right. First, it is a high enough temperature that you can actually produce hydrogen chemically with it, so it is a good source for producing hydrogen.

It also is very efficient because of the high temperature, so rather than the 30 to 32 percent efficiency for producing electricity today, you might get as high as close to 50 percent. It also has the potential, because of the way you would design your fuel, that you could never melt the fuel, so you could never have the type of accident you protect against from our current reactors, so it moves down that road. But that is a Gen 4 type reactor, and we are doing that internationally with other folks.

Mr. ISSA. Is it also true—I am terrible with these leading questions—that helium type production would also be able to be put completely underground?

Mr. FERTEL. Actually, the General Atomics design is below ground, that is true. That is true. You could design it that way. Or, again, you could design it aboveground, as they are looking at for some of what they call pebble bed reactors.

Mr. ISSA. I only ask that because obviously in our other hearings we are constantly dealing with the question of terrorism and airplanes strikes and so on.

Mr. FERTEL. The Gen 3.5 is actually—you can think of Gen 3.5 in two types of designs that basically exist today, and in fact are operational in some countries. One design is what we call an evolutionary design; it is taking our current plants and moving them to where technology is right now. So I have gone to digital systems rather than analog systems. I have taken everything I have learned on my current plants and moved it both from a technology and operational perspective going forward. I have also done a bunch of things that are smarter in how I am going to maintain my plant for operational activities, so what I have learned when I have run into interferences in lay-down areas, I have now built it in so it is better.

So it is an evolutionary design. It doesn't take the technology at all, it is still a light/water reactor design, it works the same as my current plants, it is just moved along in technology to where we are today or where we think we can be, and it has taken up all the lessons learned from the operation of current plants.

The other Gen 3.5 that we have is we have moved to what we call passive designs. We call both of these advanced light/water reactors. We did message testing and passive designs, which the engineers thought was great. Passive design is if I can move the water by gravity rather than a pump and motor, why don't I do that? So if I need water to get to here, rather than pumping it from here to here, why don't I have it flow downhill to that? Pretty simple.

Mr. ISSA. Meaning a pump failure is no longer a catastrophic failure.

Mr. FERTEL. That is right. One, I eliminate equipment, so I save some money because I don't need as much equipment; and, two, I decrease the failure modes from a safety standpoint. So basically you have gone to passive designs for moving water around or for heat convection.

Now, I was kidding on passive, because the engineers thought passive was great. We did message testing with the public, and the public's reaction to passive was it sounded like it didn't do anything when it got into trouble and, oh my God, that sounds terrible. So we had to drop passive.

Mr. ISSA. So it is now called self-healing?

Mr. FERTEL. We will try that one. We just call it advanced. But that is what you have in 3.5, you have an evolutionary design, then you have a design that is basically trying to eliminate failure modes and equipment if I can do it through any sort of natural processes. And both of those designs right now are being licensed or have been licensed by the Nuclear Regulatory Commission. The evolutionary design is actually operating in Japan; they have two large General Electric advanced boiling water reactors operating in Japan right now.

Mr. ISSA. One followup question on that line, which is we are known in America for being the most eclectic nuclear producer; we have no two plants that you can walk into that look alike. And I know from safety studies that has been one of the problems. You train for the plant you are at because we built them one off in most cases. Would this 3.5 provide, if you will—and this is terrible to say—the airbus type cockpit, to where people and inspectors would have significant improvement in the ability to learn one, inspect, or operate all?

Mr. FERTEL. The very short answer is yes. The whole intent going forward is to sort of implement the French model, which is standardized families of plants, and basically say if I am going to build the advanced boiling water reactor or, in this case, the economic simplified boiling water reactor, which is what they are marketing in our country, you would build a family of those, they would be identical.

If I were an operator at one and the chairman was an operator at another one, it wouldn't matter which control room we walked into. Same thing on maintenance, and even going down, if we could, we would like to keep the equipment standardized, to the degree we could, so that you could basically have common inventory and safe money on supplies.

Your observation on our industry, which I did grow up in in a bit, it was sort of the American way, because in France they had——

Mr. ISSA. The American way before Henry Ford.

Mr. FERTEL. I mean, in France you had one electricity company, you had one reactor supplier, you had one fuel supplier, and they were all owned by the government. So when the government made a decision you should do something, everybody kind of marched to the same road. In our case, basically every utility wanted something slightly different than their brethren, and every supplier saw those as out of scopes. So capitalism here created a myriad of different plant designs.

But, no, the answer to your question is going forward we are doing to go with standardized designs.

Mr. ISSA. Excellent.

One more question that I had which was peripheral, but you touched on it. The 2025, 2030, 2040, about the time we want to be a hydrogen economy, the next generation, Gen 4, produces significant amounts of hydrogen. How significant is that? What does it really relate to from a standpoint of providing it as a fuel or for other industrial uses?

Mr. FERTEL. You mean as far as the nuclear role in that?

Mr. ISSA. Right. If we were to begin rolling out that next generation, let us just say in 2020, and ramp up to where, by 2050, that was the standard, these more efficient, and it were producing our entire base load, how much hydrogen would it produce that theoretically is going to be used for driving automobiles?

Mr. FERTEL. I don't know quantitatively the answer, but what I can tell you is you won't use the plant for dual purposes, in all likelihood. You would probably build the high temperature gas reactors that would produce hydrogen for you, and you would produce high temperature gas reactors that are going to produce electricity.

There may be certain times where you might be able to use it for a dual function, but in talking to at least the Department of Energy folks and the industry folks that are looking at it, they are saying that if you really are going to produce hydrogen in the quantities that you are going to need, you are going to dedicate the plants to doing that.

Likewise, if you are using the plants for electricity, and the value of the plants for electricity would be they are smaller; I can build them in increments in a more competitive electricity market, as opposed to the large plants we build right now. But it sounds like you would have separate plants. Though they would be capable of doing both, you probably wouldn't build them, or at least most of them, to do both.

Mr. ISSA. Is there any other practical way to produce the quantity of hydrogen necessary to move our entire fleet of automobiles and trucks on hydrogen? Is there any other practical way to do it?

Mr. FERTEL. The other practical way is you are basically using fossil fuels to split them to get hydrogen, and then you are burning. It is sort of counterproductive to produce emissions to reduce emissions. So we don't think so. There are honestly people at the national labs who aren't sure that even using nuclear to produce hydrogen is the right thing, that is the answer to our problem; not the nuclear, but the hydrogen.

But clearly in talking with folks, if we are going to produce large quantities of hydrogen, nuclear seems to be a way that we should seriously look at trying to do it, and I think that is why our Government has decided that the Gen 4 reactor they want to look at is the very high temperature, because they see the dual value, and that is why the Idaho folks want to see a reactor built there to try and begin to demonstrate its use in that mode.

Mr. ISSA. And, Dr. Moore, as an expert on this whole sustainability question, how do you see that playing, as far as looking, to a great extent, beyond our careers, into the 2040 timeframe? Is this sensible or, as you were so good in pointing out, if not this, then what? Is there an "or what" that you can see on the horizon?

Mr. MOORE. Well, again, I haven't done the math thoroughly on it, but it is very obvious to me that there is no other non-CO_2-emitting form of energy that you could make that much hydrogen with. I mean, it would take a lot of nuclear plants to make enough hydrogen to replace all of the fossil fuel in the transport fleet.

The other option is that hybrid technology will come in and be with us for 40 or 50 years before there is a change to another technology from that. That is another possibility. Another possibility is that someone will eventually invent a battery or electrical storage device where then you could use the nuclear energy to charge the vehicle directly, rather than having to make hydrogen.

It is not just the making of the hydrogen that is technically difficult with the idea of going to a hydrogen fleet. Then you have to distribute it. It is very corrosive. Then you have to figure out how to get enough of it into an automobile to make it go 300 miles. And they still haven't figured that out yet. GM is experimenting with 10,000 psi tanks, and you still can't get enough in there and still have room for your suitcase in your car. So there are quite a few technical obstacles besides the manufacturing of the hydrogen.

But once again, as with power generation, there is no other technology that we know of today that can make the kind of dent in fossil fuel reliance that we are thinking about in terms of both CO_2 emissions, air pollution, and energy security, reliance on offshore sources. Nothing else that I know of could do that.

Actually, in the break we had a discussion about conservation. I know that subject was mentioned fairly high up in the President's speech yesterday, and, of course, that has to be a central part of a comprehensive energy policy. I know that is not what we are here to talk about today, but just to go on record——

Mr. ISSA. Dr. Moore, we wouldn't have invited you if we didn't want to be complete in dealing with nuclear versus alternatives, so please feel free to elaborate.

Mr. MOORE. Conservation is an across-the-board thing, it doesn't matter how you are producing the electricity—and in all other energy areas as well—it doesn't matter what your fuel is, the issue of conservation has to do with efficient use. For example, we could probably turn half the lights off in here, nearly all of them, and open up the curtains and conserve the electricity that is being used to light this room right now.

Mr. ISSA. They don't trust Congressmen in the dark.

Mr. MOORE. They do in the light?

Mr. ISSA. Well, forewarned is forearmed.

Mr. MOORE. But suffice it to say that conservation is a very important part of this whole thing, and that the United States is not exactly the world's leader in conservation of energy.

Mr. ISSA. Although I will mention that California is the Nation's leader in conservation of energy.

One question I have, nuclear is a great base load because, as we all know, it doesn't turn on and off quickly. Geothermal obviously has a little more flexibility, but it is still inherently a base load. Wind, you get it when you get it; solar, you get it when you get it. If I go through all the zero emissions fuels, it would appear that hydro is the only large-scale zero emissions that is demand-oriented, turns on and off very quickly.

And each of you could participate in this. If nuclear were the answer for 100 percent of what its capacity is, how do you see it fitting in? What is its maximum? We always hear about France, for example, that believes they are at their maximum, which is about 80 percent. Where is the maximum for nuclear before you simply are in that problem that it is a base load only and peak has to come from some other source?

Mr. FERTEL. First of all, just to put our system in perspective with the French system, the amount of generation we have from nuclear power plants in this country, the kilowatt hours that keep the lights on is larger than France and the next largest nuclear country after them, Japan, combined. So going to what Patrick said, we consume a lot of electricity in this country.

In France, they actually do load follow. Now, they follow a load, they basically are either at full capacity or they will go down as the load goes down. They also export a lot of electricity, their nuclear electricity, to make money off of it to other European countries.

I think, in our country, the strength of the system continues to be the fact that you do have a different technology. I think you will always—probably not always, but at least in my lifetime—have combustion turbines for peaking. You operate them a couple percent a year. So they are there; they burn a lot of gas when they operate.

I was telling Patrick during the break that if you take a 1,000 megawatt plant—we have built 280,000 megawatts of gas since 1992 in this country. That is why gas is such a problem. And we built 14,000 megawatts of coal and nuclear since 1992. That gives you a perspective of what we have been doing. And if you take a 1,000 megawatt gas plant, combined cycle, and say it operates its base load, 1,000 megawatt plant uses as much gas as 1 percent of the Nation's residential use; 1 percent of the Nation's residential use. It sucks gas if you use it as a base load plant. But using it for peaking, it only operates a couple percent.

So I think, Mr. Chairman, what you would have, at least in the horizon we look out at—and we support conservation and efficiency. We as a Nation need to do more, and prices help us do more in this country. Industry leads that and commercial follows it, and residential customers lag it. But fundamentally high prices will drive more conservation and efficiency.

But I think we are going to burn coal. We are going to need clean coal. I mean, we have loads of coal, 250 years worth of coal, probably, so we will continue to do it. We have just got to do it smarter and begin to do less of it.

Nuclear is 20 percent right now. If I had my druthers, we would grow to probably double that or more. But that is a long time to do, because we have 900,000 megawatts on this grid. I mean, it is a monster electricity system in this country. I mean, it is just huge. And it is sort of the lifeblood of everything we do in the Nation.

So I think you are going to have, at least for the lifetime of most of the people we care about and know about today, you are going to need a mix, and you are going to still use gas, but you shouldn't use it for anything but peaking. And I wouldn't even use it for intermediate down the road because I think it has other more important uses in other processes.

I think that we still need to use clean coal and I think we should increase renewables and we should increase nuclear.

On renewables, I think the critical thing I mentioned to Patrick is you need to develop storage. Your comment on wind is right; you only get electricity when the wind blows. And if you had some storage techniques, you could have electricity longer. The only storage technique we could come up with was pump hydro, which used to be a storage technique if you looked it up with a hydro facility. But we don't have many new hydro facilities in this country. So I think you still have a mix.

Mr. ISSA. Marvin, in the energy bill there is a pump storage station for 500 kilowatts.

Mr. FERTEL. It is probably megawatts.

Mr. ISSA. 500 megawatts, thank you. 500 megawatts twin turbine in my district. It is the fourth time that I have put it into a bill. We are going to get there but, in fairness, the FERC has gone through the process and is in a preliminary stage. But it is one of those areas where I am very familiar that the 1,500 feet of rise over a very short period of time doesn't occur just anywhere.

So the ability to produce it in our Lake Elcinor area is a pleasant opportunity. It happens to also be exactly the point where the southern California power outage was caused by a lack of about half of that much power to be available at peak. And I always try to make that point.

Yes, please, Patrick.

Mr. MOORE. Just a couple points on the demand issue versus intermittent. One of the problems with the word geothermal, geothermal refers to two completely separate technologies; it refers to the type of geothermal you have in California, where you get down into deep hot vents and you are basically producing steam to run turbines. Iceland has a big system like that.

It happened when the Department of Energy in Washington decided to take on ground source heat pumps, and some people had already started calling it geothermal or earth energy at that time. They didn't want to create a new department, so they lumped ground source heat pumps in with the geothermal department, so they are both called geothermal. And it was a big mistake in terms of public understanding, because not only is all this stuff happening, it is invisible; it is in your basement and under the ground. But now people are thinking geothermal, I thought that was what they do in California or New Zealand or Iceland.

Mr. ISSA. Noted. I am going to force myself to change. I will tell you that I was fortunate enough going to ANWR by ground vehicle at my own expense. We talked about travel earlier. I took my family up because I wanted to actually drive the Tundra and experience it and get a real feel, because it is a serious consideration to expand into that wildlife and natural refuge.

But the strange thing is decades ago, when they were putting in the pipeline above ground, they were faced with the fact that, with heating and cooling, the pipe would have broken periodically, except they used ground source heat pumps, zero electricity consumed. I think it is ammonia-based in their case—don't hold me to that—but they came up with the whole concept that exactly when they needed cooling for the ground, they had a heat source in the air, and vice versa.

So they were able to maintain the permafrost year-round on the Alaskan pipeline. And the environmentalists who took us on this trip were very proud that this was a zero outside energy and environmentally probably the most responsible thing that they could come up with, in addition to all the other success stories of the pipeline.

If I can switch for a moment, one of the interesting things I discovered in preparing for this hearing was the old expression of swords into plowshares, and how that could relate to next generation nuclear. I have estimates that just the weapons grade uranium, not plutonium, that is available and that the Russians would be happy to sell us, would represent about 5 years of powering all of our nuclear power plants at the present time, and obviously we have the benefit of taking it offline.

And then a followup—since I see Marvin going, yeah, I can answer this one—if we had Gen 4, which can burn plutonium—and General Atomics I believe is the one that has this—what would be your estimate of the value based on the separate plutonium stockpile, that is also massive?

Mr. FERTEL. In 1992 President Bush signed an agreement with the Russians to basically take 500 metric tons of high-enriched uranium that they had in warheads. This was not surplus sitting somewhere, which they also have, apparently, but this was actually coming out of warheads, so it was actually dismantling warheads and taking high-enriched uranium out and blending it down. Basically what we use in power plants is low-enriched uranium, which is somewhere less than 5 percent enrichment; it cannot blow up. High-enriched uranium for weapons is well above 92 percent. So you blend it down, you get a lot of nuclear fuel out of it.

Right now, 10 percent of the electricity in this country is generated as a result of weapons material in Russia being dismantled. We get about half the fuel for our reactors coming from Russia, and that has been going on now and it is going to go through 2013, then this particular trench of 500 metric tons ends.

And the question from our industry standpoint is do we get another trench. We know they have much more weapons material. They are getting paid for this, this is actually a system where initially, when it started, it was probably one of the largest revenue sources Russia was getting. Now, they are a lot more commercial, they are getting money for selling gas to Europe and oil to others.

But Megatons to Megawatts is a very successful program being implemented by USEC, which is a Maryland company here that used to be part of the Department of Energy, and it is a really good program. Now, we don't know what they will do with the rest of their material, whether they will sell it to us, whether they will use it to sell reactors to other people and throw it in as a fuel deal——

Mr. ISSA. Comes with a full tank of gas.

Mr. FERTEL. Comes with a full tank of gas, right. Whatever they can do. But we know they have a lot more stuff, and it is important just commercially. And I know the chairman being a businessman would appreciate this: on our side the industry that mines uranium, when you get weapons material, you are basically displacing uranium, you are displacing the conversion to make it into something else, and then the enrichment part, because you are getting it as a fuel, you are getting it as a final product.

Mr. ISSA. Kind of like emptying out Fort Knox could depress the gold market.

Mr. FERTEL. That is right.

Mr. ISSA. If there was anything left at Fort Knox.

Mr. FERTEL. That is right. And also, if you were emptying it, you probably wouldn't be mining for gold, because you would know that is coming on the market. Well, that is a problem for our side because the primary producers need to know if it is coming so they know what kind of production facilities they need to build. It is a real issue for making business decisions.

On plutonium——

Mr. ISSA. Marvin, I assume, then, your message for us is we should be, as soon as possible making that commitment, but we should also recognize that we wouldn't want to provide 100 percent for 5 years and thus lay off a whole industry.

Mr. FERTEL. To be honest, you could even do 100 percent for 5 years in this country. I wouldn't recommend that. What you need for the business decisions—and, again, I am sure you understand this—is certainty. You need to know how much is coming when so that the primary producers can make business decisions on when they can finance stuff and build it. And we would advocate the sooner we could get a decision from Russia, the better off we as a Nation would be in not only getting rid of weapons material, which is certainly the primary objective, but in assuring adequate fuel supply.

On plutonium, right now there is a program that the U.S. and Russia have agreed to to look at disposing of surplus weapons plutonium. And Duke Energy——

Mr. ISSA. That is the MOx program?

Mr. FERTEL. That is the MOx program.

Mr. ISSA. That is disposal, not power generation.

Mr. FERTEL. Well, it is power generation. MOx is mixed oxide fuel, which is mixing plutonium and uranium to make the fuel so that I use it in a reactor as fuel. The French use MOx fuel right now; the Japanese are moving to use MOx fuel. And what we are doing is have a deal with the Russians to get rid of weapons plutonium.

And actually, I think the last 2 weeks, what we call lead test assemblies—which are fuel assemblies with a new fuel that you haven't tried so you want to put it in a reactor and you want to test its performance before you actually load a full core in the reactor—arrived at Duke's Catawba plant, and they are going to be testing the lead test assemblies, and if all goes right, they would be licensing the facility to be able to "use MOx fuel," which would be getting rid of plutonium that the Russians have.

I think the bottom line, Mr. Chairman, is anything our country can do to help get weapons material made more benign and then put into reactors so you are actually getting rid of it is probably a very, very good thing for not only our Nation, but for the world, because it is getting rid of stuff that is not good stuff to have around. And the more we can push it, the more better off we would be.

The uranium is probably a bigger problem, to be honest with you, than the plutonium, because there is more high-enriched uranium around than there is plutonium.

Mr. ISSA. And more all the time being enriched, apparently, over there.

Any other comments on that round of questions?

[No response.]

Mr. ISSA. The President, by talking about nuclear yesterday—and, as you said, repeatedly since the State of the Union—is touching on an issue in which there may not be a majority opposed to it, but the minority, including some of your old colleagues, Dr. Moore, are pretty active.

Where do you think public opinion is on new nuclear power plants? I have already stated the result of a professionally done poll, but obviously only in a district that is familiar with nuclear. Where do you think public opinion is and will education, properly done—and I don't mean propaganda, I mean fair education—would it be helpful to move that to a point in which nuclear power would be more doable?

And, actually, I would like to start with Dr. Moore, because you obviously know enough about nuclear to have very strong opinions on it.

Mr. MOORE. Yes. And I don't think you can count on certain of the environmental groups changing their minds on the subject. It is a winner for them, for one thing, and it is along the lines of many of the campaigns these days are unfortunately basically just scare campaigns, and this is one that fits very neatly into that category of just making people afraid, whether it is a Frankenstein foods or PCBs in their salmon or pesticides in their fruit, or all the other things where there actually isn't much of a basis to the concern, but it works to make people afraid. So I think you will see the campaigns against nuclear energy continue.

But I think the key thing is the placement of the reactors. If they are placed in existing nuclear facilities, I don't think you are going to see sufficient opposition to stop it from going forward, providing everything else is in place to make it go forward. I don't think it will be stopped by public opinion. If you try and put in a greenfield nuclear facility, that might be a different case, because there is a whole new NIMBY comes into it then.

Mr. FERTEL. I agree with Patrick on it certainly being easier at existing sites. I had mentioned two-thirds of the plants have either gotten license renewal or filed for it, and the license renewal process involved public hearings at the site; and the opposition around sites is really very low. There is opposition at some sites, and you could probably figure out where that might be, but most sites you get very strong support because the people that work at the plant live in the area, they have lived there for years, they know everybody and they have developed credibility; and also the political environment around there has gotten to know the plant.

Mr. Chairman, I have with me—just the stuff I had brought—a February 2005 perspective on public opinion which I would——

Mr. ISSA. We appreciate it. We will include it in the record.

[The information referred to follows:]

Public Sees Nuclear Energy as Fuel of the Future; Favorability/Support Reach New High

by Ann Stouffer Bisconti, Ph. D.
President, Bisconti Research Inc.

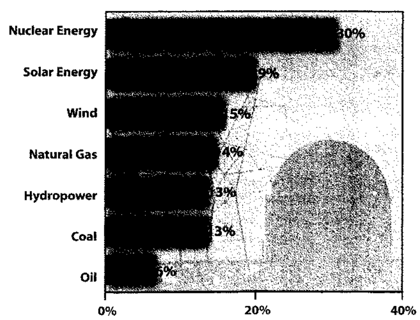
Americans consider nuclear energy an important electricity source for the future, according to a nationwide survey of public opinion. Eighty percent said nuclear energy will be important in meeting our electricity needs. Also, more Americans picked nuclear energy than any other electricity production source as one that will be used most 15 years from now.

Thirty percent selected nuclear energy—more than solar (19 percent), wind (15 percent), natural gas (14 percent), or coal and hydropower (13 percent each).

The nationwide survey of 1,000 nationally representative adults was conducted Oct. 14-17, 2004, for the Nuclear Energy Institute by Bisconti Research Inc. with NOP World (formerly Roper ASW).

Electricity Sources in the Future

▸ ***Question:*** **"Which sources of electricity will be used most in the United States 15 years from now?"**



The margin of error was plus or minus three percentage points.

For decades, the public has ranked nuclear energy and solar energy first and second, respectively, as the major sources of electricity for the future. This year, the United States is a step closer to making those expectations a reality.

Three consortia involving 16 energy companies are testing an improved federal licensing process for building and operating new nuclear plants. Congress has appropriated $61 million for fiscal year 2005 to support the these new plant programs. This will fund a government-industry cost-shared program to support the consortia.

Regionally, the South and Midwest had the highest proportion of residents (83 percent) who consider nuclear energy important to our energy future. A clear majority in the other regions also shared this view, with the West at 77 percent and the Northeast at 75 percent.

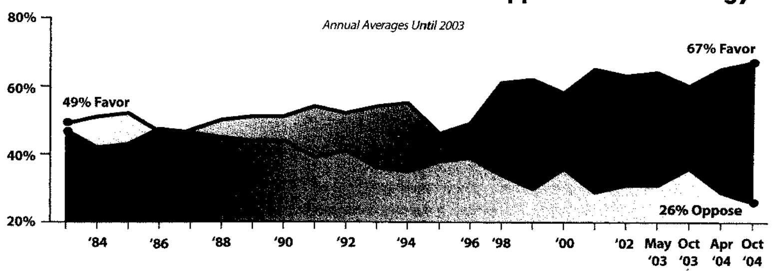
Support for Nuclear Energy Hits Record High

Favorability to nuclear energy is at a record high. In October 2004, 67 percent of respondents said they favored nuclear energy, the highest level since the surveys began more than 20 years ago. Meanwhile, those opposed fell to 26 percent—the lowest level in decades.

These trends appear to result at least in part from concerns about energy supply and price, owing to a combination of electricity shortages in 2001, a blackout in 2003, high gasoline prices and conflict in the Middle East.

The latest survey also showed rising trends in perceptions of nuclear plant safety and support for new nuclear plants (see page 4).

Trend in Percent of U.S. Public that Favor/Oppose Nuclear Energy



Nuclear Energy's Present Contribution Less Well-Known

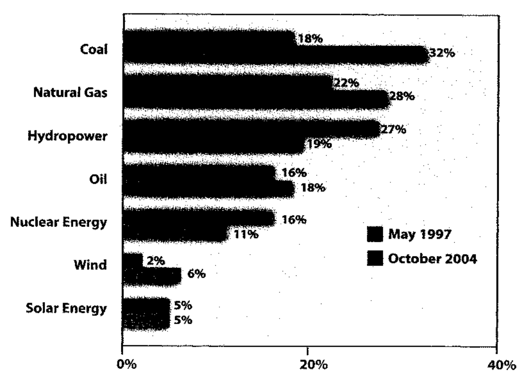
Despite their view that nuclear energy is the key source of future electricity, few understand nuclear energy's contribution today.

Nuclear energy is the second largest source of electricity and provides power for one in five U.S. homes and businesses. Yet, only 11 percent named nuclear energy as one of the sources of electricity used most today.

Nearly one-third correctly named coal, a large increase from 18 percent in 1997, when a comparable question was asked. Twenty-eight percent cited natural gas as one of the most used sources of electricity in the October survey, compared with 22 percent in 1997. The use of natural gas for electricity production has expanded significantly over the past seven years.

Sources of Electricity Today

▸ ***Question:* "What are the sources of electricity used most in the United States today?"**

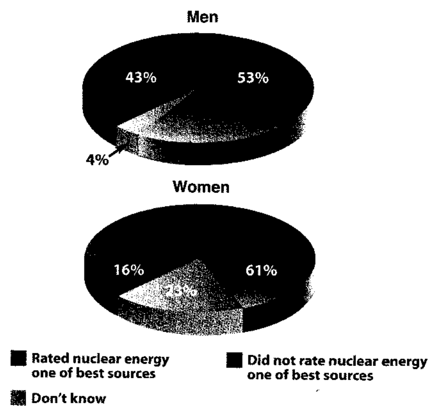


Nuclear Energy's Clean-Air Benefits Not Widely Known

The October survey also found that the clean-air benefits of nuclear energy are not widely known by the public. Nuclear energy is the largest source of emission-free electricity in the United States. Twenty-seven percent of U.S. electricity is produced by emission-free sources (nuclear, hydropower, solar, wind and geothermal). Of that emission-free electricity, nuclear energy provides 72 percent; hydropower provides 25 percent; and solar, wind and geothermal together provide 2 percent. Yet only 29 percent of the public rated nuclear energy "one of the best sources of electricity for air-quality protection." The most common rating of nuclear energy for air-quality protection was "average."

A large gender gap exists in awareness of nuclear energy's clean-air benefits. Sixteen percent of women, compared with 43 percent of men, rated nuclear energy one of the best for air-quality protection.

Percent Naming Nuclear Energy One of the Best Electricity Sources for Protecting Air Quality



Impact of Information About Nuclear Energy

Given the prospect of new nuclear power plants and limited public knowledge about nuclear energy, the survey asked respondents about nine statements conveying information about the benefits and safety of nuclear energy—in the context of new nuclear power plant construction.

Before they heard the statements, respondents were asked to picture the following scenario: "Let's imagine that more electricity is needed in your area sometime in the future and an electric company wants to add a new nuclear power plant at the site of the nearest nuclear power plant that is already operating."

All nine statements substantially increased the inclination of those surveyed to support the decision. Leading statements were:

1. Nuclear power plants help keep our air clean because they do not emit any greenhouse gases, and they are an emission-free source of electricity.

2. The federal Nuclear Regulatory Commission inspects and monitors each nuclear power plant daily. If a nuclear power plant is not operating safely, the regulator will shut it down until it improves its safety practices.

3. Switching to nuclear energy to make that electricity reduces America's reliance on fossil fuels and energy from unstable parts of the world.

4. New advanced-design nuclear power plants have state-of-the-art safety technology.

After hearing the information, those saying a new nuclear power plant at the nearest site would be acceptable increased 10 percentage points—from 62 percent to 72 percent.

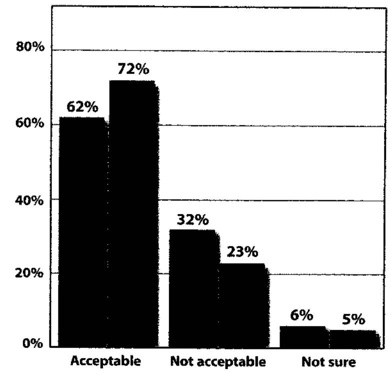
Acceptability of Adding New Reactors at Existing Nuclear Power Plant Sites

Responses Before and After Hearing Key Facts

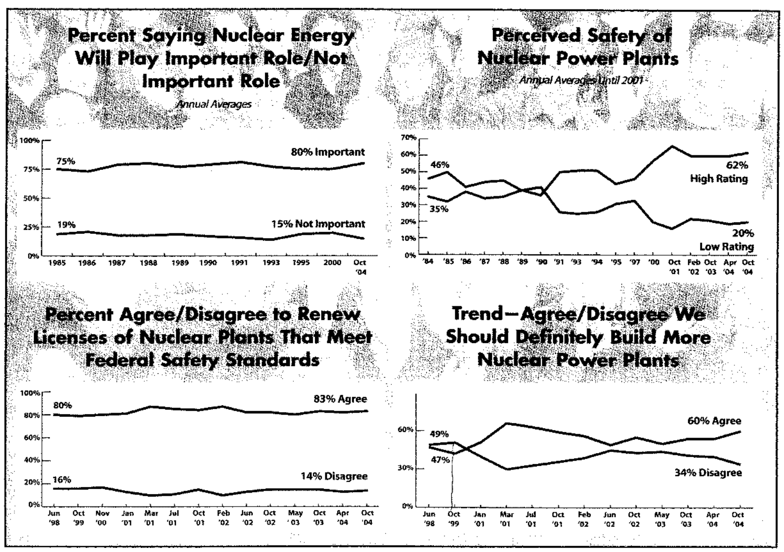
▸ *Question:* "If a new power plant were needed to supply electricity, would it be acceptable to you or not acceptable to you to add a nuclear power plant next to the nearest nuclear power plant that is already operating?"

■ Before hearing facts about safety and benefits of nuclear energy

■ After hearing facts about safety and benefits of nuclear energy



Trends on Importance, Safety of Nuclear Energy



For more information on public opinion about nuclear energy issues, please visit ***www.nei.org.***

Mr. FERTEL. It supports basically—I had not heard the San Onofree number that you mentioned, but we have been doing polling for a long time, and we ask the same questions, so you can either decide you like our question or you don't like our question, but we don't gain the question each time we ask it, so you sort of do get some trend. We have asked the question on "Do you agree or disagree we should definitely build more nuclear power plants?" going back a long way, and just to show the public does change its mind, back in the 1998–1999 timeframe, basically 49 percent said no and 47 percent said yes.

When you are out in sort of the timeframe of the end of last year, what you are getting is 60 percent say yes and 34 percent say no. You see a big switch. And that is because energy was on their screen for a while. Blackouts get people's attention; high prices for gasoline get their attention.

Or else, to be honest, I think we, as Americans, take energy for granted. When we have done focus groups when energy isn't on the screen and you ask where electricity comes from, the two most dominant answers are the switch and the outlet. So if I wanted more energy, I used to have a slide that showed more switches and outlets, and that is how you got it. Now, if you probe a little, you do get answers, but the initial answer is that.

Mr. ISSA. My son once said if you want money, you can either earn it or go to the bank.

Mr. FERTEL. That was better than go to dad.

Mr. ISSA. I am trying to keep it that way.

Mr. FERTEL. The other question—I think it goes to what Patrick said on NIMBY—is since I think about 2000 we have been asking a question which says "Given there was a need for more electricity, would it be acceptable or unacceptable to you to build a new nuclear power plant at a site where one exists?" And what we find on that is that you are in the 60's to 70 percent acceptable, because you have kind of dealt with NIMBY. If I don't have a plant near me, I can say yes, you should build it because it is not going to be near me, and if I do have a plant near me, I am probably understanding of the value of it.

And I think Americans are pretty responsible when they understand a need. I think in the abstract we are maybe not as responsible. But I would put this in: I think, counterintuitive to what people think, there is a lot more support for nuclear than is generally recognized.

Mr. ISSA. Excellent. I will mention that the nuclear power plant does a whole lot better than existing or future airports in my district. For some reason, everyone does believe they can go somewhere else for an airport.

I want to close with just a question that I think tees up the question of do we need more nuclear or not. I was born and raised in Ohio. Natural gas is the fuel of choice in Ohio for heating our homes, as it is in much of the—well, not the northeast, but the lands of the western reserve tend to be gas heavy. Ground source heat pumps are very uncommon in that area. Electric heat pumps are also considered to be losers, because electricity historically costs more than just burning natural gas, even if it is in 17 percent efficient furnaces.

If natural gas continues to go up in price, then it is obvious. But if we just take sort of the base today, if we achieve 3.2 cents per kilowatt hour, high efficiency heat pumps, ground source heat pumps, which always tend to be augmented with some electricity consumption, does it represent a viable alternative to home heating with natural gas or other fossil fuels?

Because we are looking today at a load based on the status quo, which is Ohio heating with natural gas and using electricity for lights and air conditioning. If we are looking at dramatically reducing our dependence on fossil fuel other than on mobile vehicles, which we don't have a great answer for today, the next greatest use obviously is the home. In various heating systems it varies from area.

So I will start with Mr. Jones, if you have an answer, and I will finish up with Dr. Moore.

Mr. JONES. I don't have an answer on natural gas versus heat pumps.

Mr. ISSA. Marvin.

Mr. FERTEL. I think that to think about answering your question you have to think globally. I mean, one of the things that we are seeing happening is China and India driving the price for a lot of things right now—oil, for instance; even we are concerned about nuclear fuel. As China builds a big program, they are going to tie up a lot of nuclear fuel.

And I think as the developing nations begin to use more gas, as Japan uses more gas—it is all going to be LNG because they don't have any domestic supplies—I think what it is going to do is drive up the price of gas, as the rest of the world does their thing. And as you drive up the price for gas, what we are going to find is you need to go—I mean, electricity and gas have always had this love/hate relationship on home heating, and I think that it will probably begin to favor electricity as the gas prices go up per use worldwide. So that would be my guess.

Mr. ISSA. And, Dr. Moore, I must admit I teed this up for you primarily because it is a question of sustainability.

Mr. MOORE. Well, one way of putting it is it doesn't make much sense to have a 1,200 degree Fahrenheit flame in your basement to heat your house up to 72 degrees Fahrenheit.

Mr. ISSA. Touche.

Mr. MOORE. In other words, we are using a very high form of energy for what can be accomplished with low-grade energy, and the energy that is in the surface of the earth around and under your home is a low-grade energy which is there because 50 percent of the sun's energy is absorbed by the earth, and it is sitting there waiting to be used; and there is 50 times as much energy under your house than you are ever going to need to heat, cool, and provide all your domestic hot water.

So my friend David Hatherton, president of Next Energy Solutions in Ontario, is the largest distributor of ground source heat pumps in Canada. He also built with his partner the Fort Wayne Water Furnace International plant. And I have been working with Dave for over 12 years on this subject now. There is no doubt now that as gas prices are going up, more and more people are choosing to put ground source heat pumps in their homes. His business is growing an average of 50 percent a year right now, and that is reflected across the board. So high gas prices are good for ground source heat pumps.

One of the reasons ground source heat pump sales have been centered in rural areas, and why the rural electrical co-ops have been very much involved with ground source heat pumps, is because often there is no natural gas in these rural areas and people are using propane and oil. And when you compare ground source with propane and oil, there is just no comparison; the ground source is more cost-effective. Compared with gas—until now at least, as gas prices go up and up—ground source has had a hard argument because the payback is so much longer, even 10 or 12 years, and the average homeowner won't go for something like that.

Now, in my estimation, this is purely an issue of human psychology and nothing to do with real economics, because you do get a payback with ground source; it does reduce your energy cost tremendously, because you are getting most of your energy now more or less for free out of the ground, and all you have to do is buy the electricity that you need to pump that energy into your house.

For example, many of us will willingly pay $10,000 or $20,000 more for an automobile than we really need to in order to get all of the functions of an automobile, if we want a BMW, for example, instead of buying a Chevrolet. That happens all across the country everyday; hundreds of thousands of people making that decision, when there is absolutely no practical necessity for it, it is all psychological. People will pay $20,000, $30,000, $40,000 for a home entertainment system when an i-pod hooked up to a micro-stereo would do just fine.

Mr. ISSA. Especially for those of us with older hearing.

Mr. MOORE. Right. But it is hard to get people to make the decision to invest an extra $10,000 in their home heating, cooling, and hot water supply, even though that allows them to say I have a CO_2 emissions-free home. And what we have to do is get people to be as proud of having a CO_2 emissions-free home as they are of having a pretty car. And I don't know how you achieve that, whether it is just a fundamental problem with human psychology, but I do know that it has nothing to do with economics.

Mr. ISSA. Well, thank you.

I will close by going on the record and saying that I have both a Lexus and a Toyota Prius. I want to appeal to both voters any chance I can.

Mr. MOORE. That is very political.

Mr. ISSA. Actually, I really love the Prius, it is the ideal car for here in Washington, DC. All kidding aside, it is the statement—and, Patrick, you alluded to this all throughout. We have to use all these sustainable alternatives, nuclear being the subject du jour, but no question at all that we can't give up on any of these.

I look forward to having you back, if you will come back as we progress through this process.

And with that, with unanimous consent, we are adjourned.

[Whereupon, at 12:13 p.m., the subcommittee was adjourned.]

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