S. HRG. 111–375

ENERGY POLICY ACT OF 2005

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY ON S. 2052, A BILL TO AMEND THE ENERGY POLICY ACT OF 2005 TO REQUIRE THE SECRETARY OF ENERGY TO CARRY OUT A RESEARCH AND DEVELOPMENT AND DEMONSTRATION PROGRAM TO REDUCE MANUFACTURING AND CONSTRUCTION COSTS RELATING TO NUCLEAR REACTORS, AND FOR OTHER PURPOSES AND S. 2812, THE NUCLEAR POWER 2021 ACT

DECEMBER 15, 2009

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ENERGY POLICY ACT OF 2005

TUESDAY, DECEMBER 15, 2009

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:04 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Jeff Bingaman, Chairman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. Ok. Thank you all for being here. Today's hearing is to receive testimony on 2 bills, S. 2052, the new Nuclear Energy Research Initiative Improvement Act which Senator Udall is the prime sponsor. Senator Murkowski and Senator Crapo and I are co-sponsoring that bill.

Also, S. 2812, the Nuclear Power 2021 Act, that's a bill that I introduced with Senator Murkowski and Senator Udall and Senator Pryor as co-sponsors.

I'd like to thank the witnesses for testifying. We have 2 who hail from New Mexico or at least we claim they do.

Pete Miller, we're glad to have you here to testify. He spent many years at Los Alamos National Laboratory.

Dr. Tom Sanders, also, who is the President of the American Nuclear Society, a long standing member of Sandia National Laboratories. We welcome them here.

I'll introduce and welcome all the witnesses after Senator Murkowski makes her comments.

Small nuclear reactors, those that are less than 300 megawatts, hold a promise of reducing the cost of nuclear plant construction. Proponents claim these reactors can utilize modular construction techniques such that plant subassemblies can be built and assembled onsite, thus reducing the construction cost.

Large nuclear plant cost is a major issue when we're talking about 2,000 megawatt plants. It can exceed $12 or $14 billion. In addition, advocates believe that the small size makes it applicable to the chemical industry for process heat, thus minimizing carbon dioxide emissions.

The bills before us today establish research programs to reduce the cost of construction of small reactors as well as authorizing 2 cost shared demonstrations to obtain licenses before the NRC. There are many opinions on the merits of these reactors and this

way of facilitating the development of these reactors. We look forward to the witnesses comments on this legislation.

Let me defer to Senator Murkowski for any comments she'd like to make.

STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

Senator MURKOWSKI. Thank you, Mr. Chairman. I appreciate the hearing this morning on small modular nuclear reactors. We have a good crowd in the audience. I just wish we had more members here at the dais. But we'll work on that. It is good to see the interest here.

As we seek to invigorate a nuclear resurgence here in the United States, it can be instructive to look back at nuclear's ritz. It was through small nuclear reactors that the technologies and experience for today's larger reactors were actually born. The first nuclear power reactor built was a 60 megawatt shipping port reactor in 1957 based on technology developed for naval nuclear propulsion systems.

While today the preference has been to develop nuclear power reactors in the thousand megawatt range, support for small, modular reactors is growing as a complementary technology that may be a better fit in certain situations.

From lower up front capital costs.

Increased safety and proliferation resistance.

Longer fuel cycles.

Greater flexibility in where they can be located.

The ability for all components to be manufactured here in the United States.

As well as the ability to incrementally add new capacity as demand and grid capacity warrants it.

Small modular reactors deserve consideration as we look to how nuclear power can help the United States reduce our greenhouse gas emissions.

I would like to highlight a couple of these potential benefits.

First, smaller reactors can be utilized in off grid locations whether it's for localized power generation or for non-electrical purposes like process heat or desalination. In Alaska we have got a company that has proposed to build a ten megawatt nuclear reactor in the community of Galena. It's a pretty small, remote community, with about 600 people.

You need an airplane or perhaps a dog sled to get to it, but in an area where electricity can cost over 60 cents or more per kilowatt hour, diesel generators are the norm. We are really looking at all options for power generation. This has been something that has been discussed for a number of years.

I am pleased that toward that end we have S. 2812. The Nuclear Power 2021 Act that ensures at least one of the designs to be put forward by Department of Energy will have a capacity of not more than 50 electrical megawatts. There is great potential for small and perhaps in this case, very small reactors in off grid applications.

Secondly, small modular reactors offer the ability to incrementally ramp up the amount of electricity generated to meet the amount needed while staying within a grid's capacity. A utility or

a grid may not be able to handle an additional thousand megawatts plus of power all at once nor may it need it. Incremental build ups would allow a utility to more easily match output with demand and capacity while making up front capital costs more manageable. I think all of this sounds promising, but we know that there are hurdles to overcome.

Small reactor designs need to make it through the NRC licensing process at a time when the focus is on large reactors. We are trying to get new reactors licensed for the first time in 30 years. The interconnectivity of modular reactors also presents, a new challenge for the NRC staff.

I look forward to hearing from the witnesses this morning on how they perceive the potential for these small reactors. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Senator Udall has had a real role in this. I'll just ask if he had any comment that he wanted to make before we hear from the witnesses.

Senator UDALL. Briefly, Mr. Chairman, I just want to thank you and Senator Murkowski for holding this important hearing. I'll have questions and some comments after the witnesses share their thoughts with us.

Thank you.

The CHAIRMAN. Very good.

Senator Shaheen, did you have any comment?

Senator Landrieu.

Alright, well thank you all for being here again. Let me introduce our witnesses again.

Dr. Pete Miller, who is the Assistant Secretary in the Office of Nuclear Energy in the Department of Energy, thank you for being here.

Dr. Tom Sanders, President of the American Nuclear Society, thank you for being here.

Mr. Tony Pietrangelo, who is the Senior Vice President and Chief Nuclear Officer in the Nuclear Energy Institute, thank you for being here.

Mr. Michael Johnson, Director of the Office of New Reactors with the NRC, thank you all for being here.

So why don't you take 6 minutes or whatever time you need to make the main points that you think we need to understand about these 2 pieces of legislation, and whether we're on the right track or not with what has been proposed here.

Dr. Miller, go right ahead.

STATEMENT OF WARREN F. MILLER, JR., ASSISTANT SECRETARY, NUCLEAR ENERGY, DEPARTMENT OF ENERGY

Mr. MILLER. Thank you, Chairman Bingaman, Ranking Member Murkowski and members of the Committee. I appreciate the opportunity to appear before you and comment on legislation under consideration by the Committee, as well as to provide information on where small modular reactors fit into Department of Energy's portfolio.

In my written testimony I described the Office of Nuclear Energy's 5 imperatives that we have developed to guide our activities.

For my oral testimony I will restrict my remarks to small reactors and the 2 pieces of legislation under consideration by the Committee. To begin with there's no exact definition for what constitutes a small reactor. The International Atomic Energy Agency defines them to be less than 300 megawatt electric as does S. 2812.

This boundary is based on 2 factors.

First is liability insurance.

The second is factory fabrication and portability to a site by rail or by truck.

For liability reasons reactors above 300 megawatt electric must carry separate indemnification insurance for each unit. Reactor modules that are sized 300 megawatt electric and below can be linked together to form one reactor unit for liability insurance. Reactor modules of this size are conducive to offsite fabrication prior to transportation by rail or truck rather than by barge to an approved site for assembly.

There are several reasons why small modular reactors could have potential advantages over larger plants. Modular reactors can be linked together to create a larger plant, as I said, which allows the owner of a given facility to incrementally increase its size. This arrangement requires less initial capital outlay and results in a smaller investment risk for any given point in time during the construction. The existing operating modules can also be used to finance future additions.

The term modular also refers to potentially faster and more efficient construction techniques using factory fabrication. The U.S. defense nuclear shipbuilding Industry is an excellent example where modular construction techniques have been proven to be highly successful. This fabrication technique could reduce construction delays and schedule uncertainty.

There are areas in this country and elsewhere in the world where large plants are not needed or the existing infrastructure cannot support the larger capacity. Small modular reactors could be used to provide power to these smaller electrical markets, isolated areas or smaller grids. There is both a domestic and international market for small modular reactors. U.S. industry is well positioned to lead and compete for these markets.

There are also some potential non-proliferation benefits of the use of small reactors that could be designed to operate for decades without refueling. These reactors could be fabricated and fueled in a factory, sealed and shipped back to the site for power generation and then shipped back to the factory to be defueled. This arrangement would minimize the spread of nuclear material.

Small reactors could potentially enter into traditionally non nuclear energy markets for applications beyond electricity production.

Possibilities include low carbon process heat for fossil fuel recovery and refinement, Synthetic and biofuel production, Water desalination, Hydrogen production, and a range of other petrochemical applications.

It should be clear from the preceding comments that the Department believes that small modular reactors are an important area of research and development.

The Nuclear Energy Research Initiative Improvement Act of 2009, S. 2052, gives broad authority to conduct research into small

modular reactors as well as other related issues. The Department is still evaluating the details of this bill.

S. 2812, the Nuclear Power 2021 Act would require the Department of Energy to carry out a program to develop and demonstrate 2 small modular reactor designs. The Department is also still evaluating the details of this bill. In considering a small modular reactor program a variety of factors need to be assessed including issues such as reactor size, industry readiness and responsibilities and research and development needs.

This concludes my formal remarks. Thank you for the opportunity to testify. look forward to answering your questions and working with this Committee to achieve the Administration's goals of energy security and reducing the nation's carbon emissions.

Thank you.

[The prepared statement of Mr. Miller follows:]

STATEMENT OF WARREN F. MILLER, JR., ASSISTANT SECRETARY NUCLEAR ENERGY, DEPARTMENT OF ENERGY

INTRODUCTION

Thank you, Chairman Bingaman, Ranking Member Murkowski, and Members of the Committee. I appreciate the opportunity to appear before you and comment on legislation under consideration by the committee, as well as to provide information on where small modular reactors fit in the Department of Energy's portfolio.

Let me start by saying clearly that the administration views nuclear power as an important element in its strategy to increase energy security and combat climate change. As the President said in Prague,"[w]e must harness the power of nuclear energy on behalf of our efforts to combat climate change, and to advance peace and opportunity for all people."

Secretary Chu and I are working hard to advance nuclear power in the United States, and we expect the Department of Energy to award the first conditional loan guarantee for new nuclear plant construction soon.

In the Office of Nuclear Energy, we have developed five imperatives to guide our activities.

First, we are working with industry and the Nuclear Regulatory Commission to extend the lifetime of the existing reactor fleet. The 104 NRC-licensed commercial nuclear reactors produce roughly 20 percent of our nation's electricity but 70 percent of our carbon-free electricity. Whether those plants retire at 60 or, for example, 80 years of age could greatly affect our carbon emissions profile in the future. Research is needed to answer outstanding questions about how long these reactors can safely be operated.

Second, we are engaged with industry to enable new plant builds and improve the affordability of nuclear energy. I mentioned our efforts with respect to loan guarantees, but also some of our research, such as the soon-to-be-implemented Modeling and Simulation Hub, we expect will also help reduce costs.

Third, we are working to reduce the carbon footprint of the transportation and industrial sectors. Nuclear power can supply more low-carbon electricity for increased electrification of the transportation sector, and provide low-carbon process heat for a range of industrial applications.

Fourth, we are researching ways to create a sustainable nuclear fuel cycle. In particular, we are looking at ways of extending nuclear fuel supplies and reducing the amount and toxicity of waste requiring a permanent repository.

And fifth, we are working to understand and minimize proliferation risks. All nuclear fuel cycles entail some amount of risk, but that risk can be reduced with appropriate technology applications and international guidelines and agreements.

SMALL MODULAR REACTORS

With that, let me turn to the focus of today's hearing: small modular reactors (SMRs) and their potential benefits.

Let me first define what we mean by "small" and "modular".

To begin with, there is no exact definition for what constitutes a "small" reactor. The International Atomic Energy Agency defines them to be less than 300 MWe as does S.2812. This boundary is based mainly on two factors: (1) liability insurance,

and (2) factory fabrication and portability to a site by rail or truck. For liability reasons, reactors above 300 MWe must carry separate indemnification insurance for each unit. Reactors modules that are sized 300 MWe and below can be linked together to form one reactor unit for liability insurance. Reactor modules of this size are conducive to off-site fabrication prior to transportation by rail or truck, rather than by barge, to an approved site for assembly.

The term "modular" implies several things that could create a potential advantage over larger plants. First, modular reactors can be linked together to create a larger power plant. This is potentially advantageous because it allows an owner the flexibility to incrementally increase the size of a plant. As demand increases, the owner can add more modules. Secondly, a smaller plant requires less initial capital outlay or investment. The existing operating modules can then be used to finance future additions. Multiple units are also important during refueling or maintenance because taking a single module offline does not require the shutdown of the entire plant.

The term "modular" can also refer to potentially faster and more efficient construction techniques using factory fabrication. The U.S. defense nuclear shipbuilding industry is an excellent example where modular construction techniques have been proven to be highly successful. These same techniques can be applied to the commercial nuclear industry. This fabrication technique has the potential to make nuclear energy more economical and appealing to investors because it reduces the perceived "risks" associated with new nuclear builds such as construction delays and schedule uncertainty.

There are several reasons why small modular reactors may prove advantageous compared to the Generation III+ nuclear plants in terms of economics, performance, and security.

First, the high capital cost for new nuclear reactors has been a challenge for private entities to finance. Smaller projects would carry lower investment risk and could be more affordable to smaller utilities. This reduction in investment risk also provides an advantage in rate recovery, regardless of whether the licensee is regulated through state public utility commissions or whether it must sell the electricity in unregulated commercial markets.

Second, there are areas in this country—and elsewhere in the world—where large plants are not needed or the existing infrastructure cannot support the larger capacity. Small modular reactors could be used to provide power to these smaller electrical markets, isolated areas or smaller grids. There is both a domestic and international market for small modular reactors and U.S. industry is well-positioned to lead and compete for these markets.

Third, some of the SMR designs may offer significant environmental or safety advantages for siting in industrial settings or where, for example, water for cooling is a problem. Some reactor designs would produce a higher temperature outlet heat that can be used for either electricity or process heat for nearby industries while others use little or no water for cooling.

Fourth, there are also some potential nonproliferation benefits to use of small reactors that could be designed to operate for decades without refueling. These reactors could be fabricated and fueled in a factory, sealed and shipped to the site for power generation, and then shipped back to the factory to be defueled. This approach could minimize the spread of nuclear material.

Fifth, small reactors could also enter into traditionally non-nuclear energy markets for applications beyond electricity production. The possibilities include low carbon process heat for: fossil fuel recovery and refinement, synthetic or biofuel production, water desalination, hydrogen production, and a range of other petrochemical applications.

Finally, while traditional economy-of-scale concepts favor larger nuclear plants, there are a number of reasons why SMRs may have some economic advantages.

As mentioned previously, a sizeable portion of the cost and schedule uncertainty for building large nuclear plants is the amount of work that must be performed on site. Factory production and fabrication, and transport to and assembly onsite can significantly reduce that uncertainty.

Research into small modular reactors could address several of the Office of Nuclear Energy's imperatives: improving the affordability of nuclear power; supplying low-carbon electricity and process heat to the transportation and industrial sectors; and minimizing proliferation risks. More importantly, the advancement of SMRs will respond to U.S. economic and environmental market conditions for low-carbon energy sources.

COMMENTS ON S.2052 AND S.2812

It should be clear from the preceding comments that the Department believes that small modular reactors are an important area of research and development.

The Nuclear Energy Research Initiative Improvement Act of 2009, S.2052, gives broad authority to conduct research into small modular reactors, as well as other related issues. The Department is still evaluating the details of the bill.

S. 2812, the Nuclear Power 2021 Act, would require the Department of Energy to carry out a program to develop and demonstrate two small modular reactor designs. The Department is still evaluating the details of the bill.

CONCLUSION

In considering a small modular reactor program, a variety of factors need to be assessed, including issues such as reactor size, industry readiness and responsibilities, and research and development needs.

That concludes my formal remarks. Thank you for the opportunity to testify and I look forward to answering your questions and working with the Committee to achieve the administration's goals of energy security and reducing the nation's carbon emissions.

The CHAIRMAN. Thank you very much.

Dr. Sanders, go right ahead.

STATEMENT OF THOMAS L. SANDERS, PRESIDENT, AMERICAN NUCLEAR SOCIETY

Mr. SANDERS. Thank you, Chairman Bingaman, Ranking Member Murkowski and members of the Committee. Thank you for the opportunity to testify. I am here in my capacity as President of the American Nuclear Society.

ANS is dedicated to the peaceful uses of nuclear technology and is comprised of 11,000 members across every part of the nuclear enterprise from industry, laboratories, universities and government. In general our membership believes that nuclear energy can and really should play a major role in supplying energy in a carbon constrained environment. Let me say from the outset that there are significant roles for both large and small reactors in the future mix.

The discussion of small modular reactors should not be viewed as an either/or proposition. That said, SMRs offer many unique benefits over their larger cousins. You'll hear these benefits over and over, I suspect, as we go through the panel here.

The debate in Washington these days focuses on the cost of nuclear verses other forms of energy and specifically the large upfront costs of installing new generation capacity. However the view of the nuclear issue only from or through the lens of the U.S. market is to miss half the picture. As you'll see from this chart over here, more than 60 countries are actively seeking or have expressed interest in developing new nuclear energy generation capacity. While some of these countries already have nuclear plants, others would be new entrants including many of the developing world.

At the same time as you'll see, from the pie chart at the bottom left hand corner of this chart. Over 80 percent of the world's grids cannot absorb a large typical type of reactor, in particular one gigawatt plant. So the market is really there for small modular reactors.

So what are the take aways?

First, the world is embarking on a nuclear expansion with all the opportunities and risks associated with that. While we tend to hear about countries like Iran and North Korea, most nations interested

in nuclear energy are motivated by sincere desire to improve standards of living for their people. In general a world with plentiful clean energy will be a more peaceful, more prosperous and environmentally sustainable world.

Second, the United States actually has very little say over how this renaissance will happen because nuclear energy supply infrastructure has become thoroughly internationalized in the last 3 decades. If the United States is unable or unwilling to provide nuclear technology interested nations have plenty of other options. Frankly from a global standpoint the choice we face is clear. We can either commit ourselves to facilitating the renaissance as a major supplier of safe, proliferation, resistant nuclear technology or we can stick our heads in the sand and hope that other supplier nations will promote our values associated with safety, security and proliferation resistance.

If we choose a path of engagement the next step required is a build a better mousetrap, one that can compete on the global marketplace. This is where small, modular reactors come in. As you'll see from the next chart, SMRs comprises a diverse set of technologies. Secretary Miller covered those very thoroughly. The common thread is 10 to 300 megawatts transportable by train or rail and basically 4 different types.

Small light water reactors are based on well understood technology. As Senator Murkowski stated we know that history from the days of Atoms for Peace program in the beginning days of the nuclear navy.

Sodium or lead cooled fast reactors could have the advantage of promoting a creative grave approach to the nuclear fuel cycle such that you could provide reactors to developing nations and not have to worry about refueling them for ten to twenty years.

High temperature gas reactors are proposed designs that are well fit to process heat applications such as hydrogen production, water desalination, shale oil recovery and other beneficial activities. 60 and 100 watt reactors in our shale oil foundation out in the West would basically produce enough oil from that formation to accommodate or reduce the needs for imports from the Middle East, Nigeria and Venezuela.

The fourth category is what I call radical designs. While these innovative concepts require longer term research and development efforts their simplicity of operation and walk away safe power are desirable attributes that we should pursue.

There are some who are not comfortable with the notion that the United States. should actively promote and supply nuclear technology around the world. They believe the risk to proliferation are too great. However there is an emerging consensus in our ANS membership that the U.S. nuclear community that in fact the opposite is true, that a revitalized domestic nuclear manufacturing sector is critical and necessary component to sustaining U.S. nuclear influence around the world.

So what would a revitalized small modular focused U.S. manufacturing industry look like? As you can see from the next slide, our national security infrastructure provides us with a head start. We have 60,000 people working in our naval community, in our shipyards as nuclear workers, as designers in 2 laboratories at

Knolls and Bettis and throughout the service industry that provides that. These are American jobs. These are not jobs that we import from abroad because their international security sector.

We have an operating geological repository in our defense infrastructure that could accommodate transuranic waste from recycled small modular reactor fuel. We have many years of operational data for water and sodium cooled systems. We already have modular manufacturing techniques in our shipyards. We have the ability to make the fuel and vision for most of these designs.

What we need is the collective wheel to make long term investments. So that the U.S. can again, become a major supplier. I can say confidently that the Bingaman/Murkowski/Udall legislation represents a strong foundational effort to augment the Federal Government's role in U.S. modular reactor development in a way that furthers our environmental, foreign policy and economic objectives.

ANS also encourages Congress to consider other aspects. These include accelerated development of codes and standards, updates to U.S. laws and regulations like the American Competes Act that encourages rapid maturation and transfer of modular reactor technology from our laboratories, universities to our industries. Streamlining export control laws to minimize the incentives to offshore small modular reactor component manufacturing and integration of nuclear engineering science and skilled trade education efforts to ensure that we have a technically competent work force.

In closing, there are clear security, economic and environmental imperatives for the U.S. to make a long term commitment to small modular reactor development both here at home and abroad. This concludes my testimony. I would be happy to answer any questions the Committee may have. Thank you.

[The prepared statement of Mr. Sanders follows:]

PREPARED STATEMENT OF THOMAS L. SANDERS, PRESIDENT, AMERICAN NUCLEAR SOCIETY

Thank you, Chairman Bingaman and members of the Committee for the opportunity to testify before the Committee today. I am here in my capacity as President of the American Nuclear Society (ANS). Our society is dedicated to the peaceful use of nuclear science and technology. We have about 11,000 "national" members and another 10,000 or so who are strictly members of 51 "local sections" spread across 38 states. We also have 38 student sections at major US universities and 11 sections in other countries.

Our constituents come from all sectors of the nuclear enterprise: utilities, research laboratories, government and state agencies, industrial vendors and suppliers, universities, and other areas of nuclear science and medicine. We have 19 technical divisions that cover almost every aspect of nuclear science and technology—from the mining of ore to the burial of fuel cycle byproducts.

In general, the ANS membership believes that nuclear energy can and should play a major role in the provision of affordable and reliable energy in a carbon-constrained environment. Let me say from the outset that there are significant roles for both large and small reactors in the future US energy mix. The discussion of small modular reactors (SMRs) should not be viewed as an "either-or" proposition. That said, SMRs offer many unique benefits, from affordability to transportability and ease of manufacturing and construction. SMR designs and market opportunities have been discussed thoroughly over the past five years at ANS conferences and we have started several special committees to look at economic, licensing, policy, and US infrastructure issues related to small reactor development. Some of these preliminary results will be discussed here and are presented in detail in the background report submitted for the record. We are also supporting SMR-related activities initiated by other government and private organizations. For example, we have

supported the Department of Commerce's Civil Nuclear Trade Initiative and are working closely with the AFL-CIO in revitalizing the US nuclear manufacturing sector.

The debate on nuclear in Washington these days tends to focus on the cost of nuclear energy versus other forms of energy generation. Thus, the current domestic interest in SMRs has originated primarily from the challenges in financing the large up-front costs of installing new domestic nuclear generation capacity and for distributed energy applications throughout the US. However, to view the nuclear issue solely through the lens of US low carbon energy needs and domestic economic opportunities is to miss half the picture.

As you'll see from the chart before you, more than 60 countries are actively seeking or have expressed interest in developing new nuclear energy generation capacity. While some of these countries already have existing nuclear plants, others would be new entrants, many of whom are from the developing world. At the same time, you will see from the pie chart over 80% of the world electrical grids cannot absorb 1 GW nuclear plant in their current configuration.

So what are the take away lessons? First, it's clear that the world is about to embark on a global nuclear renaissance with all the associated opportunities and risks. Despite the headlines we see these days, the overwhelming majority of nations interested in nuclear energy are motivated by a desire to improve standards of living for their people. And in general, a world with plentiful clean energy will be more peaceful, more prosperous, and more environmentally sustainable.

Second, the US actually has very little say over whether this renaissance happens, as the nuclear energy supply infrastructure has become thoroughly internationalized in the last three decades. If the US is unable or unwilling to provide nuclear technology, there are plenty of other supplier options for interested nations.

Frankly, from a global standpoint, the choice we face today is clear. We can either commit ourselves to actively facilitating this renaissance as a major supplier of safe, proliferation-resistant nuclear energy technology, or we can stick our heads in the sand and hope that other supplier nations will do it right.

If we choose the path of global engagement, the next step required is to build a better mousetrap that can compete on the global marketplace. This is where SMRs come into the picture.

As you'll see from the next chart, the category of small modular reactors comprises a diverse set of technologies and applications. The common thread is their size, generally from 10 to 300 MW electricity, small enough to be shipped on a flatbed or rail car and exported to other nations as a complete unit.

For purposes of this discussion, SMRs can be grouped into four different kinds.

1. Small light water reactors These are based on well understood technology, and the US possesses an existing domestic manufacturing capacity for the purposes of supplying the Navy with propulsion reactors. These reactors would make an attractive option for existing nuclear plant operators to add capacity in a scalable fashion.

2. Sodium or lead cooled fast reactors. These are small pool type reactors that operate at low pressures. Their fast neutron spectrum essentially generates fuel at nearly the rate it is consumed, thereby allowing extended refueling intervals of up to 20-30 years. They have desirable safety characteristics, and when combined with advancements in turbine technology can be operated in an extremely safe manner for long periods of time. There are also other liquid metal coolants on the horizon that could further enhance those capabilities.

3. High-temperature gas reactors. These proposed designs can be optimized for process heat applications such as hydrogen production, water desalination, and shale oil recovery. They could be located in industrial parks to offset the use of fossil fuels for process heat generation.

4. The fourth category is what I call radical designs. While these innovative concepts will require longer-term research and development efforts, their simplicity of operation could provide "walk away safe" power to remote communities here in the US and around the world.

There are some who are not comfortable with the notion that the US should actively promote and supply nuclear technology around the world. They say that we can exercise sufficient influence simply by exporting our regulatory best practices to other nations. They believe that the risks of proliferation are too great. However, there is an emerging consensus in the US nuclear community that in fact the opposite is true—that a revitalized domestic nuclear manufacturing sector is a critical and necessary component to sustaining US nuclear influence around the world. Consider the so-called "123" agreement, which is our primary foreign-policy tool for promoting US nonproliferation objectives with other nations. 123 agreements with the

US only make sense for other nations when they are actively interested in procuring US-owned technology, and, to put it bluntly, there isn't much US owned nuclear energy technology left today.

So, what would a revitalized, SMR-focused US nuclear manufacturing industry look like?

As you can see from the next chart, our national security infrastructure provides us with a head start. We already have a manufacturing infrastructure in place to produce the components of small naval reactors, and the modular approaches used by our shipyards to construct naval vessels are applicable to the mass production of SMRs. We have an operating geological repository in our defense infrastructure that could potentially accommodate transuranic waste from recycling SMR fuel. We have many years of operational data for water and sodium cooled systems. We already have advanced manufacturing techniques. We have the ability now to manufacture the fuel forms envisioned in these different designs. What we need is the collective will to make long-term investments in these game-changing technologies so that the US is positioned to positively influence the global nuclear renaissance.

As a 501(c)(3) not-for-profit organization, the American Nuclear Society does not normally endorse congressional legislation. However, I can say confidently that S. 2812, The Nuclear Power 2021 Act, represents a strong foundational effort to augment the federal government's role in US SMR development. It would provide the DOE with the authority to enter into public-private partnerships to develop and license small modular reactors. We believe this would significantly accelerate US SMR reactor development in a manner that furthers US environmental, foreign-policy, and economic objectives. In addition, S. 2052, The Nuclear Energy Research Initiative Improvement Act of 2009, would provide needed investments for revitalizing US competitiveness in the global marketplace. Its focus on SMR concepts, advances in energy conversion technologies, advanced manufacturing and construction, resolution of licensing issues, and enhanced proliferation controls will help develop the enabling technologies we need for large-scale SMR deployment in the US and around the world.

ANS also encourages Congress to consider other aspects of SMR development. These include accelerating the development of SMR-related codes and standards; updates to US laws and regulations that would facilitate accelerated maturation and transfer of SMR-relevant technology from the national laboratories to US industry; streamlining export control laws to minimize the incentives to "off-shore" SMR component manufacturing; and integration of university-based US nuclear science and engineering education programs with SMR development efforts to ensure we have technically skilled workforce to design, deploy, and operate these reactors in the future.

In closing, there are clear security, economic, and environmental imperatives for the US to be an active participant in the global nuclear renaissance. Many of our industrial members have recognized the huge potential for SMRs around the world. Organized labor sees the promise of hundreds of thousands of high-paying jobs. Our national laboratories and universities have developed ground breaking research and development and state-of-the-art technology that can be put to the task. We are ready to take the next step.

This concludes my testimony, and I would be happy to answer any questions the Committee may have.

Thank you.

The CHAIRMAN. Thank you very much.

Mr. Pietrangelo, go right ahead.

STATEMENT OF ANTHONY R. PIETRANGELO, SENIOR VICE PRESIDENT AND CHIEF NUCLEAR OFFICER, NUCLEAR ENERGY INSTITUTE

Mr. PIETRANGELO. Chairman Bingaman, Ranking Member Murkowski and other members of the Committee, thank you for inviting the industry to participate in this hearing on small scale reactor projects. My name is Tony Pietrangelo. I'm Senior Vice President and the Chief Nuclear Officer at the Nuclear Energy Institute. NEI is responsible for establishing unified policy on regulatory, financial, technical and legislative issues affecting the nuclear industry.

Today the industry's focus, as it has been in the past and will continue to be in the future, is on the continued safe and reliable operation of 104 nuclear power plants in 31 states. The safe, reliable operation of these clean energy facilities is a prerequisite to building new nuclear energy projects in the United States. In the area of new construction our focus is on advanced large scale reactors because these are currently in the licensing process. Site preparation and preconstruction are already starting.

Along with construction of large plants our focus also is on rebuilding the nuclear supply chain and training the work force to build and operate these new facilities.

The industry also attaches high priority to achieving economic and regulatory stability for the entire nuclear fuel cycle including fuel supply, materials, licensing, used fuel management and development of small reactor technologies for electricity generation and use in industrial applications such as process heat. There is a growing interest in the development of small modular reactors, yet until these designs and the regulatory and institutional infrastructure are better defined the industry will be reluctant to move forward with construction of these projects. As a result we will continue to give priority to large nuclear plants.

The industry envisions small scale modular reactors falling into one of 3 groups.

Integrated light water reactors.

High temperature gas cooled reactors.

Advanced liquid metal cooled reactors.

Small modular reactors could reliably perform a variety of essential functions including providing clean and reliable electricity in locations where a large reactor cannot be used.

Reducing the capital outlay for a company wishing to use nuclear energy.

Reducing the impact on the environment by using air cooled as opposed to water cooled heat sources.

Enhancing construction capability and schedule by manufacturing and fabricating components and systems in a factory before being shipped to the site.

Providing energy free industrial process heat as well as electricity generation.

Improving nuclear fuel utilization and reducing the amount of high level radioactive byproducts that will require disposal.

The development and regulatory approval of new nuclear designs could cost more than one billion dollars and take 20 years before first reactor is operational. The nation's electricity infrastructure including power plants and transmission are aging. Electricity demand will continue to increase even with the wide ranging energy conservation and efficiency measures.

Building small reactor technology in a timeframe that supports the nation's demand for low cost, reliable electricity and the Administration's climate change goals will require industry/government partnerships. These partnerships would complete research and develop projects and ensure a more rapid use of these technologies. A proven model for government/industry partnership is nuclear power 2010 which is supporting the development and approval of new and improved large nuclear plant designs and the

testing of the new 3 part licensing process for these reactors, 10 CFR Part 52.

There have been substantial benefits from the NP 2010 program beyond the technical achievements.

For example, government and industry investments in the NP 2010 program are expected to stimulate more than 100 billion dollars in new nuclear plant construction over the next 10 years creating tens of thousands of high paying jobs and reinvigorating America's manufacturing sector.

For example, each new reactor will create up to 2,400 onsite construction jobs for each reactor project between 400 and 700 jobs for operations and management of these facilities once built and thousands of jobs in design, manufacture and transportation of components of materials to support new reactor construction.

The industry supports the provisions of the 2 legislative proposals, S. 2052 and S. 2812, as well as the provisions of S. 2776, the Clean Energy Act of 2009 as they relate to small modular reactors. We urge the sponsors of these bills to work together and combine the small reactor provisions into a single bill. Legislation to develop small scale reactor technology and allow for accelerated construction of the first reactor designs should do the following.

Define the scope, priorities and funding for R and D.

Define the scope of government/private cost share provisions for design development and prototype simulation and testing.

Provide funding to assist the Nuclear Regulatory Commission and the industry in resolving generic regulatory issues specific to small modular reactors.

Define private/government cost share projects for the development and RC review and implementation of first of class combined license applications up to the NRC authorization for fuel load and support the expansion of industrial infrastructure, factories, fabrication and training of the work force to manufacture, build and operate these facilities.

There are generic regulatory issues relating to design approval, construction and operation of small reactors that must be resolved before designs can be completed to a level that supports a design certification, procurement and finalization of major contracts. The industry's committed to work with the staff at the NRC and other public stakeholders to put in place a practical and transparent, regulatory process for these new technologies and designs. The industry and the NRC are familiar with light water reactor technology. As a result this technology can be built earlier than the other 2 technologies if we move forward now and authorize to fund government/industry partnerships the first small modular reactors could be built by 2020.

In conclusion there are substantial benefits that can be derived from small modular nuclear energy plants. These designs merit Congressional support. These designs expand the strategic role of nuclear energy in meeting national, environmental energy security and economic development goals. The nuclear energy industry believes that appropriate public/private partnerships such as those described in S. 2052 and S. 2812 are important to ensure that our nation continues to grow economically without adversely affecting the environment.

Thank you for the opportunity to address the Committee.
[The prepared statement of Mr. Pietrangelo follows:]

PREPARED STATEMENT OF ANTHONY R. PIETRANGELO, SENIOR VICE PRESIDENT AND CHIEF NUCLEAR OFFICER, NUCLEAR ENERGY INSTITUTE

Chairman Bingaman, Ranking Member Murkowski, and members of the Committee, thank you for your interest in nuclear energy and in addressing the policies that can facilitate the research, development and deployment of small, modular nuclear power plants to meet national energy needs and reduce carbon emissions.

My name is Tony Pietrangelo. I am a senior vice president and the chief nuclear officer at the Nuclear Energy Institute (NEI). NEI is responsible for establishing unified nuclear industry policy on regulatory, financial, technical and legislative issues affecting the industry. NEI members include all companies licensed to operate commercial nuclear power plants in the United States; nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

My testimony will cover three major areas:

1. Modular, small reactor designs can help achieve our clean energy goals and create jobs.
2. Public/private partnerships can accelerate development and deployment.
3. Legislation before your Committee contains practical, proven provisions.

1. Modular, small reactor designs can help achieve our clean energy goals and create jobs.

Near-term construction of large, new nuclear plants will address two of our nation's top priorities: Additional supplies of clean energy and job creation. Small, modular reactors can complement these large-scale projects by expanding the level of deployment and application options for carbon-free nuclear energy. Small-scale reactors provide energy companies and other users with a broader array of energy options. Each satisfies different needs in the U.S. energy portfolio and is part of a more holistic approach to the effective implementation of nuclear energy.

Today, nuclear energy is one of the few bright spots in the U.S. economy—expanding rather than contracting over the past few years—creating more than 15,000 jobs in design and engineering, in the nuclear supply chain, and in site preparation for new construction. In the same period of time, the nuclear industry has invested more than $4 billion in new nuclear plant development, and plans to invest approximately $8 billion more to be in a position to start major construction in 2011-2012.

These investments in new nuclear plants will help the United States meet its climate change objectives. Both the Energy Information Administration's assessment of the Waxman-Markey legislation and a recent National Academies' study on America's energy future found that the United States must nearly double the existing 100 gigawatts of carbon-free nuclear energy by 2030 to meet our climate goals. These studies are consistent with the International Energy Agency's findings in the World Energy Outlook 2009.[1] The agency found that by 2030, an additional 330 gigawatts of new global nuclear energy must be added, nearly doubling the existing global nuclear generating capacity, to achieve climate policy goals.

The United States and other nations are planning the construction of more than 130 new large and small, modular nuclear generating plants, which has increased interest in expanding the U.S. nuclear engineering and manufacturing capabilities and facilities.

Achieving deployment at this speed and scale represents a significant challenge. It must be undertaken in conjunction with an aggressive development and deployment of energy efficiency and conservation measures, renewable energy sources and other low-emitting energy technologies. This level of low/non-carbon emitting technology deployment will be a catalyst for a major expansion of the American engineering, manufacturing and construction sectors. It provides new industrial opportunities for state-of-the-art factories, foundries and fabrication facilities for domestic and export markets. Private investment and government incentives and support for what needs to be a mini-Marshall Plan for America will generate tens of thousands of high-paying jobs and clean energy.

While it is true that the United States yielded its leadership position to international competitors on nuclear plant manufacturing in past decades, we have not yielded our innovation or entrepreneurial spirit. Small-scale reactor designs already

[1] International Energy Agency's World Energy Outlook 2009, 450 Policy Scenario

in development provide the opportunity to re-establish American global nuclear leadership.

SMALL REACTOR DESIGNS TARGET A VARIETY OF MARKET APPLICATIONS

There are many small, modular reactor designs under development to meet specific U.S. and international market needs. Small-scale designs may be more compatible with the needs of smaller U.S. utilities from a generation, transmission and financial perspective compared with large 1,400 megawatt plants. As a result, these smaller reactors will complement the construction of large nuclear energy facilities, which are the subject of intense regulatory review by the Nuclear Regulatory Commission.

Small light water reactors being developed are designed to exploit the benefits of modular construction, ease of transportation, and reduced financing, all of which could create a compelling business case. Since these designs are typically smaller than 300 megawatts electric (MWe), they could be used to replace inefficient fossil-fired power stations of similar size that may no longer be economical to operate in a carbon-constrained world. The infrastructure, cooling water, rail and transmission facilities already exist at such facilities.

Small-scale reactors can be built in a factory environment and shipped directly to the plant site. This will require the expansion and updating of existing facilities and the construction of new state-of-the-art factories. The small size and modular construction will allow these plants to be built in a controlled factory setting and installed module by module, reducing the financing challenge and matching capacity additions to demand growth.

A second set of small reactor designs are high-temperature gas-cooled reactors. These reactors could be used for electricity generation and industrial process heat applications, such as those used in the petrochemical industry. These reactors also could be used for the development of tar sands, oil shale and coal-to-liquids applications, resulting in a minimal life-cycle carbon footprint.

A third set of small, modular plants includes liquid-metal cooled and fast reactor technologies that hold the promise of distributed nuclear applications for electricity, fresh water and district heating in remote communities. This group of reactor designs could provide nuclear fuel cycle services, such as breeding new fuel and consuming recycled nuclear waste as fuel. These reactors could also support government-sponsored non-proliferation efforts by consuming material from former nuclear weapons, thus eliminating them as a threat.

Small reactor technology has the potential to help America remove carbon from the electric, transport and industrial sectors. However, each small reactor technology has unique development needs and different timelines to reach the market.

2. Public/private partnerships can accelerate development and deployment.

The economic, energy security and environmental benefits of small reactor technologies make a strong case for accelerated development and deployment. However, a variety of factors must be addressed to achieve this outcome. The development and deployment of a new nuclear reactor technology can take two decades, with design costs exceeding $1 billion. The cost and time required to design, develop, and license a small reactor is not necessarily reduced linearly with size. In addition, it takes time and resources for the Nuclear Regulatory Commission to develop the institutional capacity to license new reactor designs.

All of these issues increase the risk and uncertainty for vendors that face expensive design and licensing challenges. Traditional partnerships between technology vendors, component manufacturers and end users are necessary but insufficient in themselves. Absent additional business risk mitigation through government incentives, the potential benefits of these small, modular reactor concepts may go unrealized.

DEPARTMENT OF ENERGY'S NUCLEAR POWER 2010 PROGRAM PROVIDES A SUCCESSFUL MODEL

There is a successful public/private partnership model for development of small-scale reactors in the Nuclear Power 2010 (NP 2010) program. This program has been successful in reducing business risk, enabling earlier deployment of advanced large reactor technologies. A government-industry, cost-shared program, NP 2010 has given project developers and technology vendors the necessary incentives to test a new NRC licensing and siting process. The lessons learned by these first projects will be shared with industry and NRC staff so that future applicants and NRC staff will have a better understanding of the expectations and standards for new reactors. When taken with the industry's commitment to standardization, NP 2010 will en-

able a more efficient and predictable review process. Furthermore, the funding for first-of-a-kind engineering is allowing completion of reactor designs to a level of detail that is enabling better cost estimates to be developed and long-lead components to be procured.

The NP 2010 program has achieved significant results to date including:

1. The approval of three early site permits. This activity has provided a roadmap for future early site permit applicants allowing sites to be pre-approved for a 20-year period.
2. The development and submittal of reference combined construction permit and operating license (COL) applications for NRC review and approval along with an additional 15 COL applications.
3. The development and NRC review of a design certification application for the General Electric ESBWR design and an amendment to the design certification for the Westinghouse AP1000 design.
4. The completion of engineering work to support development of construction cost estimates and procurement of equipment.
5. The development of guidance documents for applicants and NRC staff for implementing 10 CFR Part 52 that when coupled with the industry's commitment to standardization and the approval of the reference COL applications, should ensure that subsequent application development and review will be more efficient, significantly reducing the review schedules.

There have been substantial, additional benefits of the NP 2010 program beyond the technical achievements. For example, government and industry investments in the NP2010 program are expected to stimulate more than $100 billion in new nuclear construction over the next 10 years—creating tens of thousands of high-paying jobs.

3.Legislation before this committee contains practical, proven provisions

The industry supports the provisions in the two legislative proposals, S. 2052, Nuclear Energy Research Initiative Improvement Act of 2009, and S. 2812, Nuclear Power 2021 Act. In addition, we support the provisions in the proposed S. 2776, Clean Energy Act of 2009, as they relate to small, modular reactors.

S. 2052 authorizes the Secretary of Energy to carry out research, development and demonstration programs to reduce manufacturing and construction costs relating to nuclear reactors, including small-scale, modular designs. By focusing federal research support on programs to reduce the cost of licensing, construction and the manufacturing plant components, S. 2052 can accelerate the construction of small, modular reactors. The cost sharing provisions are designed to provide the greatest federal support to the research and development activities, with the cost share provisions for demonstration programs being shared equally by government and industry.

Chairman Bingaman's Nuclear Power 2021 Act directs the Secretary of Energy to carry out programs to develop and demonstrate two small, modular reactor designs. This legislation is targeted to reactors that are less than 300 MWe and requires that one design be not more than 50 MWe. It would seek to obtain design certifications and combined licenses for the two designs by 2021. Proposals for this initiative will be made on the basis of scientific and technical merit, using competitive procedures, and taking into account efficiency, cost, safety, and proliferation resistance.

We urge the sponsors of these proposed bills to work together and combine the small reactor provisions into a single bill. We support the proposed cost-share arrangements described in the proposed legislation. Legislation to develop small-scale reactor technology and allow for accelerated construction of the first reactor designs should include the following provisions:

- define the scope, priorities and funding for research and development;
- define the scope of government-private cost share provisions for design development and prototype simulation or testing;
- provide funding to assist the Nuclear Regulatory Commission and the industry in resolving generic regulatory issues specific to small, modular reactors;
- define private-government cost-share projects for the development, NRC review; and implementation of first-of-class combined license applications, up to the NRC authorization for fuel load.

There are several generic regulatory issues relating to construction and operation that must be resolved before designs can be completed to a level that supports a design certification, procurement and finalization of major contracts. These regulatory issues include: control room layout and staffing levels, unique design features, construction during operations, security, and the endorsement of advanced seismic

technologies and designs that would enable these designs to be built in more areas of the country.

The industry's prime focus is the continued safe and reliable operation of the existing 104 nuclear power plants. Other main areas of industry focus include the construction of advanced, large-scale reactors on schedule and within the budget estimates, and the establishment of the necessary infrastructure, workforce and manufacturing capability, to support the new nuclear deployment projects The industry also attaches high priority to achieving economic, political, and regulatory stability for the entire fuel cycle, including fuel supply, materials licensing and used fuel management and the deployment of small reactor technologies for electricity generation and use in industrial process heat applications.

CONCLUSION

The potential benefits of small, modular nuclear energy plants are substantial and should be pursued and supported. These designs expand the strategic role of nuclear energy in meeting national environmental, energy security and economic development goals. The nuclear energy industry believes that appropriate public/private partnerships, such as those described in S. 2052 and S. 2812, are important to ensure our nation continues to grow economically without adversely impacting the environment.

Thank you for the opportunity to present this information to the committee.

The CHAIRMAN. Thank you very much.

Mr. Johnson, go right ahead.

STATEMENT OF MICHAEL R. JOHNSON, DIRECTOR, OFFICE OF NEW REACTORS, NUCLEAR REGULATORY COMMISSION

Mr. JOHNSON. Chairman Bingaman, Ranking Member Murkowski, members of the committee, thank you for inviting me to participate in this hearing today. As the Director of the U.S. Nuclear Regulatory Commission's Office of New Reactors, I'm pleased to have this opportunity to discuss our preparations for performing licensing reviews of small modular reactors. The NRC regulates the civilian use of nuclear materials in the United States and we take our mission to protect health and safety and the environment very seriously.

Several vendors have approached the agency to discuss their interest in gaining approval to build and operate modular reactors in the United States. We will take steps to ensure that any new modular reactors approved by the NRC are operated safely. The current proposed designed generally provide for less than 300 megawatts per module. We expect that those—that multiple modules would be installed on a site.

They can be categorized as integral pressurized water reactors, high temperature gas cooled reactors and liquid metal reactors.

The integral pressurized water reactors are smaller, less powerful versions of the existing reactors.

High temperature gas cooled reactors use helium gas as a coolant and operate at much higher temperatures than today's reactors.

Liquid metal reactors are significantly different from the others and use liquid metals such as sodium as a coolant.

The NRC has primarily licensed light water reactors but we've had some experience in licensing high temperature gas cooled reactors and reviewing liquid metal reactor designs over the last 40 years. These reviews were performed on a case by case basis. We plan on developing generic, regulatory guidance to streamline our reviews and stabilize the regulatory environment.

Potential licensing applicants for small modular reactors have sent the NRC letters that outline proposed application dates. The

earliest possibly arriving in fiscal year 2011. In fiscal year 2012, we expect to receive multiple applications. In fiscal year 2013, we expect to receive from the Department of Energy an application for a design certification for the Next Generation nuclear plant or NGNP. The NRC has been working closely with DOE to ensure that we will be ready to review that application.

We have prepared for these activities by establishing an Advanced Reactor Program within the Office of New Reactors. Both the Advanced Reactor Program and the Office of New Reactors are focused on licensed activities for new designs. Oversight of the existing reactors is a focus of a separate office. Our existing regulations and guidance focus on light water reactors and do not necessarily translate to other technologies. Therefore the NRC is identifying and conducting needed research, developing analytical tools and resolving policy issues that could affect any or all small modular reactor technologies.

We are preparing review guidance for both the NRC staff and the industry. We are also training our reviewers on specific technologies and preserving existing knowledge to support future licensing. This is consistent with the approach being used for NGNP.

It is critical that we undertake these preparations in parallel with and not subsequent to the development of small modular reactor technologies. To that end we have been interacting with the national and international community to stay abreast of developments and refinements in the technologies. In addition the NRC has both multilateral and bilateral agreements with many countries. As appropriate we are including discussions on small modular reactor development and licensing with these countries.

In reviewing our regulations we have identified some issues common to all small modular reactor technologies as well as issues relevant to specific technologies. We therefore intend to address common licensing issues generically whenever possible recognizing that there may be some implementation issues unique to each design. In general our readiness to review the various reactor technologies will also depend on how informed we are on the degree of innovation in the proposed design. As increasingly innovative technologies are proposed it is imperative that our development of the requirements and the regulatory review guidance proceed along with technology development. Furthermore, as companies submit applications to the NRC our ability to conduct efficient and timely reviews will largely depend on the applicant's ability to submit complete, technically sufficient, high quality applications.

In summary the NRC is working proactively to fulfill our mission and be prepared to review design certification and combined license applications for the different small modular reactor technologies. We're actively engaged with the industry and the international community regarding these technologies. The NRC and the industry have much work to do before commencing licensing reviews for small modular reactors. But we continue to make progress. We look forward to updating the Congress as we proceed.

Mr. Chairman, members of the Committee, this concludes my remarks on the NRC's preparation activities for performing licensing reviews of small modular reactors. I would be pleased to respond to any questions you may have.

[The prepared statement of Mr. Johnson follows:]

PREPARED STATEMENT OF MICHAEL R. JOHNSON, DIRECTOR, OFFICE OF NEW REACTORS, NUCLEAR REGULATORY COMMISSION

Mr. Chairman and Members of the Committee, thank you for inviting me to participate in this hearing today. As Director of the U.S. Nuclear Regulatory Commission's (NRC's) Office of New Reactors, I am pleased to have this opportunity to discuss the status of the NRC's preparation activities for performing licensing reviews of small modular reactors (SMRs).

The NRC's job is to license and regulate the Nation's civilian use of byproduct, source, and special nuclear materials in order to protect the public health and safety, promote the common defense and security, and protect the environment. In this capacity, the NRC has been approached by a number of vendors interested in design certifications for a new class of reactors, described as SMRs.

While there is no universally accepted definition of these designs, the power levels for a single module are generally below 300 megawatts electric, and multiple modules can be 1 installed at a single site. For the purposes of this testimony, we are categorizing the designs—based on the underlying technology—as integral pressurized-water reactors (iPWRs), high-temperature gas-cooled reactors (HTGRs), and liquid metal reactors (LMRs). The iPWRs are similar to existing power reactors but are physically smaller, produce less power, and have the steam generators and circulation pumps, if any, installed inside the reactor pressure vessel rather than as separate components. In contrast to iPWRs that use water as the coolant, HTGRs use helium gas as the coolant and operate at much higher temperatures. Experience with HTGRs is limited in the United States, as the Peach Bottom Unit 1 reactor received its operating license in 1966 and was shut down in 1979, and the Fort St. Vrain reactor received its operating license in 1973 and was shut down in 1989.

Liquid metal reactors are significantly different from iPWRs and I-ITGRs and use liquid metals, such as sodium, as the coolant. The NRC has limited experience in licensing LMR designs, as the agency was conducting a regulatory review of the Clinch River reactor in the early 1980s until the project was terminated in 1983. Review of these SMRs was done on a case-by-case basis without the benefit of well-developed regulatory guidance governing the submission and review of these applications. Development of regulatory guidance would increase the effectiveness and efficiency of the review process and enhance regulatory stability.

The NRC has to a limited extent, been engaged in the review of modular reactors since the mid-1980s. This consisted of preliminary reviews of three conceptual modular reactor designs submitted by the U.S. Department of Energy (DOE). Of these reviews, two were for LMRs (a sodium advanced fast reactor and a power reactor innovative small module) and the other was for an HTGR (a modular high-temperature gas-cooled 2 reactor). Although formal applications for these designs were never submitted, the preliminary reviews conducted by the NRC provided insights into the key safety and licensing issues for non-light-water reactors.

More recently, in 2004, at the request of the company PBMR Propriety (Pty) Limited, the NRC began a limited scope preliminary review of the pebble bed modular reactor (PBMR), an HTGR design. PBMR (Pty) Limited began submitting a series of white papers to address technical and policy issues, The NRC performed limited reviews of several of the papers but stopped because of the need to focus on work with higher and more immediate priority.

The NRC has received letters from potential SMR licensing applicants outlining proposed application submittal dates. If these plans materialize, the NRC could receive an application for the licensing of an SMR as early as fiscal year (FY) 2011. In or around FY 2012, the NRC expects to receive applications for multiple design certifications, early site permits, combined licenses, and manufacturing licenses related to SMRs. Additionally, the Next Generation Nuclear Plant (NGNP) program is expected to provide a design certification application to the NRC in FY 2013, which will be preceded by pre-application discussions. The NRC has been working closely with DOE to ensure that we will be ready to review this application.

In anticipation of these activities, we established the Advanced Reactor Program, which is dedicated to preparing for and conducting licensing reviews of the SMRs. Our existing regulations and guidance are focused on light-water reactors and do not necessarily translate to other technologies. Therefore, we are identifying and executing needed research, developing analytical tools, identifying and resolving policy issues that could affect one or all three of the technologies, and preparing review guidance for both the staff and industry. We are also developing the reviewer skills

and implementing knowledge management activities to support future licensing activities. This is consistent with the approach being used for the NGNP.

Optimally, the necessary regulatory framework for licensing SMR technologies will be developed in parallel with, and not subsequent to, the development of the SMR technologies themselves. To that end, we have been interacting with the national and international community to stay abreast of developments and refinements in the SMR technologies. We are coordinating research and licensing activities with organizations such as the International Atomic Energy Agency, the Nuclear Energy Agency within the Organization for Economic Cooperation and Development, and the Generation IV International Forum. The NRC has both multilateral and bilateral agreements with many countries, and, as appropriate, we are discussing SMR development and licensing with these countries.

As we have undertaken the review of our regulations and guidance for SMRs, we have identified some common issues, as well as technology-specific issues. While several technologies exist within the broad spectrum of SMRs, the staff intends to address those common licensing issues generically.

Regarding technology-specific issues, for the iPWRs, we are in a relatively good position to undertake these licensing reviews. Our initial assessments suggest that we will need only limited research and revisions to existing regulations and guidance to support licensing activities.

For HTGRs, consistent with the NGNP, the NRC has been working with DOE to develop and coordinate research activities needed to support licensing reviews of these designs. We also are identifying policy issues and gaps in our review guidance and are beginning activities to resolve them. The NRC is sponsoring research that focuses on key issues for HTGRs, such as modeling reactor system performance and materials exposed to very high temperatures. These research activities coupled with those from DOE are expected to support the resolution of licensing issues for HTGRs. While substantial work remains to be completed, the activities underway should support the Agency's licensing review of an HTGR design.

For LMRs, the NRC is just starting to review the regulations and guidance pertinent to these designs. While earlier LMR designs have been reviewed in the United States, we anticipate that many changes will be needed to the existing light-water reactor guidance, and perhaps to the regulations, to support efficient licensing of the new LMR designs. We also expect that significant research will be needed to support these changes. Given the magnitude of the work required and the NRC staffs limited experience with LMRs, preparing the staff to review a LMR licensing application may take several years.

In general, the NRC staffs readiness to review the various reactor technologies will also largely depend on the level of innovation in the proposed design. As increasingly innovative technologies are introduced, it becomes even more important that the development of requirements and regulatory review guidance proceed in tandem with technology development to the extent possible. Furthermore, as applications are submitted to the NRC, the agency's ability to conduct efficient and timely reviews will largely depend on the applicant's ability to submit complete, technically adequate applications of high quality.

In summary, the NRC is working proactively to fulfill its mission and be prepared to review design certification and combined license applications for the different SMR technologies. We appreciate the support we have received from the Congress for our activities in this area. We are actively engaged with our many stakeholders and the international community with respect to the different SMR technologies. The NRC has much work to do before commencing licensing reviews for SMR, but we continue to make progress and look forward to updating the Congress as we proceed.

The CHAIRMAN. Thank you very much. Let me start with a few questions.

Dr. Miller, let me ask you. The S. 2812 requires cooperative agreements with cost sharing by the government. Can you comment on the level of non-Federal cost sharing that we outline in the bill? I think we have one level for design work and another level for the actual getting the application done. Do you have any thoughts on that?

Mr. MILLER. Thank you very much, Senator. As I've looked into that I believe the numbers that are in the bill are in fact consistent with our policies and our practices within the Department. It's con-

sistent, for example, with the NP 2010 program. So I guess I don't see any issues associated with whether or not those numbers would be consistent with the program.

Now having said that, as I said in my comments, we haven't had a review of the legislation yet within the Department.

The CHAIRMAN. This is also for you, Dr. Miller. The bill S. 2052 contemplates a nuclear energy research initiative authorizing 50 million per year for 5 years. Is that a reasonable level of funding for the Congress to contemplate on the subject if we were able to get that authorized and appropriated?

Mr. MILLER. Yes. So let me first again say that there hasn't been a review of the legislation. So I can't comment specifically on that.

But I can, in my experience at national labs and universities about initiating these Federal research and development programs and it seems, in my personal opinion, to be consistent with a program like this. That level that may in fact increase over years, but it seems consistent with a program of this type, from my experience.

But again, I want to repeat the Department hasn't really reviewed the legislation yet.

The CHAIRMAN. S. 2812 authorizes the selection under merit review of 2 candidate small reactors to begin a demonstration program for licensing. One is to be under 300 megawatts. The other is to be under 50 megawatts.

Is this the appropriate size/categories we ought to be looking at here? Is this the appropriate number of candidate small reactors that we ought to contemplate the government assisting with?

Mr. MILLER. So, let me first comment on the No. 2. Clearly that's a judgment call. Again, we haven't reviewed that, but the experience within NP 2010 is that there were 2 designs that ended up being supported out of NP 2010.

One is the AP1000, the other one was the ESBWR. So consequently it doesn't seem outside the realm of what one might want to do. With the 300 megawatts, as I mentioned, there is some reason why that number would be an appropriate number related to liability insurance.

There is some argument for making it larger. That's another reason why we would need an opportunity to review the legislation before we were able to come down on the number.

The CHAIRMAN. Ok. The Nuclear Energy Research Initiative Improvement Act 2052, authorizes research and development. Should we also include anything about demonstrations in that legislation?

Mr. MILLER. That again is an important policy issue. In many of our programs when we were doing research and development it's clear what the government role is. It's clear what's appropriate.

As we move closer and closer to deployment it becomes more of a question of what's the government role. That's the kind of thing we really need to look at on this particular bill to identify financially what the role is. On the other hand, without expenditure of funds we can still be a facilitator.

We can facilitate industry getting together with NRC. We can facilitate workshops. So we can do things within the Department that encourage this technology without necessarily having to have funds to do it.

The CHAIRMAN. Let me ask one other question. The timeframe that we have in S. 2052 strikes me as a layperson, as a long timeframe, particularly when we're talking about light water reactors. There's an awful lot of work that's been done. We've had small light water reactors for many decades now.

Do we really need this much time between now and 2021 to get settled on a design and license in this area? Dr. Sanders, did you have a view on that or Dr. Miller, either one, any of you, any of the rest of you?

Mr. SANDERS. From our perspective it's really how much experience is available. Light water reactors have a long history of experience. Like we pointed out there is an infrastructure in place that can help motivate that and move it forward quickly.

There's some very unique designs in that category though that are real stretched from today's technology that's going to take a little bit of research and development. With the liquid metal reactors, I'd like to remind everybody we operated those kinds of reactors for 40 years in this country. That was called EBR-1 and EBR-2. A lot of the challenge is going to be assimilate all that information and put it together in a case and then bring it forward.

In many cases what you're going to see with these designs are enabling technologies that have caught up with the nuclear technology. By enabling the technologies I think new power generation concepts, advanced manufacturing concepts, marrying the factory design to the reactor design so that you can turn these out in a couple years instead of 7 years and those kinds of things. So it's a much broader R and D approach instead of just looking at the particular type of design. It's a much more integrated approach.

Mr. MILLER. May I?

The CHAIRMAN. Yes, go ahead.

Mr. MILLER. If I may add to that. As my fellow panelists have mentioned, there are several categories of reactors. Some are much further out. It really is appropriate to have a research and development program for them.

Some are more near term and we are always going to have a first of a kind issue when it comes to timing. I would expect after the first few of the more near term LWRs are actually deployed, they actually go through this process, the time is going to drop dramatically from the point of view of licensing as well as construction. In fact we have indications of reactors being built overseas that that's exactly the case that time does go down after you learn, after the first of a kind.

I expect that to happen in this case as well.

Mr. JOHNSON. Mr. Chairman, if I might?

The CHAIRMAN. Yes, go right ahead, Mr. Johnson.

Mr. JOHNSON. From a regulatory perspective it is true what the other panel members have made the point very clearly that clearly with the light—the small modular reactors that are light water reactor technology, we are closest to being able to revise whatever regulatory requirement revisions need to be made. Do whatever additional work is done to prepare our analysis tools to be able to support those. So those could be more ready in a more reasonable timeframe. As you go to the other technologies it would take longer.

But again, I think it's important that we do that work before the application shows up so that the regulator is ready to license those reactors.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. Mr. Johnson, I would like to start with you. As we look at the advantages of these smaller reactors, I think it's clear that one of the positives is the ability to locate in some more remote areas. Places that otherwise we wouldn't necessarily think about.

How does this impact the NRC's licensing process as you determine whether or not the site is appropriate? Then also, how the spent fuel issues and how they will be managed?

Mr. JOHNSON. Thank you. Those are exactly the kinds of questions that we are beginning to take on as we look at licensing small modular reactors. We've done work to identify each of the policy issues including citing issues, emergency preparedness, for example, security. What are the security requirements?

We've done outreach with external stakeholders, members of the public and the industry to catalog those policy issues. Then we'll work through those policy issues. So, I don't have an answer today with respect to what the impacts would be. But we certainly recognize that those policy issues do exist and will resolve those in time to support licensing.

Senator MURKOWSKI. Let me ask you on that point because you have indicated that you're setting up these review guidances and training reviewers. Do you have the sufficient staff with the technical expertise that is required to be dealing with these new designs? Are you ready to go or is it something that you are preparing for?

Mr. JOHNSON. Thank you. I would say it really depends, excuse me, on the technology that we're talking about. If it's the small modular reactor, that is the light water reactor technology, we have a lot of experience with light water reactor technology. We have expertise. We have analysis codes that are fairly easily translatable.

So we are ready. We could be ready to proceed fairly quickly with respect to those.

Senator MURKOWSKI. What about the new design?

Mr. JOHNSON. With respect to the new designs such as high temperature gas, we are working in coordination with the Department of Energy. In response to the Energy Policy Act of 2005 we have identified the gaps. I would say, in terms of our regulations and the requirements and in terms of the research that is needed, we've got a ways to go, but we're going to—we can make that, travel that distance, in time to support the deadline that was established in the licensing strategy.

With respect to the liquid metal reactors we're just beginning to look at what it takes in terms of the research and the changes in our requirements. Today where I sit I think those changes could be significant. It could take us a number of years to develop those requirements to conduct that research and to have the expertise on staff to be able to support the reviews.

Senator MURKOWSKI. Let me throw this out to any of you, in terms of what you feel the biggest hurdle is that we're facing as we're trying to advance these small modular reactors and allow

them to be constructed here in the United States? Is it regulatory? What is the biggest hurdle that we face?

Mr. Sanders, you look like you're ready to go.

Mr. SANDERS. I'd say it's commitment.

Senator MURKOWSKI. Commitment from?

Mr. SANDERS. Commitment on behalf of the government as well as our industries, as well as our laboratories, as well as our universities to get the job done. I don't believe that any of these are a long term research and development program anymore. I believe that we have done a lot of research in a lot of different nuclear concepts for a number of years since 1953.

The real challenge is going to be how do we take advanced technologies that have been demonstrated, continue the demonstration and the maturation of those technologies and pass them off to U.S. industry and get beyond that valley of death that exists and we are aware of that can make our industries very competitive in this area and our regulators much more comfortable in addressing these.

Senator MURKOWSKI. I appreciate that. Would anyone else like to respond?

Mr. Miller.

Mr. MILLER. As I've looked at this and I assume Senator, your question has to do with near term deployment of these technologies and what is the hurdle associated with getting going and getting it started. It just seems to me, as I look at the licensing activities and the activities here in the Department of Energy, where we are attempting to finish our first loan guarantee, which we hope to announce really soon to get going with a GEN III-Plus large reactor, that our resources and attention to be on that right now and not on the smaller modular reactors as much as it should be.

Mr. PIETRANGELO. I think with respect to electricity generation the No. 1 issue is are they going to be cost effective in terms of being able to sell electricity in whatever market they're in. That's the key issue for the large modular reactors or large reactors as well. So I think doing the R and D to get to a detailed design to be able to cost out these projects, getting all the regulatory issues resolved so we know how to deal with how many operators, the security requirements, etcetera so that you can with reliability determine what the cost of generation will be.

I think that's the number 1 hurdle.

Senator MURKOWSKI. Mr. Johnson.

Mr. JOHNSON. The regulator is going to say that the obstacles, repair and the regulatory infrastructure in conjunction with developing the technology such that when the application shows up we're ready to proceed with that application review in a timely way. I think the success that we're having in terms of reviewing the large light water reactors is that we have, in fact, developed the review guides up front. We have the tools. We've had the complementary research.

I think we should borrow from that in terms of the recipe that we use in addressing small modular reactors going forward.

Senator MURKOWSKI. I think it all comes down to a commitment to making it happen. Thank you.

The CHAIRMAN. Senator Udall.

Senator UDALL. Thank you, Mr. Chairman. Again, let me acknowledge the hard work of you and Senator Murkowski. I appreciate the opportunity to have my bill considered today.

I do have a longer statement for the record I'd like to include in the record.

The CHAIRMAN. It'll be included.

[The prepared statement of Senator Mark Udall follows:]

PREPARED STATEMENT OF HON. MARK UDALL, U.S. SENATOR FROM COLORADO

Thank you, Mr. Chairman. I am glad that we are having this hearing to receive testimony from different communities about the two pieces of legislation before the committee. It has been a pleasure to work with you and your staff, Mr. Chairman, and the Ranking Member and her staff on this promising area of nuclear energy research.

Given the economic, national security, and environmental threats that our current energy system creates, we need a comprehensive and cleaner energy policy. In this regard, nuclear energy clearly has emerged as an important player in our search for a stable and domestic energy source that has less greenhouse gas emissions.

But nuclear energy, like all of our energy sources, does face several challenges: high capital cost and the long licensing and construction times. My bill is intended to help address some of these challenges.

This is why I have asked the Department of Energy to explore small modular reactors, which have the potential to overcome many of these challenges outlined in my bill.

Smaller reactors have the potential to be more affordable to smaller utilities, and the ability to add modules one at a time could prove advantageous.

There is also that possibility that small modular reactors could be fabricated at factories, cutting down on construction time.

There are reasons why small reactors might have a streamlined licensing process, and I look forward to hearing from the Nuclear Regulatory Commission as to their thoughts. If, for example, the reactors were air-cooled, instead of employing large amounts of water, the licensing process could potentially speed up. Water use is a serious issue in many parts of the country, especially out West, and this capability could improve its applicability.

All in all, there is great potential for small modular reactors to advance nuclear power's role in the power sector and help grow a more carbon-free economy. I look forward to hearing testimony from our expert witnesses, the recommendations they have for the bills and the discussion that follows.

Thank you, Mr. Chairman.

Senator UDALL. Thank you for that. Dr. Miller, let me turn to you. Good to see you.

When it comes to the small modular reactor program that we're discussing here in a broad sense, also specifically in regards to these 2 bills. What are the essential components in your mind of a successful small reactor program?

Mr. MILLER. Thank you, Senator. It's good to see you, sir.

We think of this program as having 3 components. The very important, near term, LWR technologies that we've been talking about here and I agree with what my colleagues have said about the need to get on with deploying those and understanding, you know, what the costs will be and what the licensing issues are. I think that's one whole block of issues related to the LWR. So that's part of a program.

Another part of the program would be the next wave that might come, which are the gas cooled reactors that are embodied in the NGNP program and other potentially gas cooled reactors that could be deployed for other applications in addition to electricity production. I think those are further back in the line of development. But

I think a healthy program should include support for that component.

Then last we've been quite encouraged with the energy and vigor with which the university and small companies have come forth with some pretty innovative approaches to production of nuclear energy that attempt to address more the reduction of waste, the high burn up of fuel-and therefore much better uranium utilization and issues related to proliferation risk. So there's some very innovative, thoughtful, further out approaches that have come forward that we think also should be part of a vigorous small modular reactor program.

Senator UDALL. Let me follow up before I turn to Mr. Pietrangelo. When you talk about a better utilization of fuel, does that also have a positive effect on the concerns we have about proliferation?

Mr. MILLER. Certainly it does that. But also the idea is to try to get the maximum energy one can out of every fuel element in order to minimize the impact on eventual, final geologic disposal pad. So it's meant to address both of those.

Senator UDALL. Both of those, ok.

Mr. Pietrangelo, if I could, following up on Dr. Miller's comments on the non-electric generation applications or processes. Could you comment on the small reactor companies what they may offer in these areas of non-electric applications and what currently looks like the best business case in this area?

Mr. PIETRANGELO. Yes, I'm not familiar with the business cases for the specific designs that are being looked at. I think Dr. Sanders went over a lot of the potential applications for the higher temperature gas cooled reactors and desalination and other industrial applications for the chemical industry and a number of other industries.

But at this point I don't think we know enough to know which of those is the best suited for which application. I think that's one of the goals of the R and D effort, obviously, is to get the detailed designs down and be able to look at those individual projects and determine what the best applications will be. So at this point there's a lot of potential, but we think we need to drill down to doing the blocking and tackling and figuring out exactly, you know, what can do what and how much it will cost and where it could be deployed.

Senator UDALL. Dr. Sanders, on that note, let me turn to you and ask you about the safety advantages of small reactors verses existing reactors and the GEN-III Plus reactors.

Mr. SANDERS. When people ask me about safety advantages I remind everybody that the safety standards in place have to be met. So by definition every licensed reactor whether it's large or small is going to meet the same standards. But complexity is the issue.

One area where small modular reactors have a distinctive benefit over very large systems is reduced complexity. The liquid metal reactors are pool type reactors. They're low pressure. There's no high pressures involved on the primary side. So there's none of the issues associated with pressure boundaries.

All of these applications then are intended to be placed underground. They basically are about the size of this room, I believe.

Most of the concepts I've seen and we've covered these in ANS presentations and conferences for the last 5 years is many unique, valuable ideas out there across our infrastructure from universities, laboratories and industry.

The complexity is the big issue, in my opinion. Fuel complexity is a big issue. Those are the issues that depending on the pros and cons and the advantages of a particular fuel type can be as simple as something like metal fuel or as complex as something that we don't even know about yet.

So, but the bottom line is they'll all meet the same safety standards related to security, safety and safeguards by definition.

Senator UDALL. Just out of curiosity you talked about putting a reactor underground. Would the ceiling in this room be ground level or would it be deeper?

Mr. SANDERS. Possibly for about a 100 megawatt system, yes.

Senator UDALL. Thank you. Thanks, Mr. Chairman.

The CHAIRMAN. Senator Burr.

Senator BURR. Dr. Miller, I was encouraged to hear and I read in your written testimony that you expect the Department of Energy to award the first loan guarantee, you used the word soon in your written testimony in a response to Senator Murkowski, you used the word quickly. Could I ask you to define either one of those for me?

Mr. MILLER. Thank you very much, Senator. I think the most direct way to answer the question is to say that the Secretary has said several times that we expect to announce the first loan guarantee before the end of calendar year 2009. Now having said that, every day makes that less and less likely since the time remaining is shorter and shorter.

However, I believe that's still a credible statement.

Senator BURR. I thank you for that. You also mentioned that DOE would be implementing a modeling and simulating hub as a way to help reduce cost of constructing new nuclear plants. Will you include people from the construction process in that simulation?

Mr. MILLER. Yes. Very good. So the 2010 appropriations has 22 million dollars for the Department of Energy's nuclear energy program to begin a modeling and simulation hub.

We've drafted a funding opportunity announcement to define that hub. We've had our first workshop among the community. The workshop was extremely well attended with people from industry, universities, and national laboratories as well as our international partners. Many international partners are quite interested in our activities.

The overall concept of the hub is to be able to do what we refer to as a multi-physics tool that will allow you to analyze the complete reactor innards. We have a history of picking parts of it and analyzing those very well, but not doing as well of integrating them and look at the interplay of all of the various complex things that are happening within a reactor, especially when it potentially goes off normal and how do you make sure you prepare for the activity of it going or the possibility of it going out of normal.

Senator BURR. Dr. Miller, what are your cost reduction targets?

Mr. MILLER. So in the FOA right now all we're doing is involving industry. We're defining the final FOA. We're going to get responses from them. We expect our people who respond to the FOA to talk about things like what you're talking about.

So the issue is we expect a response to that from the people who write proposals for this modeling and simulation up. We hope they respond to that.

Senator BURR. Ok. Ok. Mr. Johnson, I would take for granted at the NRC there's an area that deals with safety. There's an area that deals with security. There's an area that deals with processing applications.

Would that be a correct assumption on my part?

Mr. JOHNSON. Yes.

Senator BURR. Since we haven't permitted any reactors for a number of decades what's that piece that processes applications been doing all that time?

Mr. JOHNSON. The—I was hesitant to give you an answer with a simple yes. I probably should have expanded. With respect to operating reactors for example, there are continual activities associated with overseeing operating reactors.

They include inspection, enforcement, processing licensing applications because operating reactors change their licenses. So we process those. Doing technical reviews associated with that. There's some research that is done associated with that.

An analogous sort of thing happens in the area of new reactors. We've established an Office of New Reactors separate from the operating reactor office because we don't want to distract that focus, that safety focus. In my office I have folks who are in charge of the process, making sure the process works. Separate folks who understand that the safety review——

Senator BURR. The creation of that entity is how old?

Mr. JOHNSON. The creation of that entity is approximately 3 years old.

Senator BURR. You know, did we envision before 3 years ago that we were going to have to begin to look at new reactors?

Mr. JOHNSON. We did, indeed.

Senator BURR. This is not a revelation that all of a sudden popped up. I'm curious because and this is not—I'm not taking a shot at the NRC. But, you know, any business with the responsibility that you've got would always have some degree of forward thinking preparing for what's going to come that's around the corner.

Yet, it seems like every time we get ready to boost the nuclear industry we're held back by the need for NRC to try to put together the structure of regulation. You know, I'd sort of turn to you, Mr. Sanders. You talked about the critical mass that we have to meet for this to go forward. You talked about private sector commitment, government, academia, etcetera.

Is it realistic to believe if all that were in place if Mr. Johnson and the NRC don't have—they haven't clearly communicated what the regulatory and permitting pathway is forward will it go forward?

Mr. SANDERS. It'll go forward. But to be fair to NRC, NRC's resources are constrained by the existing infrastructure. Keep in

mind that and correct me if I'm wrong. A lot of your budget comes from existing utilities and focusing on them as a customer base.

What NRC needs, in my opinion, is a development budget of their own that allows them to prepare for these other designs that may be coming down the pike and a national imperative to help make U.S. industry more competitive by supporting them in the regulatory process and moving things forward.

Senator BURR. I'll take that, Mr. Chairman, as an answer to the last question I was going to ask which is how could we change the legislation to better support the objectives of building small reactors. I think I could put large reactors in there as well. I take that as a constructive suggestion to the Committee about how we address it.

I thank the Chair.

The CHAIRMAN. Thank you. Senator Shaheen.

Senator SHAHEEN. Thank you, Mr. Chairman. Welcome to our panelists. I'm—Dr. Sanders, you were talking about the size of this room being a size for a modular nuclear facility. Am I correct in understanding that?

Mr. SANDERS. That's correct. A lot of the cartoons that you saw over there basically are looking at about a pit similar to a 2 story building and maybe even half of this room as total underground in placement.

Senator SHAHEEN. So I'm trying to get a view of this room on a rail car. I assume when we're talking about the construction we're dividing it up into pieces in order to get it on the rail car.

Mr. SANDERS. Part of my—excuse me, part of the modular concept is how you ship it. There are designs that are sealed at the point of origin. They are somewhat smaller than the 40 megawatt.

But if you're talking about 300 megawatt I'd suspect you're talking about something that's a little bit larger, quite a bit larger. But the basic point is they are all small enough to go underground. From a security perspective that really reduces a lot of your requirements for what we call guns, gates and guards.

Senator SHAHEEN. One of the concerns that has been expressed about the nuclear industry has been a concern about shipping. One of the debates around how do we deal with the waste that's been around taking it from plant sites and shipping it to someplace. I'm not going to say Yucca Mountain because I don't want anybody to get upset about that, but to ship it to a central location.

How much of that is a concern when we're talking about a modular facility? Dr. Miller talked about being able to assemble the modulars at a location, ship them to where they're going to be used when the fuel has been used up, shipping them back to deal with the fuel. So how would that compare to concerns currently about waste that's generated at larger nuclear plants.

Mr. SANDERS. That depends on the particular design. Some of these designs don't have to be refueled for up to 10 or 20 years. That means a shipment every 10 or 20 years.

Some of them will have to be refueled on a more regular basis. So it really depends on the design. When people ask me about shipments, I like to remind them that we've made 7,000 Type B shipments to the waste isolation pilot plant in New Mexico. 7,000

drums, 700 shipments, 10 years of operation, so it isn't something new.

As far as placing small reactors in different locations around the country I like to remind folks that in San Diego harbor you probably have 5 or 6 sitting there in Norfolk, Virginia, in Bremerton, Washington and in New Loudon, Connecticut. Small modular reactors that are transportable being transported as we speak. They're called aircraft carriers and submarines. They meet the same criteria that these small pressurized water reactor designs meet.

So I——

Senator SHAHEEN. We have—I'm from New Hampshire were we have the Portsmouth Naval Shipyard.

Mr. SANDERS. Yes.

Senator SHAHEEN. So, we appreciate that. In thinking about where other countries are in developing these modular reactors and I don't know who would like to answer this. But how does the United States compare on current technologies that are being or and what's being developed? Where are we with the rest of the world?

Mr. MILLER. I'll take an attempt at that Senator. My perception of what is happening is that all the major utilities, excuse me, the major vendors, such as Areva, for example, have a component of their activities in this arena and see this as a business opportunity. This also includes countries; for example, China has a small reactor design. India has a small reactor design.

So I would say that there's a lot of interest to enter this new market. My observation is the United States is in a much better position to be a potential vendor in this arena than it is to break into the GEN III Plus world, which is much further along as far as deployment.

Senator SHAHEEN. Thank you.

Mr. JOHNSON. Senator, if I might?

Senator SHAHEEN. Yes.

Mr. JOHNSON. From the United States NRC perspective, we also are interacting with international regulators who are beginning to see similar interest in their countries. So we've established bilateral relationships and are learning, as they learn, requirements and guides and those kinds of things.

Senator SHAHEEN. Thank you.

The CHAIRMAN. Senator Landrieu.

Senator LANDRIEU. Thank you, Mr. Chairman. I have a longer statement I'd like to submit to the record.

The CHAIRMAN. It'll be included.

[The prepared statement of Senator Landrieu follows:]

PREPARED STATEMENT OF HON. MARY L. LANDRIEU, U.S. SENATOR FROM LOUISIANA

Thank you, Mr. Chairman, and also, thank you to our distinguished panelists.

I appreciate the Chairman holding this hearing today on S. 2052 and S. 2812, two bills that promote the use of small modular nuclear reactors.

In the past I have supported numerous provisions to support the nuclear industry and I will continue to push forward towards a nuclear renaissance in America. I support these two bills before the committee, which is why I am agreeing to co-sponsor them today.

Nuclear has the potential to provide clean, cheap energy for our country and I welcome the opportunity to discuss how we can move forward to bring more nuclear power plants online.

Small modular reactors may have some advantages over larger nuclear plants in the United States.

First, the high capital costs associated with large nuclear facilities can be significantly reduced. Whereas large nuclear reactors typically cost in the neighborhood of $14 billion, experts believe that small reactors could be constructed at costs ranging from $200 to $500 million.

Second, some estimate that small nuclear facilities could be built in just two years; significantly shorter than the current 7-10 years it takes to build a large facility.

Third, smaller reactors (defined as 300 megawatts or less) can be used in smaller electricity markets, where it does not make sense to build a 1000 megawatt nuclear facility. This provides more opportunity to produce clean, carbon free energy.

Fourth, small modular reactors are also more flexible in how they may be operated. If multiple reactors are used at the same location, refueling becomes easier as one reactor can be brought off-line to refuel while the other reactors continue to generate electricity.

Fifth, these reactors are frequently small enough to be shipped using rail or truck.

These primary advantages: affordability, speed of construction, and flexibility may indicate that for these initial years of what I hope will be a true "nuclear renaissance", we may want to think smaller instead of larger—and build more small nuclear reactors.

Small modular reactors are facilities of the future that should be a part of the nuclear renaissance. The technology is real and with a dedicated commitment from the government and industry, I see a bright future for not only the country, but in particular Louisiana.

In Louisiana, we could marry a small modular reactor with a coal-to-liquid facility, or a coal-to-syngas facility. In this way, we could provide affordable synthetic gas to our chemical manufacturers and have a stable (and lower-carbon) source of diesel for our trucks and aircraft. In the Shreveport area of Louisiana, we have a lignite mine, the Barksdale Air Force Base, and several chemical manufacturers in the same region. I believe that this area could host a small modular nuclear facility with generated electricity for the Air Force Base, while using its process heat to run a coal-to-liquid facility providing our troops with a stable source of low-carbon diesel.

Obviously, I have a parochial interest in such a project—but it also serves as an example of how a smaller nuclear reactor could advance clean energy on multiple fronts.

In sum, as our country searches for the solutions become a cleaner more independent producer of energy, nuclear energy should have a large seat at the energy table. We keep talking about renewable energy and I support renewable energy development, but solar panels, windmills, hydropower and biomass—by themselves—are not going to make this country energy independent. America cannot be energy secure unless we fully develop the conventional energy resources we can produce here at home with a greater reliance on nuclear.

I look forward to hearing the testimony of the witnesses on this important subject.

Senator LANDRIEU. I'd like to thank you, Mr. Chairman and Senator Udall for your leadership. This is very, very encouraging, the testimony that I've heard. Not only because it may, we may develop a path to the creation of more electricity generation, but other applications that I'm hearing might be possible as well.

But almost equally important is the jobs opportunity here for small business expansion and jobs for Americans because that really needs to be our focus. To me this seems like such a possible step forward. So I have 2specific questions.

One, in other areas of energy production/exploration, water seems to be an issue whether you're talking about offshore, the cleanliness of water in our oceans and offshore drilling or the shale production and the lack thereof and the concern. Who wants to answer the question about what are the water requirements for these small nuclear modular units? Are there any places in the country that are either better suited or less suited?

Who would like to answer that?

Dr. Sanders.

Mr. SANDERS. I'll take a crack at it.

Senator LANDRIEU. Ok.

Mr. SANDERS. Again that depends on the design. There are state-of-the-art secondary sides of these plants that don't make steam, the gas reactor. Also it needs a heat sink. But there isn't much water use in the reactor system, for example, nor in the liquid metal.

A lot of the locations where you would put these actually have accessible water that's currently not used. It's either salt water or saline aquifers. Southeastern New Mexico has lots of water underground for example. But it's salty water.

So it's not useful for crops or irrigation or other activities. But it's very useful for the heat sink for just about any kind of reactor design. In the process of using that heat sink, you can actually desalinate that water and, for example a 100 megawatt system based on the calculations from one of our members, could generate enough water to irrigate about 50,000 acres of useless water otherwise.

So again, it's the integrated approach to both the market opportunities, the design and not all designs work in this particular capacity and the potential market. Water sales out West, they're a big market. So there's another opportunity that solves both the problems. Makes use of water that otherwise has no use.

Senator LANDRIEU. Ok. It goes without saying that places that have rivers, streams.

Mr. SANDERS. Oceans.

Senator LANDRIEU. Oceans, if you needed it, it would be there.

Mr. SANDERS. Right.

Mr. PIETRANGELO. Senator, some of the interest in the industry is in the potential for these smaller modular reactors to replace aging fossil fueled plants where the infrastructure is already there with respect to water transmission, etcetera. So that's some of the potential, at least in the electricity generation piece where the infrastructure is already there and would serve a national need as well.

Senator LANDRIEU. Absolutely. We have a great deal of that in a part of the country that I come from.

My second question is this, Mr. Johnson, and if follows up on what both Senator Murkowski and Senator Burr sort of alluded to. Every time we get excited about moving forward it seems as though we get slowed down. What I'd like to do is turn all these green on go.

So what do you need in terms of a parallel enterprise so you can do all of your current work that we're asking you to do and then what other resources do we need to provide to you so that we can have a parallel effort and move a little more quickly here?

Mr. JOHNSON. Thank you, Senator. I want to first say that the licensing strategy or the licensing approach, the process that we're using today to license the large light water reactors and the licensing process that we'll use to license the small modular reactors is set, is actually part 52 and it's a process that is working. So we're set with respect to the licensing process that we would use.

The difficulty is with respect to translating requirements that we have that are very specific to light water reactors to be ready to

review different technologies. We understand how to do that. We understand, for example that we need to look at the gaps in our regulations and then see where there are——

Senator LANDRIEU. But do you need people? Do you need smarter people? Do you need more people? Do you need university support? What do you need?

Mr. JOHNSON. So where we are in that process is to do that gap, look at those gaps, identify how big those gaps are and then use that to go back and build our resource needs, our scheduler needs. That's where we are in the process. The difficulty is that it's tough to do that with any degree of precision not working, not being brought along as the technology is being brought along.

So that's what—that's the challenge. The challenge is to understand to be involved with the Department of Energy and with the industry as they are developing these different technologies so that we are lock step developing our requirements and our guides and so that we're ready to go. I think it's achievable.

My pleading would be that we do it in parallel though and not wait until it's all done. Then go to the regulating.

Senator LANDRIEU. But do you have the resources to do it in parallel, both personnel, research budgets, equipment, space, etcetera?

Mr. JOHNSON. We haven't—we have resources programmed for the next generation nuclear plant as a result of the Energy Policy Act and that licensing strategy for NGNP. So we have those resources that we've been working through the process. We are just getting to be able to develop the detailed resources going forward for the other small modular reactors.

We'll work those through the process. We have not yet.

Senator LANDRIEU. Ok. Mr. Chairman, I just don't think there should be a resource issue for us. I mean, from where I sit and we all sit in the same place, I mean we are literally spending billions, billions of dollars in all sorts of different ways.

I would hope that we could find the resources to spend here. It seems to me to have so much promise for what this country needs right now, starting with jobs and economic vitality, but also reaching the great goal of energy security for this Nation. So we can disentangle ourselves from decades, centuries, decades at least, of, you know, of wars being fought over these resources.

So I'll leave it at that. But I'm not getting very clear answers on resources. As an appropriator, I'm going to press very hard on this through the Appropriations Committee.

Mr. Chairman, thank you. I'd like to be a co-sponsor of the legislation.

The CHAIRMAN. We'll be glad to have you added as a co-sponsor on both pieces of legislation. Thank you very much.

Senator Risch, did you have questions?

Senator RISCH. Chairman, I do not at this time.

I just want to state that we at the Idaho National Engineering Laboratory are anxious to participate in this. As you know Idaho has the first city that was lit by nuclear energy in the world. We built the first nuclear plant right at the INL in Idaho.

We're committed. We're anxious. We have a trained population there who is used to dealing with these kinds of issues.

Like Senator Landrieu, I believe that this is the wave of the future. If you truly want to engage in the production of energy and do it in a manner that does not release carbon into the atmosphere and produce the large amounts of energy that a society needs to live the quality of life that we all want to live. It's going to take nuclear to do it. I think we all need to reinvigorate and recommit ourselves to the renaissance that has started, that started quietly and needs to move forward much more aggressively.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much. Let me just ask a few other questions. Dr. Miller, I'll start with you here.

One of the things that we're proposing in S. 2812 bill is essentially for the Secretary to settle, to put together a merit based review of the various potential designs in these size reactors and to settle on a standard design. Now in the case of larger nuclear power plants one of the, sort of part of the common conventional wisdom around here is that the French did a much better job than we did of settling on standard design and going ahead and building a lot of them. We essentially left it up to everybody to develop their own design and it slowed us down. It made it more difficult and raised safety issues as well.

What's the right answer to how you continue to encourage innovation and still get a design settled upon so that construction and deployment and use of these reactors can occur in a timely way? What's your answer to that? We're saying the Secretary shall develop a standard design for each of 2 small modular reactors. One would be not more than 50 megawatts.

Is that the right number? Should there be 2 very small ones and 2 others less than 300? What's the right answer to that?

Mr. MILLER. Thank you very much, Senator Bingaman. Again, I have to start by saying that the Department needs to analyze the legislation which has not occurred yet. So let me say that the colleagues at the Nuclear Regulatory Commission have suggested that it would be helpful if in a small modular reactor program the Department would help them prioritize through some merit base peer review system which of these designs are mature enough and have enough applications and potential buyers, if you will, to be at the head of the queue as the Nuclear Regulatory Commission begins its activities.

We've had several conversations of which this suggestion has been made. It's certainly a reasonable suggestion. But I have to say that we have not put together a program yet.

Of course, I'm unable to talk about the 2011 budget process. So I can't just go into a lot of detail about that. But I'd like to have enough time, in fact, get back to you for the record eventually when we're able to about these kinds of things.

[The information referred to follows:]

The Department of Energy's FY 2011 Budget Request, submitted on February 1, 2010, includes a request to solicit and consider, through a competitive process, up to two small modular reactor (SMR) designs for financial cost-share assistance. These funds will help demonstrate the potential of the nascent SMR technology that provides more flexible siting for generating plants and will encourage new competition in the marketplace. Department cost-share funding will only support the Nuclear Regulatory Commission (NRC) design certification process for the selected de-

signs, which will advance their commercial deployment if the design certification is granted by the NRC.

Since light water reactor (LWR) SMR designs do not require extensive research and development or prototype testing to demonstrate safety, these designs likely will be the first to be submitted to the NRC for design certification. In the near term, the Department's cost-share SMR program will focus on these LWR SMR designs. The SMR design certification program proposed in FY 2011 will be a competitive process that will be informed by workshops and will consider a range of commercial licensing and deployment factors, including a reasonable demonstration of a domestic commercial customer for the design. We do not consider it necessary to specify specific sizes (e.g., less than 50 or 300 MWe) of the SMR designs that will be evaluated. We expect the marketplace will help determine the right size(s) of small modular reactors that can be readily licensed and deployed.

The CHAIRMAN. Anyone else have a comment on that? Anyone who has looked at it?

Mr. PIETRANGELO. NP 2010 selected 2 designs and that's coming to fruition now.

The CHAIRMAN. Right.

Mr. PIETRANGELO. Even despite NP 2010 there were 3designs certified in the late 1990s and another 3 going through certification now. So, even when all the designs weren't considered as part of the NP 2010 process, a lot of companies are still going forward with the design certification.

The CHAIRMAN. So you think the fact that we are directing the Secretary to settle on 2 designs here would not preclude others from continuing to go ahead and develop.

Mr. PIETRANGELO. Not—right. Not based on what's happened in NP 2010.

The CHAIRMAN. Ok. Alright. Senator Murkowski.

Senator MURKOWSKI. Just a couple more questions, Mr. Chairman.

Dr. Miller, you mentioned a couple times that the next generation nuclear plant project and the announcements that came in September about $40 million for completion of conceptual design activities. Can you give me an update on that in terms of how many responses the Department got from this announcement? When you anticipate making some kind of an award for the project? If you consider this sufficient and if not, whether you would look to other alternatives to achieving the goals that we're setting out here with this Next Gen project?

Mr. MILLER. Thank you very much for the question, Senator. As you point out, the funding opportunity announcement went out. The date for submission of responses has past. We have received responses. It's in the hands of the source selection official in a competitive environment. So we're not allowed to publicly discuss what is happening in that.

We hope to have a decision made within weeks, within the January or early February time frame, after which we can talk about this.

Senator MURKOWSKI. Dr. Sanders, the term you used was reduce complexity when you're talking about some of the advantages with the smaller reactors. One of the great debates, of course, with dealing with nuclear power is figuring out what we do with the spent fuel. Can you describe how the amount of the spent fuel that we're talking about from multiple small reactors, that would be inter-

connected, how this compares with the spent fuel that we see from one large 1,000 megawatt reactor?

Mr. SANDERS. Again, that depends on type.

If it's a pressurized water reactor with essentially the same type of burn up for x amount of megawatt days you're going to have the same amount of fission product because it takes the same amount of fissions in order to make that.

If it's a gas reactor design there will probably be a little bit different burn up rate occur.

If it's a liquid metal design it could be designed with a conversion ratio of one, which is basically for every atom that's consumed an atom is generated for future consumption.

So that's how you get to these ten, twenty year in core cycles. What I believe is needed is really the holistic approach to not 1 or 2 specific reactor designs. But how do I manage all of this in total? How do I use specific reactor parts or reactor types to manage my byproducts of other reactor types?

We know how to do that.

Senator MURKOWSKI. We do or we don't?

Mr. SANDERS. We do know how to do that. We have done that and in the laboratories in the early days. The first electricity generated in Idaho was actually generated by a small breeder reactor based on some of these concepts.

We went away from that for a couple of reasons. The pressurized water reactor, light water reactor technology was what the Navy picked for various reasons that make a lot of sense. A parallel commercial enterprise came out of that decision that basically sold 400 reactors around the world. That's where we're at from an opportunity perspective today.

If we think outside of the box a little bit and think in terms of a holistic fuel cycle and how can I have the right approach that meets all the performance requirements that we want to accomplish whether it's proliferation prevention through export controls and exporting the right technologies to managing the byproducts of whatever reactor system that comes back. That's doable. It's called a systems approach. It's an integrated approach. It may take more than 1 or 2 types of reactors.

That's really where we need to start is what are the performance requirements that would allow us to accomplish the objectives you just set. How can we manage or receive waste? Most of that waste is valuable. Ninety-eight percent of it is useful, but it depends on the particular reactor type that you choose.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Udall, did you have additional questions?

Senator UDALL. Thank you, Mr. Chairman, I do. I want to turn to Mr. Johnson. We've had a lot of conversation about the licensing process. I'm curious if you thought the process might be quicker for some small reactors if, particularly, the reactor was air cooled?

Mr. JOHNSON. Thank you. We haven't—regarding the process we do essentially, again, the same process. As we get details regarding what that design looks like, again assuming that we get a complete application that is technically sufficient. We'll look and see how long it will take us to do that review.

Absent those details it's hard to determine how long that review will take. So I can't comment further.

Senator UDALL. As you develop greater understanding, I'd certainly appreciate the NRC sharing with us your thinking and the direction in which you're heading.

Dr. Miller, let me come back to you again. You talk about SMRs being built here and then being shipped to other countries. Could you expand on how this would help with non-proliferation concerns? Then perhaps if others would like to comment when you are finished?

Mr. MILLER. Thank you, Senator. Some of the more advanced concepts visualize the possibility of a sealed core that would be purchased by a country deployed, and operated there. The designs purport to be able to continue to provide electricity for decades without refueling. Then at the end of that period of time, there would be the whole sealed core, which could be underground, as Dr. Sanders said, and which could be taken back as spent fuel inside a sealed core, potentially refueled and taken back to the country.

So this kind of an arrangement would have the benefit of having a situation in which the IAEA safeguards requirements would be less stringent owing to the lack of accessibility to the material. It, of course, still would be safeguarded by the IAEA. It still would have all those requirements. But there's at least reason to believe that it would be an easier safeguard issue than the present reactors are.

Senator UDALL. Would others care to comment?

Mr. Sanders.

Mr. SANDERS. There's also enabling technologies that we haven't taken advantage of in command and control and intelligence systems and the ability to monitor reactor operations around the world that have moved along in parallel with the information age boom, but haven't been integrated into the operations globally of nuclear power plants.

There's also the huge advantage of, you know, avoiding the weak links to sealed cores, but also minimizing the amount of times you have to come back and get that and open it up and replace it and that kind of thing.

So again, this is, this holistic approach that integrates all these performance requirements together and comes up with the optimal network of reactor systems and fuel cycle approaches.

Senator UDALL. Dr. Miller, I believe there have been conversations in the IAEA community about overseeing this entire fuel cycle in the future. Is that correct?

Mr. MILLER. There have been conversations about both what we refer to as the front end as well as what we refer to as the back end. In the front end the issue is finding ways to guarantee fresh fuel supplies by having some type of fuel bank, Senator. This would complement the commercial business of providing spent fuel which is there. It's vigorous. It's international business.

But there are some concerns that these may not be completely secure in the sense that a country might feel vulnerable that another country might stop their access to fresh fuel. So IAEA, as well as many other entities have been discussing how you would

deploy this type of thing, especially in a world in which the number of countries, as Dr. Sanders mentioned, that are interested in nuclear is a growing, it seems to be a growing number. It's very important that we look at this.

In the back end it's not nearly as mature. But there have been discussions within the international community. We certainly, in the Department, have been part of those discussions to look at the back end and how one might find a way to take back to either a third country that's agreed to do this in a safe and secure way or even the origin country.

So that if you're a nascent nuclear power country, you can say, this is really, really great. I don't have to have an enrichment capability. I don't have to go find a final disposal place.

I can now have nuclear energy without these aspects of nuclear energy. So it's more of a carrot-and-stick approach. It's more saying this is a good deal. I'm going to sign up to this deal.

So there's lots of discussions of how one might enable that. As you can imagine, it's not a simple thing to do with international agreements. But there is a lot of discussion of this.

Senator UDALL. Thank you for that elaboration. Thanks again to the panel for taking the time to be here today.

The CHAIRMAN. Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman. Nuclear power is a key component of making America's energy clean, affordable and reliable. We must increase America's nuclear energy capacity. When it comes to energy I believe we need it all.

That's why I support a comprehensive, all of the above strategy for American energy. Uranium is a critical feed stock for nuclear power plants. We currently import about 90 percent of our uranium. We need to change that.

The good news is that we can change that because America has vast uranium deposits. We need to encourage domestic uranium production. I believe it will foster job growth, promote economic security as well as energy security.

The Department has invested significant time and effort in developing a transparent and coherent strategy for managing its uranium stockpiles. The excess uranium management plan represents broad consensus among stakeholders. It ensures the Department of Energy receives fair market value for the sales of its uranium. It also provides market certainty for domestic producers and consumers.

Now unfortunately the Department has decided to turn its back on the management plan. That's threatening jobs in Wyoming and a number of other states. So despite clear concerns in Congress, the Department is moving forward with their plan.

The Department of Energy is going to transfer nearly 1,200 metric tons of uranium to the U.S. Enrichment Corporation over the next year. Additional transfers will follow in the years after that. Now the purpose is to fund additional temporary jobs, temporary jobs at the Portsmouth plant in Ohio. Now I support creating jobs in Ohio, but not at the expense of jobs in Wyoming.

In October I sent a letter to Secretary Chu signed with 6 other Senators. We raised concerns that it would negatively impact the domestic uranium industry in jobs in our states. The Governor of

Wyoming also sent a letter. I'd like to read a line from it. He said, "The loss of mining and mining related jobs in Wyoming and elsewhere will be a direct outcome of the Department's present course."

The Casper Star Tribune, our statewide newspaper wrote an editorial about it. The title, "Uranium sales would hurt Wyoming industry." It says, "The uranium industry's planned expansions and future operations in Wyoming should provide long term high paying jobs to Wyoming miners for years to come but those projects could be postponed or lost forever unless the Department of Energy reconsiders this ill timed sale of excess uranium before it's too late."

So Dr. Miller, the Excess Uranium Management Plan provided a ramp up to 10 percent of the U.S. requirements by 2013. That ramp up was intended to safeguard uranium producers and consumers from the Department of Energy uranium transactions. The Department has decided to abandon the gradual ramp-ups instead it almost reached the 10 percent in 2010. In 2011 it will go to 12 percent.

Now this market cannot absorb that quantity without a plunge in the price. Your office led the efforts to develop the management plan. Why was that ramp up plan abandoned?

Mr. MILLER. Thank you very much, Senator. What we considered the core of that management plan is this 10-percent limit on what the Department will release to the market. The decision was made, that 10 percent will not be exceeded over the period of time in which a market analysis, which was commissioned by the Department, said that there would not be an adverse impact on uranium prices.

We will do another market analysis prior to a decision in 2011 or beyond. So the only decision that's been made is through FY 2010. Again, our analysis that we do prior to making such a decision has said that there's not a major adverse impact on uranium prices. We continue to abide by the 10Rrcent spirit of that management plan.

Senator BARRASSO. As I'm looking at page 26 of Energy Resources International the DOE's market analysis says that the numbers are going to go up and it will be 12 percent in the year 2011. So I agree Federal law requires that any DOE sale or transfer not adversely impact domestic uranium mining. But the price of uranium dropped since the Department of Energy made its announcement.

The Department of Energy's actions are already having an adverse impact on domestic uranium mining. The question is does the Department recognize the negative impacts its actions are going to have on jobs of the states where the Senators signed the letter?

Mr. MILLER. Let me, again, thank you, Senator. We have met with the appropriate people or we think the appropriate people. People from the mining community have come to see us. We've discussed it with them. I believe the plan that we came up with is responsive, is responsible, and again, prior to 2011 we're going to do another market analysis prior to making any determination for that year.

So the determination is only through 2010.

Senator BARRASSO. The fact sheet that I have from the Department on the clean up at the Portsmouth facility and I have a news release that came out from the Department of Energy. You know, new jobs coming to Piketon talking about the Portsmouth site in Piketon, Ohio. It says, they'll be $850 million invested over 2 years.

Does the Department plan to permanently continue this level of funding or are these jobs temporary?

Mr. MILLER. Thank you about that. Thank you for that question, Senator. When it comes to that aspect of the program I'm going to have to get back to you for the record because that part is in the EM part of the Department of Energy as opposed to the NE part. So I can't answer that specific question.

Senator BARRASSO. Because I would suggest it doesn't make sense to create temporary jobs in Ohio at the expense of long term mining jobs in Wyoming. So I would appreciate you getting back to me. I would encourage you to rethink this entire proposal. Thank you.

Mr. MILLER. Thank you, Senator.

Senator BARRASSO. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. Senator Sessions? Oh, Senator Sessions, go right ahead.

Senator SESSIONS. Thank you. While I am a supporter of nuclear power, I believe it has a role to play and unless the economics don't work, I absolutely believe it's a critical part of our future for clean energy in the world. I just can't imagine we're not pursuing it more vigorously than we are. Some of the matters cause me concern.

I know a number of the President's supporters oppose nuclear power. He said during this last campaign he had some modest comments of favoring nuclear power. Mr. Miller, you state that the Administration views nuclear power as an important element in its strategic strategy to increase energy security and combat climate change.

You and Secretary Chu are "working hard to advance nuclear power in the United States." Yet the only thing we have done, I think, to advance nuclear power in the past 30 years is to establish a 2-year blue ribbon commission to look at the options for nuclear power, ways to Yucca and nuclear recycling, which really slowed down, I think, the path we were on. Commissions have a number of values. One of them is to slow down something if you don't want it to go fast in its 2 year commission.

So in June, Mr. Jaczko, the Chairman of the NRC, made a statement at the Heritage Foundation, "that the NRC may issue one license before the end of his term in 2013." Just one. So Mr. Miller, what are we waiting for? How can we get more progress established here?

Mr. MILLER. Thank you, Senator. So let me first thank you for your support for nuclear energy. I share your view of how important it is to the country as we look forward to reducing our carbon emissions.

I can't comment on the licensing parts of your question. I'll defer those to my colleague from the Nuclear Regulatory Commission. But from our point of view I would say that in the short period in which I've been at the Department, I have been quite encouraged with the energy that's gone into finally getting a nuclear loan guar-

antee released by the Federal Government. I think that's going to happen pretty darn soon.

Senator SESSIONS. There was discussion about before the end of the year. Is that? It's getting close.

Mr. MILLER. Yes, sir. You know that's, I think that's only about 16 days, if I count.

Senator SESSIONS. It looks like we're missing that. Are we missing that date?

Mr. MILLER. No, I'm standing by hoping we're going to have a loan guarantee by the end of this calendar year. I'm standing by that hope and prayer that that's going to happen.

So I think that's the answer to your question as far as near term deployment.

Senator SESSIONS. That would be a step. That would be something positive.

Mr. MILLER. That would be a huge step. It would be a very important, huge step. I think it would be the beginning of starting a wave of these Gen III Plus reactors moving forward.

The second thing I'm very encouraged about is the support that the administration is giving to the notion of the need for having this additional vehicle of small and modular reactors in attempting to do what's appropriate for the Federal Government to get those deployed. To get the designs perfected so that we can make a difference nationally and internationally in this market. So I'm encouraged by that as well.

I'm encouraged by the enthusiasm and energy of the scientists at our national laboratories, including Idaho National Laboratory, which has taken a new and fresh look at innovation and at ways in which we can continue to have a strong research and development program for deployment in both the near and long term. So I'm encouraged by what I see, from where I sit and what's happened.

Senator SESSIONS. One thing you say, I know NRC is an independent agency and must maintain its safety, independence regulatory function. However, if we're going to move forward with expanding nuclear power, the question is do we have enough people and are we configured in a way that we can safely do it. So you have some influence, administration does over Mr. Johnson's budget. If he doesn't have enough people it could slow down.

So how are you, Mr. Johnson, shaping up? If you had to invest a good bit of effort and time in looking at these smaller modular plants, could that slow down your base responsibility of maybe, not acting fast enough on some of the proven reactors that we have?

Mr. JOHNSON. Thank you. The budget that we have in place and the priority scheme that we are using does place higher priority on the large light water reactors that we're currently working on. We have sufficient resources and staffing to work those applications that are before us.

Again, we're making good progress against those schedules. Ultimately what we license we'll be able to operate to provide adequate protection with health and safety. But again, we're making good progress on the schedules. Those are higher priority.

We also have as a priority the Next Generation Nuclear plant that we are working on a joint licensing strategy with the Depart-

ment of Energy. We are making progress and have resources to move along with respect to that.

The lower priority than are the remainder of the small modular reactors. We are looking as we get more information about what those—what will come forward and what those technologies will be, what we need to develop, to close the gaps in our regulatory requirements. We'll refine our resource estimates and then we'll come forward with those. We're not there today.

The CHAIRMAN. Senator Risch, did you have a question?

Senator RISCH. Briefly.

The CHAIRMAN. Go ahead.

Senator RISCH. You know one of the biggest criticisms we get is the licensing process and how difficult it is and particularly how lengthy it is. It seems to me it's time for a next generation of licensing. I mean, certainly when we started with nuclear no one really knew where we were going or how—what the extent of the danger was.

Of course, we've—the industry is now no longer an adolescent. It's an adult industry. It seems to me that we need a next generation of licensing just as we do the plants.

Could you comment on it starting?

Mr. Miller, could we start with you and maybe all of you could comment briefly on that suggestion?

Mr. MILLER. Yes. Thank you, Senator. I think you have a good observation. I think there is—it is appropriate for our various communities to get together for a conference, for a workshop to think about what are the radical, maybe not radical, what are the major changes that could be made, what other creative changes that could be made in the approach that we're taking the licensing, especially if we get a chance to really implement it and see it a little bit longer than it is now.

It would be a little difficult to do it before we've even issued our first combined construction and operating license. But when we've gone through that and we can look back and experience it, I think it's quite appropriate for us to look and say, ok. So here's what happened. Now what can we do different, better.

I have to agree with you.

Senator RISCH. Dr. Sanders.

Mr. SANDERS. I think the critical need is to push the process. The first of the, you know, I always tell people the most important shipment to whip was the first one. Then after the first one it became very much an everyday operation.

We've got to get that first reactor done basically. Regardless of what process is used or whatever, it's a matter of timely completion of that first one whether it's a light water reactor, a gas reactor or whatever. I think NRC needs—I'm not real clear on how their budgetary process is, but a lot of what they do depends on applicants and is paid for by applicants.

So a lot of the issues are related to the flexibility they have to address these generic issues in a timely fashion, the generic issues that are outside of the boundaries of their current customer base. I'll leave it to you guys to comment on that if that's not what you understand.

Mr. PIETRANGELO. I'd like to defend the current process. Part 52 was established in 1992, well in advance of any of these applications. But this is the first time we're going through the combined license application with new designs in parallel, not as envisioned in 1992 where you'd have an early site permit, a certified design on the shelf that could be referenced than a combined license application.

So I think the NRC is working very hard, as is the industry, through standardization to get through that first wave in a timely way. But we see improvements in a second wave. We're not pushing the NRC to move any faster on this first wave.

So I think some of the criticism about how long it takes is because we're both in a learning curve going through this process for the first time with respect to combined license applications. We do expect efficiencies in a second wave, but I'd rather do it right rather than fast with these first reactors that are going to come online in more than 30 years.

Senator RISCH. We subscribe to that. We've been saying it should be done right rather than fast on this and many other subjects recently. Thank you very much.

Mr. Johnson.

Mr. JOHNSON. Yes. Thank you. I would just add that we have already made as Mr. Pietrangelo indicated, significant improvements to the process from the previous 2 step process to the current one step process. I'm always mindful of the fact that at the end of that license, when we issue that license, we actually have granted the authority to construct and to operate conditional upon verification that the plant was constructed in accordance with the design and the license and the regulatory requirements for 40 years.

So we need to do it—we need to make sure that we do it right. It has a safety review associated with it. It has an environmental review associated with it.

Both of those reviews provide for external stakeholder, public involvement. Those, we think, are a critical part to that process. The National Environmental Policy Act provides very discreet roles for the public that set the process length.

So, again, I think because this is as important as it is that we involve the public and that we get to the right safety decision, the process is appropriate. Can we make it better? We continually look to make it better. We've identified some improvements and we'll implement those on the second wave certainly.

But I think the process that we have in place in appropriate.

Senator RISCH. Mr. Chairman, thank you. Thank you, all of you, for that refinement. I appreciate that. I appreciate the defense of the process.

Having said that, I would encourage everyone to continue to look for opportunities where you can do efficiencies. There isn't anyone in America that doesn't want you to do this safely. It needs to be done safely. You can't make a mistake.

But because of the experience that you've had, I encourage you to continue to look for opportunities to streamline the process. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Murkowski, do you have any other questions?

[No response.]

The CHAIRMAN. Let me thank you all. This was very useful testimony. We will try to take your advice to heart and move ahead with some legislation.

Thank you very much.

[Whereupon, at 11:54 a.m. the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Questions

RESPONSES OF ANTHONY R. PIETRANGELO TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your testimony on the bottom of page 2 notes that small-scale reactors will "require the expansion of existing facilities and construction of new state-of-the-art factories." Do you think building such facilities will add extensively to the baseline cost of these small reactors?

Answer. No, the construction of state-of-the-art factories will ensure that these small modular reactors are competitive with other forms of clean generation. In addition, it will help modernize U.S. manufacturing and fabrication so that it is more competitive with other countries through increased efficiency and productivity, thus increasing the potential for exports and American jobs.

These new modular reactors will be manufactured and fabricated away from the generation site, easing and improving quality control. Such a process will enable greater construction efficiency and productivity to be achieved through the incorporation of lessons learned. The same personnel will perform the same tasks for multiple units going to different sites, as opposed to separate personnel performing the tasks at each site. This should reduce construction schedules and improve competitiveness.

Question 2. Do you think the nuclear industry has the vendor base to support the construction of large-scale reactors and these newer small-scale reactors?

Answer. There is sufficient global nuclear manufacturing capacity to support the first wave of four to eight U.S. nuclear power plants that will become operational around 2017. The global plans for the expansion of nuclear generation over the next 20 years will require increased global manufacturing capability. The initial indications are that other countries are beginning to invest in new manufacturing facilities to support this anticipated demand.

Over the past two years, the U.S. nuclear industry has been conducting an outreach program to help educate U.S. businesses about the potential new opportunities in the nuclear industry both here and overseas. This effort has included holding a series of regional workshops to educate companies about market opportunities, to explain the quality requirements and specifications for nuclear components and to provide guidance on establishing high-level quality programs for the supply of nuclear components. In response to growing demand and greater awareness of market opportunities, we have already seen an increase in the number of domestic nuclear suppliers. ASME Section III Nuclear Certificates (commonly called "N-stamps") held in the U.S. have increased 22 percent since the beginning of 2007-from 221 in January 2007 to 269 in May 2009. Three additional workshops are planned for this year.

Congressional manufacturing and worker training incentives, tax credits, and grants would help to ensure U.S. industry competitiveness and will enable U.S. companies to expand their manufacturing capabilities to meet the expected increased demand for high-quality components for the global nuclear market.

Question 3. You note in your hearing testimony on page 3 that "The cost and time required to design, develop and license a small reactor is not necessarily reduced linearly with size." Are you saying the up-front cost for licensing will be about the same as a large reactor?

Answer. Yes, we anticipate that the up-front licensing costs for the first-of-class units will be similar to the costs for obtaining the first combined licenses for the large Generation III+ reactors.

For small modular reactors, there are a number of regulatory policy issues, specific regulations and guidance that will need to be developed or amended to enable the deployment and safe operation of these plants. Many of these issues and regulations are generic to all small modular reactor technologies. These amendments and revisions will assure that the regulatory process for small modular reactors is efficient and well understood by both the industry and the NRC staff. Such actions should reduce the number of misunderstandings and misinterpretations normally associated with the first implementation.

Once the first-of-class units have been licensed, we expect that the high level of standardization coupled with the Nuclear Regulatory Commission's design-centered review approach for combined license applications will significantly reduce licensing costs and schedules.

The schedules for licensing subsequent small modular reactor generating stations will depend on whether there is an approved early site permit and whether NRC environmental reviews take credit for environmental reviews and conclusions that have already been completed.

RESPONSES OF ANTHONY R. PIETRANGELO TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Assuming that a small nuclear reactor design of around 300 electrical megawatts has been licensed by the NRC, could you estimate how long it would take to construct and get the reactor on line? How about a smaller reactor of around 50 electrical megawatts? How does that compare to estimates for large reactors?

Answer. There are numerous small modular reactor designs under development. Each design has a different modular generating capacity and can combine a varying number of modules based on customer needs. The development of these designs is advancing beyond concepts to a level needed to support NRC design certification applications in the next 30 to 36 months.

A 300-electrical megawatt modular plant design would generally require multi-module configurations for many of the designs being developed, with some designs supporting industrial cogeneration applications. Provisional construction estimates for the power block to fuel load for the first-of-class module is approximately 36 months, with another six to 12 months for start-up testing, depending on the uniqueness of the modular design features. Subsequent modules could be completed in a shorter time frame because the civil and structural work could be completed in parallel with or as part of the construction of the first module. The estimate assumes that state and local permits have been obtained and site preparation activities are complete before the combined license is issued. In addition, an operator training program would have to be established shortly after the start of power block construction to ensure that the operators are trained under an accredited program. The schedule and scope of site preparation activities will vary based on site-specific circumstances.

Modular construction in a factory setting also is expected to improve the construction process and quality, adding increased certainty to the entire construction schedule. The construction schedule is expected to be reduced as lessons are learned and incorporated into construction practices. Experience indicates that the construction schedule for the Nth plant could be reduced by six to 12 months.

For a 50-electrical megawatt modular reactor plant, a larger proportion of the construction activity would be completed in an off-site factory setting. As a result, the amount of on-site construction would be smaller, resulting in a shorter construction schedule. The schedule for start-up and power ascension testing is expected similar to that of a 300-megawatt plant.

The estimated schedule for a large (in excess of 1,000 electrical megawatts) nuclear power plant varies dependent on design, site-specific circumstances and contractual conditions. The construction time for the power block, first safety-related concrete pour to fuel load is generally between 48 and 54 months. The start-up and testing phase is an additional four to six months. Based on recent construction experience in Japan and Korea, it is expected that the schedule could be reduced to less than 42 months for subsequent plants as construction experiences are incorporated into the process, assuming a high level of standardization between projects is maintained.

Question 2. You note that small-scale designs may be more compatible with smaller utilities than a large 1,000+ megawatt plant. Have you heard from utilities who are interested in smaller nuclear plants?

Answer. Yes, interest covers the spectrum of utilities: large and small; regulated and unregulated; investor-owned, public power and cooperatives. In addition, there is interest from the industrial sector in the high-temperature modular reactors, once the reactor designs are developed for use in industrial process heat applications.

Whether this interest grows into actual projects depends on project economics, which are affected by design, construction, operational considerations and regulatory requirements. Until there is clearer definition of the specific regulatory requirements, it will be difficult to develop designs to a level that will enable cost estimates to be developed with a degree of certainty needed to support a project authorization.

Question 3. S. 2812 provides for DOE to develop and obtain from the NRC design certification for two small reactors. In looking at lessons learned from the Nuclear Power 2010 program, are two designs enough or does the program need to be expanded?

Answer. We believe two designs are sufficient to establish a baseline set of projects and clarify the regulatory expectations and requirements for small modular reactors. This should stimulate other companies to move forward with the development of additional designs. The Nuclear Power 2010 project demonstrated that the momentum developed thorough government incentives for two designs will stimulate other vendors to move forward with designs to gain market share in the new nuclear generating construction cycle. There are five large nuclear generating designs referenced in existing combined license applications even though the Nuclear Power 2010 project covered only two of those designs.

Question 4. In S. 1462, the American Clean Energy Leadership Act, this Committee included language to help develop our energy work force, including nuclear workers. Is additional language needed to assist the development of workers for small modular reactors?

Answer. We support the current proposals outlined in S. 1462 and encourage the Committee to consider a worker training tax credit for the expenses of training workers for nuclear power plants and facilities producing components or fuel for such plants.

The tax credit would be graduated and based on a percentage of wages-e.g., 40 percent of the qualified first-year wages of qualified workers, 30 percent of the qualified second-year wages, 20 percent of the qualified third-year wages of qualified workers. The credit would apply to participants in a U.S. Department of Labor Registered Apprenticeship program (or a participant in a State Apprenticeship Program recognized by the U.S. Department of Labor) and participants in an accredited program of the Institute of Nuclear Power Operations' National Academy for Nuclear Training.

The tax credit mechanism will allow workers who will be engaged in the construction, manufacturing and operation of nuclear reactors, including small modular reactors, to receive the highly specialized training necessary to meet the industry's qualification standards. Some of this nuclear training may require specialized equipment or apprenticeship structures that may be more efficiently accessed through on-the-job training than through the community college system. Having access to this mechanism, in addition to the support outlined in Section 433 for community college programs, will provide a broader scope of resources available for work force development.

RESPONSES OF MICHAEL R. JOHNSON TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your testimony at the bottom of page 4 indicates that in general small reactors that are based on light water designs that are "in a relatively good position to undertake licensing reviews". Can you clarify that statement relative to the other designs out there?

Answer. The U.S. Nuclear Regulatory Commission (NRC), including the work of its predecessor agency, the Atomic Energy Commission (AEC), has been conducting licensing reviews for light water reactors (LWRs) for over 50 years and has substantial experience and an established regulatory structure for performing reviews of these types of nuclear reactors. In fact, the NRC based its regulations and review guidance on LWR technology. The new small modular LWR designs being proposed are a variation of the existing large scale LWRs. They will use the same fuel and same coolant, and will implement some of the same or similar design features as the existing large scale LWRs. For these reasons, the NRC does not expect the new small modular LWR designs to require substantial changes to the current regulatory framework. The NRC staff believes that it is therefore relatively well positioned to undertake licensing reviews for the new small modular LWR designs in the near term.

The NRC has conducted a limited number of licensing reviews in the past for both high temperature gas reactors (HTGRs) and liquid metal reactors (LMRs). However, those designs are significantly different from the ones being proposed today. Unlike LWRs, these technologies employ different coolants, new fuel types, and new design

features. Because of these significant differences, the NRC must conduct extensive research to support development of the regulatory framework to conduct licensing reviews.

Question 2. About how many inquiries for licensing "New Reactors" has your office received or expects to receive?

Answer. In characterizing new reactor licensing, it is important to draw a distinction between applications submitted by reactor vendors for certification of a reactor design versus combined license applications submitted by utilities. For small modular reactors, the NRC has been approached by reactor vendors proposing as many as nine different designs spanning three separate technologies (LWRs, HTGRs, and LMRs). Based on letters the NRC has received from small modular reactor vendors, we could receive a design certification application as early as fiscal year (FY) 2011, with others following in FY 2012. The exact number of anticipated design certification applications is not known due to uncertainty in the vendors' business plans. Additionally, the Next Generation Nuclear Plant (NGNP) program is expected to provide a design certification application to the NRC inFY 2013.

The NRC has not been approached by any utility to indicate specific plans to submit a combined license application that would rely upon small modular designs. Therefore, at this stage, it is too early to predict how many combined license applications for small modular reactors may be submitted to the NRC.

Question 3. The NRC is obviously under a tremendous work load, maintaining the safety and security of the 104 existing reactors and reviewing upwards of 18 combined operating licenses. Can your office support the work load it expects to receive with the volume of small reactors that might be coming in - some of which are not traditional light water reactors?

Answer. In anticipation of the workload in performing the licensing reviews of new reactors, the NRC established the Office of New Reactors—separate from the Office of Nuclear Reactor Regulation—to focus on these licensing reviews, thereby limiting the impact on the oversight of the safety and security of the 104 existing reactors. Similarly, in anticipation of the workload for small modular reactors, we have established the Advanced Reactor Program within the Office of New Reactors to focus on reviews for these smaller designs.

The NRC is currently developing resource estimates required to support review of the design certification applications that the reactor vendors have indicated will be submitted for small modular reactors. The NRC staff will continue to work through the budgeting process with the Commission regarding appropriate resource allocations.

RESPONSES OF MICHAEL R. JOHNSON TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. As you look to establish regulations and guidance for high-temperature gas-cooled and liquid metal reactors, do you anticipate that the regulations will be based on existing light-water reactor regulations with changes to accommodate differences in technology, or will they be newly developed regulations?

Answer. Changes will need to be made to the specific analysis methods used, and the criteria that are to be satisfied in demonstrating compliance with those regulations. Significant research will be needed to develop and evaluate these new or revised analysis methods and criteria. It is possible that changes to the existing regulations will be warranted but that will be evaluated on a case-by-case basis.

Question 2. You expressed a desire that the regulatory framework for small modular reactors be developed at the same time as the technology itself. What level of cooperation have you received from industry to help understand some of the innovative technology that is being proposed?

Answer. The NRC is coordinating with the Department of Energy on the NGNP to identify and resolve challenges associated with HTGRs. In addition, the NRC has held pre-application meetings with several of the potential vendors to discuss some of the innovative design approaches being proposed. For example, NRC recently held a public workshop to discuss licensing issues for small and medium sized nuclear reactors that included industry, the Department of Energy and other stakeholders. As the industry's plans continue to materialize throughout FY 2010 and FY 2011, the NRC will increase its pre-application meetings such that we maintain our effectiveness in keeping abreast of new and innovative design approaches.

Question 3. Since some small reactors have much less nuclear material than conventional large-scale nuclear power plant and hence pose less safety concern, would the NRC modify its requirements for emergency planning zones around a reactor site to be consistent with the size of the reactor?

Answer. NRC's regulations currently allow for the review and approval of different sized emergency planning zones (EPZs) on a case-by-case basis for reactors

below 250 megawatts thermal or for gas-cooled reactors. Therefore, the NRC does not currently anticipate the need to modify its regulations in this regard. The applicants for these small reactors would need to develop a risk basis and detailed justification for a proposed change in EPZ size that would be significantly different from current LWRs. Then, the NRC will review that justification and reach a finding on its adequacy in supporting a revision to the EPZ for a specific design.

AMERICAN NUCLEAR SOCIETY,
La Grange Park, IL, January 8, 2010.

Hon. JEFF BINGAMAN,
Chairman, Committee on Energy & Natural Resources, U.S. Senate, 304 Dirksen Senate Building, Washington, DC.

Hon. LISA MURKOWSKI,
Ranking Member, Committee on Energy & Natural Resources, U.S. Senate, 304 Dirksen Senate Building, Washington, DC.

DEAR CHAIRMAN BINGAMAN AND RANKING MEMBER MURKOWSKI: Thank you and your committee again for the opportunity to present the views of the American Nuclear Society (ANS) and express our support for your legislative initiatives regarding the development and certification of small modular reactors.

Thank you also for soliciting our input on the questions submitted for the record regarding our testimony. To the extent possible, I have surveyed several ANS members to develop our response to these questions. In addition, as President of the ANS, I have initiated three Special Committees that are tasked to further explore issues related to the U.S. Nuclear Enterprise. Specifically, we are evaluating the national security advantages and opportunities for rebuilding a healthy export capability from the U.S., generic regulatory issues associated with small modular reactors (SMRs) in comparison with today's large reactors, and opportunities to optimize the nuclear fuel cycle in the U.S. by a holistic approach to waste and materials management using an optimum spectrum of small reactor types capable of converting today's "waste" into fuel for tomorrow's SMRs.

The members of these committees have been drawn from all of our constituent sectors: universities, labs, government, utilities, and the supply industry. We expect to be able to report our results at our annual meeting in June 2010.

In addition, we are supporting a more detailed analysis of the high quality jobs that would be created if U.S. unions and industries were again major suppliers to the global marketplace. We are working with the American Council on Global Nuclear Competitiveness, the AFL-CIO, and the Department of Commerce's Civil Nuclear Trade Initiative in this area.

Please contact me at any time for additional information on these and other activities. I and the other members of the ANS applaud the leadership that you and your committee have shown in support of nuclear science and technology.

Sincerely,

THOMAS L. SANDERS,
President.

RESPONSES TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your testimony on page 4 mentions "a fourth category of reactors." Can you explain them and shed light on how close these reactors are to proof of concept and perhaps licensing?

Answer. The first three categories of small modular reactors (SMRs) we discussed are based predominantly on concepts that have at least been demonstrated in some detail over the last fifty years. The fourth category of reactors we alluded to are actually quite similar to the gas and liquid metal cooled concepts, but will have superior performance attributes that will require more fundamental research before licensing can be achieved. For example, proof of concept has been well demonstrated for sodium cooled fast reactors by almost four decades of operation, but extending core lifetimes to two-three decades between refueling will require further research on fuel materials prior to achieving certification for the longer operational cycles. Similar reliability issues also need to be resolved for some of the high temperature gas reactor (HTGR) concepts based on "pebble" fuel designs, the lead-bismuth cooled fast reactor concept, and the molten-salt fueled reactor. Each of these has been proven conceptually in the laboratory, and each could have very significant future impacts in terms of return on investment and cost reduction.

Other reactors included in category four have not been demonstrated in the lab, but do have a wealth of underlying analysis dating back several decades in some

cases. These include the "walk-away" nuclear batteries that have been proposed in the literature. Serious long-term efforts are underway to develop detailed conceptual designs and to conduct proof-of-principle demonstrations for these. The goal in each case will require significant technology leaps to extend in core fuel duration to several decades and perform operations with very little hands-on operational and maintenance requirements. Licensing will likely require at least a decade of prototype demonstration to build the data base necessary for design certification.

Question 2. Your testimony on page 3 notes that small light water reactors are the best understood based upon our current experience with today's fleet. What differences are there between small light water reactors and the ones we have developed over the years?

Answer. In general, we do not expect the basic nuclear, thermal, fluid flow, heat transfer, and power generation attributes of the small light water reactors (LWRs) to differ significantly from the large reactors in use today. The two main performance enhancements envisioned are 1) extending the refueling interval to at least five years, and 2) reducing plant "footprints" by optimizing and reducing the size of components. In some cases, some components may be eliminated. With a significant size reduction, any SMR can then be placed underground without additional cost. Today's operating small and medium sized LWRs in the commercial fleet are virtually identical to their larger counterparts. The new designs being proposed basically would place all the components within what is called the primary pressure boundary to reduce overall plant dimensions considerably. When combined with a design for longer fuel lifetime, these new concepts will be somewhat similar to another category of small light water reactors—the Navy's nuclear propulsion systems.

LWRs for naval applications have a number of important differences from the concepts being considered now for small modular commercial reactors. In general, naval nuclear propulsion systems are optimized to meet the military requirements for the ships in which they are installed. While it would be possible in principle to use a submarine reactor for a commercial application, it would not be the most cost-effective solution. Specific differences include the following:

a. The cores for naval reactors are designed to withstand combat conditions. They are mechanically rugged as a result. Cores are either replaced periodically, or not at all, so the fuel bundle shuffling that is used in commercial reactors is not practical for naval reactors. In essence, the fuel form for naval reactors is highly developed such that the ship will never need to be refueled. This does not mean that a naval core could operate for 33 years at full power. Rather, the "life of the ship" core will support normal operations for a submarine life of 30 years. Total time at sea, of course, is less than 33 years and the typical power level when operating is much less than full power for tactical reasons. The exact lifetime in Effective Full Power Hours is classified as is the core technology itself. The drive to develop a life of the ship core for a submarine is partly economic; refueling a submarine reactor is very expensive.

b. Naval nuclear propulsion plants are designed, to the extent practical, to be able to isolate failed components and still retain substantial operating capability. This is a military requirement. As a result, steam generators and reactor coolant pumps are located in primary loops that are isolable from the reactor. Typically, redundant reactor coolant pumps are installed as well so a single failed pump will not compromise the ability to make full power. Similar considerations apply throughout the rest of the plant where practical. Small light water reactor designs such as those envisioned by U.S. entrepreneurs, can have the steam generators and other components located within the primary pressure boundary. While there may be some requirements for accessibility for inspection or repair during a refueling outage, this is not a reactor safety or licensing issue so much as it is a long-term economic issue.

Despite these differences, small modular commercial plants would benefit from most Naval LWR technologies. In addition, new submarine and aircraft carrier plants are being designed to also be operated with smaller crews, to require less maintenance, and to facilitate any maintenance that is required. These trends are directly applicable to small modular commercial designs as well.

Question 3. Your testimony on page 4 notes that the "manufacturing infrastructure" is already in place with small naval reactors used in our shipyards. Can you please explain that in more detail?

Answer. I am looking for more complete information on this, but the construction of naval nuclear propulsion plants involves components from hundreds of vendors across the U.S. Many of these vendors produce equipment and supplies that must meet very rigorous standards for any nuclear systems. Therefore, the infrastructure exists to produce essentially all of the components and supplies that would be necessary for a small modular commercial reactor as well. In addition, the two nuclear-

capable shipyards, Electric Boat in Connecticut and Newport News in Virginia, have developed the ability to build large complex modules under nearly factory conditions and assemble them into ships. This technology, already widely used to build boiling water reactors (BWRs) in Japan, would be even more important for initiating the yearly construction of a few small modular commercial reactors.

RESPONSES TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Some of the proposed small reactors are anticipated to operate for 30 years without the need for refueling. Would the spent fuel from those reactors need to be treated any differently than conventional reactors that refuel every eighteen months? How does this compare to the spent fuel in naval propulsion systems?

Answer. The details of naval fuel are classified so our comments must be general. Small liquid metal reactors (LMRs) have metallic fuel, which would best be recycled using pyro-chemical processes. Virtually all the actinides and uranium would then be recycled into new cores, and only fission products would be sent to a geologic repository for disposal. Removing the actinides and uranium from the waste volume going to the repository would reduce the disposal burden on the repository by at least a factor of five. This in turn would increase potential repository capacity on the order of five times and would reduce the effective lifetime of the radiation hazard from hundreds of thousands of years to more like 300 years. Used fuel from LWRs or gas reactors that may have a longer fuel lifetime would also benefit from recycling with the actinides being used to fuel small fast reactors. There is, however, a limit to how long an LWR core can be effective because of the fuel depletion and increasing neutron absorption in the fission products that are produced during operation.

Question 2. You mention that more than 60 countries are seeking or expressed interest in developing new nuclear generating capacity. What lessons can we learn from international efforts on small-scale nuclear reactors?

Answer. Most of the emerging market opportunity across the world is for smaller reactors. According to the International Atomic Energy Agency (IAEA), a small reactor is 0 to 300 megawatt electric, while a medium-sized reactor generates 300 to 700 megawatt electric. Fundamentally, most countries cannot really absorb large thousand-megawatt electric nuclear systems. Of 442 nuclear power plants around the world last year, 139 were small-and medium-sized reactors. Table 1 lists the current fleet of small-and medium-sized reactors. These reactors generated 61.6-gigawatt electric, or 16.7% of the world electricity production. Of 31 recently constructed nuclear power plants, eleven were smaller systems.

Table 1. World's Operating Small-Medium Reactors

Developing/Transitioning Countries		
Argentina – 2	Armenia – 1	Brazil – 1
Czech Republic – 4	Mexico – 2	Hungary – 4
Slovenia – 1	Slovakia – 5	Pakistan – 2
Ukraine – 2	India – 16	China – 5
North Korea – 1	Russia – 11	
Developed Countries		
Britain – 18	Belgium – 2	Canada – 10
Finland – 2	Japan – 14	Netherlands – 1
South Korea – 6	Spain – 1	Sweden – 2
Switzerland – 3	Taiwan – 2	U.S. – 10
France – 1		

Most of these countries would prefer similar sizes in the future for one of two reasons: 1) affordability, and 2) smaller sizes allow them to add capacity as needed and to perform shutdown maintenance and refueling without having to import large and costly amounts of replacement electricity.

Large-scale development of advanced, versatile small modular reactors for the emerging world market is the key to enabling nuclear energy to grow as needed and to exploit nuclear energy's million-fold advantage in energy intensity compared to all other energy sources. More than 50 concepts and designs of innovative SMRs are being evaluated for their use by an IAEA team that includes Argentina, Brazil, Canada, China, Croatia, France, India, Indonesia, Italy, Japan, the Republic of Korea, Lithuania, Morocco, Russian Federation, South Africa, Turkey, U.S.A., and Vietnam.

Several countries are developing SMRs to penetrate these markets. Russia, Japan, and South Africa are promoting small LWR, liquid metal, and HTGR concepts, respectively. Russia has a unique market advantage because they are offering a "cradle-to-grave" fuel cycle agreement with their customers. Any country purchasing a Russian system will not have to worry about developing a disposal system. All used fuel will be returned to Russia.

America must also be a competitive supplier to this evolving global marketplace to assure that U.S. values related to safety and proliferation prevention are also promoted around the world. Working with other nuclear societies, ANS has supported and encouraged a global nuclear fuel cycle model for the 21st-century based on "cradle-to-grave" materials and technology agreements. Fuel suppliers would operate reactors and fuel cycle facilities. Fuel users would operate reactors, lease and return fuel, and not have to worry about disposal of radioactive materials. The IAEA would provide safeguards and fuel assurances, backed up with a reserve of nuclear fuel for states that do not pursue enrichment and reprocessing

This cradle-to-grave concept addresses virtually all potential proliferation concerns with the expanded use of nuclear power. Developing such a comprehensive fuel cycle service capability would provide market advantages superior to the current approach, virtually defining how nuclear trade in the 21st century will evolve, and enable the nuclear powers to help the developing world acquire the energy resources necessary for achieving a prosperous future, with controllable environmental impacts. From a U.S. national security perspective, it would strongly discourage user nations from developing enrichment and reprocessing capabilities that are arguably the most acute proliferation threat we face today.

We believe that the time is right for a new paradigm for global nuclear trade, and the development of small modular reactors that are appropriate for the emerging global market is one key to regaining U.S. export capabilities.

Question 3. We in Congress often discuss and debate ideas for creating American jobs. Your testimony discusses how small reactors provide an opportunity to re-build and expand the nuclear manufacturing industry in America and create jobs.

a. Has the industry examined the number of jobs that might be created from a small reactor nuclear factory?

Answer. The ANS is working with the Department of Commerce, the American Council on Global Nuclear Competitiveness (ACGNC) and the AFL-CIO to develop an estimate of the number of jobs that would be created if U.S. industry and labor became major suppliers to the global market for small modular reactors. A report will be available by June 2010. Our expectation is that a typical factory (or group of factories) could easily produce 100-200 of these systems per year. We expect that the total time required between the initial order and emplacement will be about two years.

b. How many people are employed for the manufacturing of the naval nuclear reactors?

Answer. I am trying to get better information on this. The Naval Reactors Program employs thousands of people. The Fiscal Year 2009 Budget Request shows over 200 personnel associated with headquarters activities and field offices. There are about 3400 engineers and scientists at the Navy's Bettis Laboratory and about 2500 engineers and scientists at Knolls Atomic Power Laboratory (KAPL). These personnel are not building reactors, of course, but do design and manage all aspects of operation, maintenance, and disposal of naval nuclear plants. In addition, there are 10,500 workers at Electric Boat and more than 15,000 workers at Newport News. Most of these shipyard workers are involved in integrating all components of the vessels. Finally, there are hundreds of component suppliers providing products that range from steam generators to welding electrodes. According to the Heritage Foundation, the aircraft carrier industrial base consists of more than 2,000 companies in 47 states. Likewise, the submarine industrial base consists of more than 4,000 companies in 47 states (Web Memo no. 1693, dated November 5, 2007 by the Heritage Foundation). See also ADM Donald testimony to House Armed Services Committee June 13, 2005, concerning the vendor base for nuclear construction.

c. How many naval nuclear reactors are built each year?

Answer. Naval nuclear ship construction is budget limited, and the vendors and shipbuilders involved in these plants could easily build more than they are today. Increased production would likely improve their efficiency and reduce unit costs. At present, approximately one new submarine is being built each year, with two per year planned in the out-years. The next aircraft carrier is now under construction but it will not be delivered for some years to come. Thus, approximately one-two naval reactors are constructed each year.

APPENDIX II

Additional Material Submitted for the Record

NUSCALE POWER, INC.,
Corvallis, OR, December 14, 2009.

Hon. JEFF BINGAMAN,
Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

Hon. LISA MURKOWSKI,
Ranking Member, Committee on Energy and Natural Resources, U.S. Senate Washington, DC.

DEAR MR. CHAIRMAN AND RANKING MINORITY MEMBER MURKOWSKI: On behalf of our employees and customers, as well as the university community here in Corvallis, Oregon, I want to thank you and your colleague from Colorado, Senator Mark Udall, for your leadership in encouraging the development of modular, scalable nuclear reactor technology in the United States. Your recent sponsorship of the Nuclear Power 2021 Act, and the hearing you will hold on December 15 regarding S.2052 and S.2812, are important milestones for a technology that offers emissions-free, safe and economical energy. If this letter can be presented into the formal hearing record, it would be appreciated.

Assistant Secretary of Energy Dr. Pete Miller and the Chief Nuclear Officer from the Nuclear Energy Institute will ably inform you of what we believe are the important national energy policy implications and benefits of promoting this innovative approach to a well proven domestic technology. As members of the American Nuclear Society, we appreciate that organization's contributions to the hearing as well.

As the CEO of one company that is at the forefront of modular, scalable nuclear power technology, I want to share some additional observations that I believe offer windows into the future of nuclear power in the U.S. Each has a direct bearing on the legislation you have sponsored.

- Public Acceptance—In the summer of 2008 Oregon Business Magazine ranked NuScale Power as #4 in its "Top 10 Companies to Watch." NuScale was flanked by high tech startups indicating to me a broader acceptance of nuclear power as an important component of future business development in our state and the region. The public recognizes the unmatched record of safety and performance in our industry and are ready to embrace a future in which nuclear power is a major part.
- Our Workforce—NuScale Power, incorporated in 2007, went from nothing to more than 40 highly-educated employees who are masters and PhD graduates from across the country indicating a very strong acceptance of 'modular, scalable' technology as the next evolution in the nuclear power industry. NuScale is already creating 'green jobs' in America. We couldn't be more proud of the caliber and commitment of our staff, whose average age I might add, is in the middle 30's. The acceptance of our technology within the professional community has been overwhelming.
- American Manufacturing—The potential for job creation by NuScale's technology reaches well beyond the State of Oregon. NuScale's complete nuclear system can be entirely manufactured in the United States which provides a local manufacturing base and the potential for international exports. Thus the NuScale workforce extends to our partners and subcontractors throughout the country, including: companies such as Kiewit Construction (Omaha, NE), Curtiss Wright (Pennsylvania), Electric Boat (Groton, CT), Precision Custom Components (York, PA) and GE-Energy Services (California).

While our first commitment is to the US domestic market for which the NRC and DOE have a primary obligation, we also see enormous potential for U.S. vendors to

sell innovative U.S. technologies to overseas markets at some point in the very near future. This is important to our national balance of payments, and it is important to NuScale and its strategic partners. Your legislation helps to promote the potential to create green jobs in the U.S. and expand America's presence in international markets.

Again, we thank you for your leadership in the area of modular, scalable, nuclear power reactors and look forward to working with you as this legislation proceeds.

Sincerely,

PAUL LORENZINI,
Chief Executive Officer.

STATEMENT OF JACK SPENCER, WEB MEMO, THE HERITAGE FOUNDATION

The Senate is considering two bills that are meant to help small and modular nuclear reactor development. Unfortunately, the Nuclear Energy Research Initiative Improvement Act (S. 2052) and the Nuclear Power 2021 Act (S. 2812) would have the opposite impact.

Together (or individually), these bills would smother the private-sector initiative and free-enterprise spirit that has driven small and modular reactor development in recent years. Instead of embracing this new and innovative approach to nuclear energy development, these bills would subject the small and modular reactor business to the same government-depressed trajectory that plagues traditional reactors.

The Nuclear Energy Research Initiative Improvement Act (S. 2052)

S. 2052 would authorize $250 million over five years to support the emergence of small and modular nuclear reactors. While the spirit of the act is laudable, its approach is mostly counterproductive. The essence of the act is to mandate that the Department of Energy (DOE) develop a five-year plan to "lower effectively the costs of nuclear reactors."

There are several problems with the act:

- More government support is not needed.—Private investors have been driving the small and modular reactor business in recent years. They recognized that small and modular rectors could potentially fulfill a market demand that large rectors could not, and they did it without government support.
- The government is neither capable nor qualified to reduce the prices of nuclear reactors.—Private industry has the interests, expertise, and background to develop cost-effective manufacturing and construction techniques. History demonstrates that government intervention would only slow the phenomenal progress made on the small reactor front.
- Government intervention has not produced a single new large reactor, and there is no reason to think it would work for small ones.—The federal government's attempts to subsidize the commercialization of large reactors have failed to create a viable nuclear industry. The small reactor business has taken a different approach. Instead of leaning on government to direct the progress of industry, they have by and large built privately funded commercial enterprises out of federal research and development projects. Instead of controlling this innovation through DOE meddling, the federal government should embrace it as a model for other energy sectors.
- The bill plays into the hands of the anti-nuclear agenda.—The bill directs the DOE to conduct "public workshops" to generate "public comment" to inform its five-year plan. This opens the door to over-politicization and legal sandbagging—two of the anti-nuclear lobby's favorite progress-killing tactics.
- Creating an arbitrary timeline makes no sense.—Government program timelines to produce commercial projects do not work. Once the government creates a development program, the market begins to revolve around it. Then as the timeline slips—as they always do—so does the eventual introduction of the products. Timelines should be market-and investor-driven, not dictated by Congress or the DOE.

The Nuclear Power 2021 Act (S. 2812)

S. 2812 creates a DOE program to develop and demonstrate two small and modular nuclear reactor designs. In essence, it authorizes the DOE to dictate who will make up America's small, modular reactor business for the foreseeable future.

This is the wrong approach because:

- It is anti-competitive.—Multiple companies have invested private dollars and resources to build the commercial small and modular nuclear reactor business.

By choosing winners and losers, the DOE would take away the incentive to compete and replace it with the incentive to lobby Washington. The result would be that Washington, not the market, would decide which technologies move forward.

- It stifles innovation.—This anti-competitiveness results in less innovation in the marketplace. The irony is that private-sector innovation is what has given rise to the small and modular reactor market to begin with. As the established nuclear industry became bogged down in federal bureaucracy, nuclear energy entrepreneurs were investing in new and innovative ways to bring nuclear technology into the marketplace. S. 2812 would apply the same anti-innovation bureaucracy to the small and modular reactor business.
- It deters private-sector investment.—Multiple companies are currently investing in small, modular reactors. By picking which two get government support, S. 2812 essentially punishes those companies that were not chosen. This signals to private investors to either not get into the nuclear business or to spend significant resources on lobbying instead of product development.

Not All Bad

However, the bill does contain some good provisions. In addition to raising the profile of small reactors, both bills attempt to address (though unsuccessfully) one legitimate government function: licensing.

The long-term success of nuclear power, regardless of reactor type, will depend on an efficient regulatory regime. This is especially true for small and alternative reactor types. The lack of regulatory structure for these reactors represents a major barrier to market entry. Though neither piece of legislation fixes this problem, both recognize it.

A Better Approach

Congress could allow small and alternative reactor technologies to move forward by doing the following:

Reject Additional Loan Guarantees.—Loan guarantee proponents argue that high upfront costs of new large reactors make them unaffordable without loan guarantees. Presumably, then, a smaller, less expensive modular option would be very attractive to private investors even without government intervention.

But loan guarantees undermine this advantage by subsidizing the capital costs and risk associated with large reactors. A small reactor industry without loan guarantees would also provide competition and downward price pressure on large light water reactors.

Avoid Subsidies.—They do not work. Despite continued attempts to subsidize the nuclear industry into success, the evidence demonstrates that such efforts invariably fail.

The nuclear industry's success stories are rooted in the free market. Two examples include the efficiency and low costs of today's existing plants and the emergence of a private uranium enrichment industry. On the other hand, government intervention is the cause of the industry's failures, as illustrated by the government's inability to meet its nuclear waste disposal obligations.

Build Expertise at the Nuclear Regulatory Commission (NRC).—The NRC is built to regulate large light water reactors. It simply does not have the regulatory expertise to efficiently regulate other technologies, and building that expertise takes time.

Helping the NRC to develop that expertise now would help bring new technologies into the marketplace more smoothly.

Establish a New Licensing Pathway.—The current licensing pathway relies on reactor customers to drive the regulatory process. The problem is that the legal, regulatory, and policy apparatus is built to support large light water reactors, effectively discriminating against other technologies.

Establishing an alternative licensing pathway could help build the necessary regulatory support on which commercialization ultimately depends.

More Harm Than Good

It seems that some Members of the Senate are making a real effort to help move small, modular reactors forward with S. 2052 and S. 2812. Unfortunately, their efforts would do more harm than good.

In the process of attempting to help small, modular reactors, in practice, these measures would smother the very market forces that have driven the success of small, modular reactors to begin with.

STATEMENT OF CARL BERGMANN, (CO-DIRECTOR) KEN MCLEOD (CO-DIRECTOR), WHIT GIBBONS (HEAD, OUTREACH PROGRAM), SAVANNAH RIVER ECOLOGY LABORATORY

Madam Chairman Cantwell, Ranking Member Risch, and members of the Energy Subcommittee of the Senate Committee on Energy and Natural Resources: we wish to provide a perspective on and offer our support for H.R. 2729 and the Department of Energy's National Environmental Research Parks (NERPs).

We appreciate the opportunity to provide testimony in support of H.R.2729, which has far-reaching implications nationally for advancements in energy technologies accompanied with credible environmental oversight and public education and awareness. The passage of this bill will support the country's national energy policy and the stated mission of the U.S. Department of Energy, and as stated in Sec. 3 of the bill, will not limit the activities of the Federal Government on NERP land.

The contributions to field research relating to energy technologies that can be accomplished at these DOE sites, which are unsurpassed as outdoor laboratories, are boundless. The opportunities to achieve public trust through transparent presentation of ecological research findings and advancements in environmental stewardship through education and outreach programs are limitless.

Environmental research themes leading to science-based decision making regarding energy technologies that will be further enhanced by official recognition of the National Environmental Research Parks include the following:

> Environmental characterization of the impacted ecosystems, as contrasted to the unimpacted, natural habitats, which is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies; research on ecological risks and effects, which will help to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes; and, studies on remediation and restoration of natural habitats that can be conducted on sites where large land areas are impacted by relatively low levels of metals, organics, and radionuclides.

The NERPs in the DOE complex can also serve as reference landscapes for the patchwork of commercial and private land areas that exist outside of their borders as well as providing a landscape with biological communities that can serve as a reference for climate change, without the impact of typical economic development. Long-term ecological studies require uninterrupted field research and will be enhanced when large land areas are available. Such studies can be conducted in the NERPs if they are officially designated as defined entities where long-term research can be carried out. Dedicating these areas that are minimally affected by impacts from agricultural, urban, or unmonitored industrial activities, as National Environmental Research Parks, will be in the best interest of all Americans. The establishment of the SRS and other DOE sites as National Environmental Research Parks will assure a legacy that DOE can be proud of.

In providing testimony in support of the National Environmental Research Park concept, we urge that you remember that NERPs were initially created on the premise of studying the interaction of industrial development and nature. Such studies are beneficial to the national interest. As such National Environmental Research Parks are fundamentally different from National Parks, National Wildlife Refuges, and National Forests. It should be further noted that a NERP is not a regulatory mechanism and is not restrictive of energy technology development on or around a site. Instead, it provides a framework to generate the knowledge to guide implementation of sound ecological stewardship practices consistent with DOE's directives and strategic plan.

The research conducted at the seven National Environmental Research Parks targets the interaction of energy production and environmental stewardship. To take advantage of the opportunities for collaboration through development of a nationwide network of scientists, a NERP Workshop was held at the Savannah River Site on November 19-20, 2009. A summary of this workshop demonstrates the capabilities that will be afforded each of the NERP sites in regard to environmental research and public education as they pertain to and will contribute to DOE's stated missions on the sites. We therefore have attached the workshop summary as an addendum to our testimony.

We urge you to continue the process of formalizing the DOE lands as National Environmental Research Parks, and wish to conclude with the following statement from a 1987 NERP planning document.

> The basic operating premises of the National Environmental Research Park concept are that the Department of Energy has stewardship for lands representing a large array of the Nation's ecological regions; a cor-

responding array of environmental activities (including impacts) are taking place on these lands; that a highly competent cadre of researchers are associated with these sites; and by proper organization of research to achieve agency mandated environmental goals, we can simultaneously aid in resolving environmental problems on-site, locally, regionally, nationally, and globally. In short, the National Environmental Research Park concept is basic to an ecosystem based land-use management program.

SUMMARY OF NERP WORKSHOP 2009

Across the United States there are seven National Environmental Research Parks (NERPs) on Department of Energy lands. Unlike the U.S. Department of the Interior's National Parks that preserve land, the NERP designation does not restrict future land use and NERP sites require the juxtaposition of developed and undeveloped areas. The need for "natural" and "human impacted" areas on DOE sites was a key component of the 1972 NERP charter. In fact, research on the NERPs is used to evaluate and mitigate the environmental consequences of energy use and development and to demonstrate potential environmental and land-use options.

The designation of the first NERP site in 1972 coincided with the "Calvert Cliffs Court Decision" in 1971 (U.S. Court of Appeals for the District of Columbia Circuit; Docket No. 24839) in which the justices addressed the Atomic Energy Commission's (the predecessor agency of DOE) response to federal law (NEPA), leading to the unequivocal interpretation that research on general basic ecology should be conducted at each site and that such research should extend to population biology and ecology.

No consistent funding mechanism has been in place to support environmental research on the NERP sites for the last two decades. However, the passage of H.R. 2729 has sparked resurgent interest in the research value of NERPs. The bill would recognize the DOE NERP sites (Fermilab, Idaho, Los Alamos, Nevada, Oak Ridge, and Savannah River [with the inclusion of Hanford yet to be determined]). The bill would also provide funding for the next five years to conduct research related to the environmental aspects associated with DOE missions on each site. Although the amount to be provided to each site would be modest, the productivity and value of the research, monitoring, and communications to the public far outweigh the costs.

One important outcome of such legislation would be the opportunity to create a nationwide network of NERP sites with collaborative research programs and mutual consideration of environmental issues faced by the sites. Such a network could provide an unprecedented opportunity for research aimed at addressing regional, local, and global issues pertinent to current and future energy missions.

With the prospect of creating such a network, the Savannah River Ecology Laboratory hosted a NERP workshop (November 19-20, 2009) to bring together participants from each NERP site for a two-day discussion of creating a NERP network. A majority of the workshop was devoted to discussing research being conducted at each NERP site along three major themes: climate change, stewardship on DOE sites, and the coexistence of energy production and stewardship.

In the climate change discussion it was immediately apparent that the NERP sites are ideal locations for studying the impacts of climate change for several reasons.

First, they occur in a wide variety of bioregions (the NERPs are in South Carolina, Tennessee, Nevada, New Mexico, Illinois, Idaho, and Washington) and encompass an area that is representative of over half of the American landscape. Cumulatively the NERPs are five times larger than the National Science Foundation's Long-Term Ecological Research sites (NSFLTER), making replication and large scale experiments possible to ensure that the results are meaningful to larger areas. Each NERP will be affected by climate change differently, but can result in excellent opportunities for comparative research programs with common goals. For example, Los Alamos has conducted long-term research on the relationships between carbon uptake and water loss from the individual plant to the ecosystem level. The findings address climate variability and forest or desert management issues that are applicable to any of the sites, which can develop comparable, collaborative research projects.

Second, a wealth of irreplaceable long-term data already exists at each site. Investigations concerning the potential impacts of climate change on biota require data collected over decades to address long-term changes above and beyond typical year-to-year variation. Because prior research at NERP sites has not revolved around standard short-term funding opportunities there exists unparalleled long-term data on plant and animal communities that can serve as the basis for future studies. For example amphibian populations at an isolated wetland on the SRS have been monitored continuously for 31 years.

Third, the substantial available land area within some NERP sites has allowed for some of the largest replicated experimental manipulations examining the impact of climate change (e.g. rainfall modification experiments conducted at both Oak Ridge and Savannah River).

At the end of the discussion it was agreed that with a funded NERP network the following could be undertaken:

1) compilation and on-line access to extant data sets from among the NERP sites,
2) standardization of data collection techniques for subsets of climatic and meteorologic variables where possible, and
3) coordination of future experimental manipulations to examine the variety of impacts climate change is expected to have across the regions of the US.

The discussion of stewardship on DOE lands focused on

1) the use of long-term ecological research data models on plants, animals, and natural communities to develop sound conservation and land management policies,
2) assisting DOE with environmental compliance issues, and
3) the importance of set aside areas to establish reference sites for environmental research that examines impacts of energy technologies.

As above, the major recurring topic was the existence of unprecedented long-term data sets at each NERP site, as well as the ability to study disturbed and undisturbed habitats. As additional ecological research is conducted to examine the effects of human disturbance and habitat fragmentation, participants agreed that NERP sites provide an invaluable resource unlike any other. The NERP sites cover a combined area greater than 2 million acres, and they have representative developed and undeveloped tracts of land. The undeveloped areas provide necessary reference sites to examine the ecology of biota in an undisturbed environment for comparison with the effects of disturbance in developed or otherwise altered habitats.

Also, similar to climate change research, there have been large-scale long-term experimental manipulations undertaken to investigate the impact of various land management practices including different fire regimes and forestry techniques. Such manipulations are only possible when there is the combination of large areas of land, permission to alter the environment, and sufficient time to monitor the long-term effects. NERPs are ideal for such research. Participants at the NERP Workshop agreed that it was important to collaborate on a few important environmental issues that are generally relevant across the DOE complex, while also addressing the unique environmental challenges intrinsic to each of the NERP sites. For example, surface water-riparian and fire management are both important to DOE sites but have different environmental issues that must be addressed, depending upon the region of the country.

The final research discussion examined the theme of coexistence of energy production and stewardship. Specifically, three topics were addressed, which were

1) the use of existing data to facilitate DOE's choice of sites for future mission-related activities,
2) the use of sound science to assist with environmental cleanup and ecological risk assessment, and
3) the need for new research addressing potential future DOE missions and alternative energy production methods.

Workshop participants recognized the need to continue basic research focused on the fate and effects of DOE-relevant contaminants in support of ongoing decommissioning and environmental cleanup activities. The NERP program could facilitate cleanup by providing regulators and local stakeholders with realistic, achievable cleanup goals based on credible scientific evidence. The independence of NERP research will also be important in driving stakeholder consensus regarding new site missions, especially those related to nuclear energy.

An overarching theme of the Workshop was that one mission of the National Environmental Research Parks is the education of students and the general public about site activities. Thus, each site recognized the importance of maintaining a strong and active Environmental Education and Outreach program that could inform the public of the diverse ecological activities conducted at the park and to educate students at various levels in environmental science. The two goals are

1) to train people in ecological and environmental sciences by taking advantage of the outstanding opportunities to provide unique learning opportunities to all ages, including the completion of advanced degrees based on site activities, and
2) to educate the public by promoting a stronger connection between these Federal facilities and the surrounding communities. All sites were in agreement that a cred-

ible outreach program was important to enhance public confidence that the Department of Energy is fulfilling its environmental stewardship responsibilities.

Energy production will always be a crucial component of DOE's mission. The NERP sites can provide a unique opportunity to assess the interactions between the emerging energy policy issues (wind, solar, nuclear, transmission corridors, oil, gas, and rare earth mineral extraction, etc.) and the environment. As such it is imperative that along with research developing alternative energies there be research aimed to examine, evaluate, and mitigate the environmental consequences of energy production. Creation of a nationwide NERP network that is funded on an annual basis would bring together scientists united by common goals but with unique capabilities and scientific expertise. Together they could not only assist DOE with future missions but also reduce public skepticism regarding DOE activities by providing independent peer-reviewed scientific research.

GE HITACHI NUCLEAR ENERGY,
Wilmington, NC, January 4, 2010.

Hon. JEFF BINGAMAN,
703 Hart Senate Office Building, Washington, DC.

DEAR CHAIRMAN BINGAMAN, On behalf of GEH, I applaud your efforts associated with the Senate Energy and Natural Resource Committee hearing on Small Modular Reactors held on December 15, 2009. The Nuclear Power 2021 Act (S. 2812) as well as the Nuclear Energy Research Initiative Improvement Act (S. 2052) is legislation that can advance U.S. technologies and processes.

As you may know, the issue that the private sector faces with small modular reactors is the fact that many costs do not scale with power output. While a smaller reactor will use less steel and concrete, therefore having less capital cost, there are many other costs that do not scale with reactor power. Some of the costs which do not scale include: licensing certification, licensing fees when operating, plant security requirements, control room staffing, and Emergency Planning Zones (EPZ). These costs, all necessary to meet government regulations, significantly impact the savings gained in capital costs of small modular reactors.

In particular, there is significant value in a Nuclear Regulatory Commission (NRC) license. With a NRC license "in hand" the private sector can better control the total cost of a small modular reactor. In addition, overseas sales of U.S. small modular reactors could be expected and a NRC license "in hand" would help to increase the probability of those sales. In order to improve the potential for success of small modular reactors under S. 2812 and S. 2052, the following changes are recommended:

Nuclear Power 2021 Act (S. 28121

Remove the cost shares for both the design and licensing work within the bill. Rather, replace these provisions with just one provision that provides licensing and national laboratory support in obtaining a NRC license for the reactor technology. This would apply to the first technology movers and would continue until the vendor holds a NRC license. The cost of licensing a new technology is a high hurdR. The process could be much improved and expedited by having the government cover the cost GE Hitachi Nuclear Energy Letter to Chairman Bingarnan Page two of the NRC licensing process and by providing national laboratory technical support in answering NRC Requests for Additional Information (RAI). This framework would provide the national laboratories with a very focused, near-term, goal-oriented technical and R&D support role.

Nuclear Energy Research Initiative Improvement Act (S. 2052)

Similar to S. 2812, S. 2052 stipulates cost sharing between the government and private industry. Consistent with our suggested changes to S. 2812, we recommend that Section 2, paragraph (4) of S. 2052 be deleted.

If the above changes are made to S. 2812 and S. 2052, then the focus of the legislation is apparent—perform energy research that supports licensing small reactor technologies.

These changes will provide taxpayers with near term deliverables for both the NRC and DOE. This will harness the best minds in the U.S. to produce new nuclear technologies that can be used domestically and will be attractive overseas because of the rigor associated with obtaining the NRC license.

My staff and I can provide you more details if desired.

Sincerely,

CHRISTOPHER MONETTA,
Senior vice President.

STATEMENT FOR NEI, NUCLEAR ENERGY INSTITUTE

PUBLIC/PRIVATE PARTNERSHIP FOR SMALL REACTORS WILL PROMOTE CLEAN ENERGY, JOB CREATION

WASHINGTON, D.C., Dec. 15, 2009—Legislative proposals pending in Congress to accelerate development of small, scalable reactors with electric generating capacities of no more than 300 megawatts are supported by industry and should be enacted expeditiously, an industry leader told the Senate Energy and Natural Resources Committee today.

The establishment of a private/government partnership to work together on the research and development of small reactor technology would greatly enhance a diversified energy strategy aimed at boosting energy sources that can meet rising electricity demand while reducing emissions of greenhouse gases, said Anthony Pietrangelo, the Nuclear Energy Institute's senior vice president and chief nuclear officer.

"Large nuclear energy facilities will provide the bulk of additional electricity in the near future, but small, modular reactors will act as a complement to these large-scale projects and expand the applications for carbon-free nuclear energy," Pietrangelo said.

Small reactors also have multi-use capabilities combining electricity generation with industrial process heat applications such as those used in the petrochemical industry and coal-to-liquids applications.

Pietrangelo cited analyses from the U.S. Energy Information Administration assessing the Waxman-Markey climate legislation and the National Academies of Science, which concluded that the United States must nearly double the existing 100 gigawatts of nuclear energy capacity by 2030 to meet greenhouse gas emissions reduction goals.

Small reactors of fewer than 300 megawatts-comparable from a capacity standpoint with many renewable energy projects-will be more compatible than large nuclear power plants with the needs of smaller U.S. utilities from an electricity production, transmission and financial perspective, Pietrangelo said. Small reactors also have attractive manufacturing efficiencies.

"These designs can be used to replace inefficient fossil-fired power stations of similar size that may no longer be economical to operate in a carbon-constrained world. The infrastructure, cooling water and transmission facilities already exist at such facilities, and smaller reactors can be built in a controlled factory setting and installed module by module, reducing the financing challenge and matching new electricity production to demand growth," Pietrangelo said.

He pointed to the success of the Department of Energy's cost-shared, public-private Nuclear Power 2010 program in reducing business risk and enabling near-term construction of larger advanced-design reactor technologies. A similar effort must be expended for small reactors, he said.

"The development and use of a new nuclear reactor technology can take two decades, with design costs exceeding $1 billion. The cost and time required to design, develop and license a small reactor is not necessarily reduced linearly with size. In addition, it takes time and resources for the Nuclear Regulatory Commission to develop the institutional capacity to license new reactor designs," Pietrangelo said.

He urged the sponsors of proposed Senate legislation to jump-start small reactor development to work together to combine the provisions of three proposals into a single bill. He also said legislation should include the following provisions:

- define the scope, priorities and funding for research and development;
- define the scope of private sector/government cost-share provisions for design development and prototype simulation or testing;
- provide funding to assist the Nuclear Regulatory Commission and the industry in resolving generic regulatory issues specific to small-scale reactors; and
- define private/government cost-share projects for the development, NRC review, and implementation of first-of-class combined license applications for each new type of small-scale reactor.

"The potential benefits of small, modular nuclear energy plants are substantial and should be pursued and supported," Pietrangelo said. "These designs expand the

strategic role of nuclear energy in meeting national environmental, energy security and economic development goals."

NUCLEAR REGULATORY COMMISSION,
Washington, DC, December 10, 2009.

Hon. JEFF BINGAMAN,
Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: As requested in your letter dated December 1, 2009, I am submitting, on behalf of the U.S. Nuclear Regulatory Commission (NRC), the following comments regarding S. 2052, the "Nuclear Energy Research Initiative Improvement Act of 2009," and S. 2812, the "Nuclear Power 2021 Act."

Because of our role as a regulator, the NRC offers no comments on whether, as a policy matter, small modular reactors or other new nuclear reactor technologies should or should not be pursued. The NRC's role would be limited to ensuring that any reactors utilizing new technologies will be constructed and operated in a manner that will provide adequate protection of public health and safety and the common defense and security. Accordingly, the NRC's comments relate to the NRC's regulatory role.

S. 2052

S. 2052 would require the U.S. Department of Energy (DOE) to "conduct research to lower the cost of nuclear reactor systems." This language would not, though, expressly direct the DOE to conduct research on safety in conjunction with its research related to cost reduction for nuclear reactor systems. Such safety research could be valuable in supporting the NRC's role in determining whether particular cost-saving measures are consistent with public health and safety—a determination the NRC would need to make before making any licensing decisions. Accordingly, the NRC suggests adding the words "consistent with protection of public health and safety" after the words "lower the cost of nuclear reactor systems" in the provision of Section 2 of S. 2052 that would add a new paragraph (2) to section 952(a) of the Energy Policy Act of 2005.

To the extent that the research into nuclear reactor systems leads to submission to the NRC of applications based upon new technologies or designs, the NRC may need to conduct infrastructure development and confirmatory research before receiving applications in order to ensure an efficient and effective review process once applications do arrive. To facilitate efficient licensing reviews, Congress would therefore need to provide the NRC with adequate appropriations to cover this pre-application work.

S. 2812

S. 2812 requires the DOE to obtain two small modular reactor design certifications from the NRC by January 1, 2018, and to obtain two NRC combined licenses—one for each certified design—by January 1, 2021. As the NRC staff has indicated in prepared written testimony for the Committee's December 15, 2009 hearing, the NRC has already begun conducting preparatory work on various matters related to small modular reactors. However, the amount of additional work that the NRC must do to prepare itself for efficient reviews of the small modular reactor design certification and combined license applications described in S. 2812 will vary based upon the technologies ultimately chosen. For example, the NRC expects that it is much closer to being able to efficiently evaluate applications for small modular reactors that would utilize light water reactor technology—the same technology employed in the existing fleet of large commercial nuclear plants—than applications reliant on technologies with which the NRC has much less experience.

Thus, while the NRC is not contending that the deadlines in S. 2812 are unattainable, and while the NRC would make a concerted effort to make licensing decisions within any statutory timeframe, the NRC emphasizes that the time and resources it will need to develop the appropriate infrastructure and conduct any necessary confirmatory research could vary substantially depending upon which small modular reactor technologies are ultimately pursued. S. 2812 does set target dates for ultimate receipt of NRC licenses, but it sets no deadline for determining which technologies will be chosen as the basis for the designs that the DOE and its private-sector partners would seek to have licensed. Therefore, it is not clear how much advance warning the NRC would have about which technologies the license applications will reference.

In addition, pursuant to its Atomic Energy Act responsibilities, the NRC will not grant a license if the applicant does not demonstrate to the NRC that public health

and safety and common defense and security will be adequately protected. Therefore, for the deadlines in S. 2812 to be met, the NRC would need to receive appropriations adequate to support any necessary infrastructure development and confirmatory research as well as the application reviews themselves, and applicants would need to submit high quality applications in a timely manner.

In light of the considerations described above, the NRC suggests adding language to the deadline provisions of S. 2812 to ensure there is no undue pressure on the DOE or the NRC to compromise on safety or security because of impending statutory deadlines. Section 645 of the Energy Policy Act of 2005 provides an example of possible alternative language. That act established the Next Generation Nuclear Plant Project, and Section 645(c) sets forth a specific date by which the DOE is to complete construction and begin operations of a prototype nuclear plant and associated facilities. But Section 645(c) also gives the DOE the option—in the event it cannot comply with the statutory deadline—of "submit[ting] to Congress a report establishing an alternative date for completion." The NRC believes that similar safety-valve language would be appropriate for S. 2812 to account for any complications related to safety or security that might arise as new small modular reactor technologies are developed and assessed.

If you have questions about these views, please do not hesitate to contact me.

Sincerely,

GREGORY B. JACZKO.
Chairman.

HYPERION POWER,
Denver, CO, December 17, 2009.

Hon. JEFF BINGAMAN,
Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

RE: S. 2812

DEAR SENATOR BINGAMAN: I am the CEO and a co-founder of Hyperion Power Generation Inc.—a small business technology transfer company spun out from Los Alamos National Laboratory. Hyperion was the first Small Modular nuclear power Reactor (SMR) company to meet with the Nuclear Regulatory Commission about its intention to commercialize an SMR design. Hyperion Power continues to be the market leader in the U.S. for SMRs.

I have spent the last 20 years commercializing technologies from the DOE complex and greatly respect the work done by DOE personnel. With dedicated key associates, I directly founded four Los Alamos National Laboratory (LANL) startups and assisted in dozens of others—while at LANL (on two different "tours"), as a consultant to Technology Ventures Corporation, and while working as a venture capitalist. I am uniquely qualified to provide testimony on the impact of S.2812 in particular and felt that we could have provided an essential perspective.

To Hyperion Power, and our friends at two other commercial U.S. SMR firms, S.2812 looks like a program that will favor the DOE establishment over private industry. It seems clear the bill as written will stifle innovation and could kill an industry just begun by DOE technology transfer success.

Allow me to explain

S.2812 will create a government sponsored standard and will be limited to two SMR designs. Whoever doesn't win this government competition will essentially be blocked from raising equity capital lot their firms. Investors will nut want to "back the horse" that does not win this first race, when the race is defined by the U.S. Government as The Standard Design for Small Modular Reactors. While I admit Hyperion Power and NuScale are the two most likely small business winners of this competition (since we are the closest to market), we and our stockholders would much prefer not to risk our corporate lives by supporting S.2812 as written.

Issue #1: DOE Decides What Will Be the Standard & Will Compete with Industry

A. The DOE should not be placed in the difficult position of competing with private industry, but that's what this bill will do. End of story and "game over" for private industry if this bill goes forth as written as it places the DOE in the untenable position of deciding which SMR design will be commercially successful. As you know, there are many factors that determine which commercial products will be successful. Is the DOE prepared to be a commercial judge?

B. Also, the bill (S.2812) says, "(4) Technical Considerations-In evaluating proposals, the Secretary shall take into account the efficiency, cost, safety, and pro-

liferation resistance of competing reactor designs." Our concern is the Hyperion Power Module is not optimized for efficiencyit is optimized for safety and security. DOE personnel might look at our design and judge it as non-competitive compared to other designs and select some less safe design because they are concerned about efficiency.

The NRC determines the safety and security of a reactor design. The market should decide which reactor designs will be successful, not the U.S. government. Quite frankly, and perhaps oversimplified, this is the American way—the government deciding what products to sell is most assuredly not.

Solution #1

The best solution to this issue in the current bill is to not allow any DOE reactor design in the competition unless it had been commercialized by the time this bill was announced (1 November 2009). Other solutions are to provide for up to ten designs. not two, or to not provide direct funds to any company, (our preference) and to instead alter the bill to really help the SMR industry by funding an NRC office of small reactors (see below).

Issue #2a: Previous Civilian Nuclear Programs Have Had Little Impact

Previous civilian nuclear competitions have been cited as a good argument for the structure of S.2812. However, following the 2005 Energy Policy Act, new 3rd and 4th generation nuclear programs involving existing large firms have had mixed results. The SMR firms, and especially Hyperion Power. have never requested government R&D funding (in fact we pay LANL to do work for us under a CRADA), nor has our industry asked the government to establish any commercial standards in our industry. All we have asked is for the NRC to be attentive to the needs of the marketplace.

Issue #2b: The SMR Industry is a REAL Opportunity for Small Business—Please don't kill it

You really must throw out what you know about the civilian nuclear reactor market as the SMR industry, with its roots in small business, is already breaking the Big Company stranglehold on civilian nuclear power innovation. For one thing, the SMR industry does not require the billions of dollars required by traditional (1,000MW) design firms.

Hyperion Power has taken the rough-formed design we licensed from LANL and completely altered it for the market. We'll get to market for less than $80 million—It should be self evident that an influx of tens of millions of government dollars will grossly upset this industry. To quote a phrase, if "you break it, you buy it" in the same way that the traditional large nuclear industry can't seem to survive without government subsidy. The nascent SMR industry does NOT need nor want direct government subsidy. It simply wants a chance to grow unfettered—without the threat of government-subsidized competitors.

Solution #2

If any government funds are to be directly granted to commercial partners, we ask that you consider these monies to be limited to existing small commercial reactor developers and not make those funds available to larger commercial films, such as B&W, nor foreign controlled firms such as Westinghouse, Toshiba, or GE-Hitachi.

Issue #3: It's Not Capital, It's the NRC

We have no issue, save one, raising capital for our firm: the issue is the apparent politics and "randomness" from the U.S. government regarding civilian nuclear power. S.2812 will only make this worse.

The development of Small or Modular nuclear power Reactors (SMRs) can provide an economic boost in manufacturing. Hyperion Power alone can create 15,000 jobs of a wide variety and generate $32 billion into the economy over 15 years. To compete in this industry and provide this benefit for the U.S. economy, we must be able to compete globally.

Hyperion Power has signed letters of intent from customers to purchase over 100 Hyperion Power Modules. Many of these customers, impressed as they are with our technology, have indicated they will purchase the first design to make it to market. It would be a shame to see yet another American industrial and employment opportunity lost to global competitors with more nimble bureaucracies.

To do that the U.S. must move faster. Our non-U.S. competitors will deploy units in 2013. Officials at the U.S. Nuclear Regulatory Commission have told Hyperion Power not to hope for licensing of SMRs "for several years."

Other official statements are just as troubling.

(1) NRC Chairman Jaczko

. . . would like to see the NRC make some final decisions during my time as Chairman;" and that he "would hope that by 2012 we've made substantial progress on reviewing at least one of the applications in front of us."

Interview with NationalJournal.com entitled "NRC at Center of Regulatory Roadblock," 11 September 2009

(2) Marvin Fertel, CEO, Nuclear Energy Institute

. . . licensing SMRs would "take away from the efforts of the NRC," American Nuclear Society, D.C. chapter meeting, October 2009

Clearly the establishment is against our little industry. Providing big commercial firms a token amount of money, along with the government deciding which commercial products are viable, will not solve this issue, and could in fact kill the SMR industry. Setting ridiculously long goals for licensing SMRs is equally crippling.

No help is better than this kind of help.

Solution #3

Provide $50 million in direct finding to the NRC to fund an SMR office and direct the NRC to begin evaluation of one or more commercial SMR designs by 2011. The NRC's existing policy is that a design must show it is commercially viable before they will start design certification: let that existing standard be the benchmark for which reactor is certified and keep the DOE out of the commercial market.

Issue #4: Hearing on 15 December 2009

We remain concerned about fundamental fairness, balance, and effective enquiry that will stifle the albeit "good intentions" of S.2812 and perhaps other bills by providing an unfair advantage to DOE projects. Hyperion Power and others are pouring millions of private capital into the SMR industry (and Hyperion into the DOE lab at Los Alamos). This concern was fanned by our inability to be heard at this week's Energy Committee's hearings on December 15. By his very presence Tom Sanders from Sandia National Laboratory was allowed to promote his SMR design at that hearing, but the two private companies that ignited the SMR industry were not able to voice their opinions and provide valuable information gleaned from the frontlines of the marketplace.

As you may know, Hyperion Power is a small business success story—a unique spin-out company from Los Alamos National Laboratory and a success story for the whole DOE complex. Why keep this story from the Committee?

Solution #4

As private industry was not allowed to speak at the December 15 hearings, we would like the US Senate Committee on Energy & Natural Resources to hold an additional hearing which would focus on the startups struggling in this new industry segment and invite executives from NuScale, Hyperion Power, and Adams Atomic Engines.

We would greatly appreciate the opportunity to meet with you in person in order to discuss our concerns directly.

The SMR industry did not even exist three years ago. I would hope you'd agree that it makes sense to hear from those of us who are responsible for creating interest in the industry when considering S.2812 or other bills related to SMRs.

I appreciate your attention to these important issues and look forward to a continuing dialogue regarding the best path forward for realizing the benefits of SMR technology for our economy, our security, and our global responsibility to help protect our environment.

Sincerely,

JOHN R (GRIZZ) DEAL,
CEO.

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