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HEARING ON S. 512, THE NUCLEAR ENERGY INNOVATION AND
MODERNIZATION ACT

Wednesday, March 8, 2017

United States Senate

Committee on Environment and Public Works

Washington, D.C.

The committee met, pursuant to notice, at 10:04 a.m. in room 406, Dirksen Senate Office Building, the Honorable John Barrasso [chairman of the committee] presiding.

Present: Senators Barrasso, Carper, Inhofe, Capito, Boozman, Wicker, Fischer, Moran, Rounds, Ernst, Sullivan, Cardin, Whitehouse, Merkley, Gillibrand, Booker, Markey, Duckworth, and Harris.

STATEMENT OF THE HONORABLE JOHN BARRASSO, A UNITED STATES
SENATOR FROM THE STATE OF WYOMING

Senator Barrasso. Good morning. I call this hearing to order.

I am a strong supporter of American nuclear energy. It is a vital component of our all-of-the-above American energy plan.

My home State of Wyoming plays a key role in the American nuclear energy supply by producing more uranium than any other state.

Nuclear energy is clean, safe, reliable, and affordable. It is also a major boost for the economy. American nuclear plants provide thousands of jobs and millions of dollars in benefits to local communities. U.S. nuclear power plants have run safely for decades, and many will serve our Country for years to come.

After decades of reliable power from our traditional nuclear plants, innovation is taking shape in the nuclear industry. Increased private investment in nuclear energy has led to advancements in safety, security, and cost. These advantages and advancements are exciting.

The biggest challenges these innovators face, however, are delays and costs from regulatory red tape. Many of these delays come from trying to navigate a regulatory system that was

developed around one specific technology, water-cooled reactors. Traditional water-cooled reactors have powered our Navy and our electricity grid for decades. Today's innovators are pursuing very different designs that are using high temperature gases, molten salts, and other high tech materials to advance the safety, efficiency, and reliability of nuclear energy.

The nuclear regulatory system needs to be updated to enable these innovations. That is why I am joined by my colleagues, Senators Whitehouse, Inhofe, Booker, Crapo, Fischer, Capito, Manchin, Casey, and Duckworth to introduce the Nuclear Energy Innovation and Modernization Act. This bipartisan bill seeks to modernize the Nuclear Regulatory Commission by providing a flexible regulatory framework for licensing advanced nuclear reactors.

The NRC needs a modern regulatory framework that is predictable and efficient. Reactor operators from both traditional and advanced reactors need timely decision-making from the NRC. At the same time, the Commission needs to maintain the ability to assess a variety of technologies and still meet its mission of ensuring safety and security.

Additionally, our legislation will update the Nuclear Regulatory Commission's fee recovery structure. This measure will bring increased transparency and accountability to the NRC, while improving the Commission's efficiency and timeliness.

This bill will also help preserve the uranium producers who are essential to powering this technology. The Energy Information Administration reported that uranium production in 2016 was at its lowest level since 2005.

One challenge that uranium producers face is the need for clear, predictable regulations. Under current law, the EPA sets standards of general application and the NRC implements these standards. Yet, there is no definition in the Atomic Energy Act for "standards of general application."

Paul Goranson, from Energy Fuels Company in Casper, Wyoming, submitted written testimony for today's hearing in which he states, "Clearly defining standards of general application, without reducing any oversight of the industry, would help clarify the roles and responsibilities of the EPA and NRC, reduce regulatory conflict, and provide for a more effective regulatory framework."

I am going to continue to work with other sponsors to address this more fully.

Finally, the bill addresses the Department of Energy's mismanagement of the public's stockpile of excess uranium. Since 2009, the Department has repeatedly violated its own written policy and written law when managing the public's excess uranium. As a result, the Department of Energy has failed to obtain a fair return on this uranium for American taxpayers.

For example, the Government Accountability Office found that the Department of Energy's transfer of excess uranium in 2012 may have actually cost taxpayers up to \$195 million. The Department of Energy's mismanagement has also contributed to volatility in the uranium market and has led to job losses in many States like my home State of Wyoming.

So I want to thank Senator Ed Markey and his staff for helping with these specific provisions. This bipartisan legislation will enable the development of innovative reactors with bold new technologies.

America needs to be a leader of nuclear development. We need to create an environment where entrepreneurs can flourish and create jobs here at home that will revitalize our nuclear energy sector. The Nuclear Energy Innovation and Modernization Act does just this. This broadly bipartisan bill will strengthen American energy independence, foster innovation and job creation.

With that, I would like to turn to the Ranking Member of the Committee, Senator Carper.

[The prepared statement of Senator Barrasso follows:]

STATEMENT OF THE HONORABLE THOMAS R. CARPER, A UNITED STATES
SENATOR FROM THE STATE OF DELAWARE

Senator Carper. Thank you, Mr. Chairman.

I yield my time to the Senator from Maryland, Ben Cardin.

Senator Cardin. I don't want your time, Mr. Ranking
Member.

Senator Carper. Five seconds of my time.

Senator Cardin. Thank you. Appreciate that.

As the home State for the NRC's headquarters, I ask consent
to put in my statement in regards to workforce challenges.

Senator Barrasso. Without objection.

[The referenced information follows:]

Senator Carper. Thanks so much.

Welcome, everybody. Delighted to see you again. Thank you for taking this time with us.

My colleagues have heard me tell this story before. I want to tell it again; I think it is appropriate.

Both my boys are, I am proud to say, Eagle Scouts and my wife and I are very much involved in their troop. I am a retired Navy Captain. I used to take our Boy Scout troop to Norfolk Naval Station about every three years to spend a weekend and to have a chance to climb over the ships, submarines, aircraft carriers, sleep in the barracks and even the galley; and it was a great adventure for them and, frankly, for all of us.

One day, one Sunday, we went and visited the Teddy Roosevelt nuclear power carrier and we had the opportunity, the captain of the ship came out to welcome us. We were up on the bridge and he addressed 25 scouts, 5 adults, and here is what he said. To the boys, he said, boys, when Teddy Roosevelt goes to sea, it is 1,000 feet long. The boys went, ooh. He said, boys, when the Teddy Roosevelt goes to sea, it is 35 stories high. And the boys went, ooh. And he said, boys, when the Teddy Roosevelt goes to sea, it has 5,000 sailors onboard. Five thousand. And the boys went, ooh. And he said, boys, when the

Teddy Roosevelt goes to sea, it has 75 different aircraft onboard. And the boys went, ooh. And then he finally added, and, boys, when the Teddy Roosevelt goes to sea, it refuels every 25 years. And the adults went, ooh.

[Laughter.]

Senator Carper. And I think that says almost not everything that we need to say, but a whole lot about what we need to say.

I agree very much with what our Chairman has said. A lot of people I served with in the Navy actually were on ships and submarines and aircraft carriers that were nuclear powered, and the safety record is good. We have to continue to focus on that not only at sea, but on land as well, and we have.

Today's hearing is very timely as the nuclear industry faces real challenge. The industry is what I describe as a crossroads, and which the path the industry decides to take will have ramifications on our Country and our citizens, I think, for decades to come.

Let me begin by noting that it is important to examine the benefits. There are many. The Chairman has mentioned a number of those, of nuclear energy. There are some drawbacks, as well, and we need to be honest about those and address them.

First and foremost, the energy from nuclear power plants helps curb our Nation's reliance on dirty fossil fuels and

reduces air pollution emissions that threaten our health and our climate.

Second, nuclear energy can be a major economic driver. Many Americans may be unaware that the United States invented nuclear technology. In fact, for many years our Nation led the world in nuclear manufacturing, construction, and production. The jobs and the economic benefits of this stayed here at home for the most part. Unfortunately, that is no longer the case.

If our Country decides to retake its leadership in nuclear energy, I hope we do, and is successful in that endeavor, history has shown there will be economic benefits in the form of manufacturing and construction jobs and, frankly, operating jobs.

It turns out there is, as we know, two test cases, examples in Georgia and South Carolina, real-life tests where the construction of two new reactors in each of those States has provided thousands of good paying jobs and spurred economic development in the surrounding communities.

Despite all the benefits of nuclear power, I should mention also some of the potential adverse consequences of nuclear energy. We have seen, from serious incidents like places in Fukushima, the damage that nuclear power can cause if the proper safety precautions are not in place, not up to date, and, most important, not adhered to.

With nuclear energy, safety has been, and must remain, a top priority in the operation of nuclear reactors. I salute everyone, whether it is the NRC, the folks in the industry themselves, everybody who has been involved to try to make sure that that safety record remains unblemished here in this Country.

Unfortunately, the costs of safety precautions, along with the costs of construction, operation, and maintenance of current nuclear reactors can be expensive, especially when compared to the costs of other sources of energy, including natural gas. In fact, some of the U.S. reactors are retiring, as we know, sooner than expected due to market forces.

At the same time, our Country's nuclear reactors are getting older and will need to be replaced in the years to come. Some people believe our Nation's nuclear success story is ending. They may be right, but I believe that success story may just be getting its second wind. I sure hope so. And if we are smart, we will replace our aging nuclear reactors with new technology developed in this Country that is safer, that produces less spent fuel, and is cheaper to build and to operate.

If we seize this opportunity, seize the day, the U.S. can be a leader once again in nuclear energy, reaping the economic benefits that flow from that leadership.

I am not the only one who sees the opportunity. U.S. companies have already invested in an estimated, I am told, \$1.5 billion in next generation nuclear technology, and today we will hear directly from General Atomics, a company that is investing in a design that is much smaller than current reactors, doesn't need water for cooling, is able to use spent fuel as a fuel, and is passive in design so that it will shut down easily if a significant concern rises.

As we will hear today, if this design works, this type of reactor may well be competitive in today's energy markets. This technology, like the dozens of other types of nuclear energy technology that are being actively researched, developed, and invested in today still face real material and design challenges before it is ready to be commercialized.

I should hasten to add that as companies like General Atomics make advances in the technologies, we need to make sure that our regulatory framework can keep pace. The NRC is considered the world's gold standard of nuclear regulatory agencies; however, as science and technology evolves, so must the NRC.

We also need to make sure that the NRC has the resources it needs to review these new technologies and ensure our current nuclear reactor fleet remains safe. At the same time, we must be conscious of how change to the NRC fee structure might impact

the funds required from taxpayers.

Finally, it is also important to remember that the current Administration wants to cut domestic spending to the bone, while increasing funding for defense and homeland security. If this Administration is successful, we may ultimately face a situation where there are insufficient taxpayer dollars for the NRC to work on advanced nuclear energy issues and meet its other responsibilities. We need to keep that in mind. I don't want to see that happen. I suspect that none of us in this Committee do either.

I believe advances in nuclear energy can help us sustain that nurturing environment for job creation, cleaner air for our people and our planet. We need that.

I want to again thank our Chairman and the cosponsors of the legislation he has mentioned before us for their work, the work of their staffs, and for working closely with my own staff. We look forward to building on that working relationship.

I am just happy to be here for a hearing on something we agree on. It is a good thing. We are having a series of hearings on things we agree on, and maybe we can get some good work done for this Country.

Thank you, Mr. Chairman.

Senator Inhofe. That is right. That is right.

[The prepared statement of Senator Carper follows:]

Senator Barrasso. Thank you very much, Senator Carper.

Would any of the original cosponsors like to be recognized?

Senator Inhofe.

STATEMENT OF THE HONORABLE JAMES M. INHOFE, A UNITED STATES
SENATOR FROM THE STATE OF OKLAHOMA

Senator Inhofe. Well, you know, it is hard for me to accept the fact that it was 20 years ago, 19 years ago that I became chairman of the subcommittee of this Committee that deals with nuclear energy, and I remember when I became chairman they had not had an oversight hearing before the NRC in 10 years. Now, you can't let a bureaucracy, no matter how wonderful everyone is, go without oversight. And, of course, we changed that; we became very active at that time.

I dramatically shortened my opening statement because they have already spoken for me. I agree with the comments that were made.

It is important for everyone to understand this is the second time around for this, because we introduced this bill last year, and last year we had Senators Whitehouse, Booker, Crapo, myself, and others working on essentially the same bill that we have.

Now, I have to say confession is good for the soul, and Senator Whitehouse and I don't always see eye-to-eye on every issue. That is a shocker to a lot of people, but on this issue we do. So it shows the broad base of support that we have, and I think this is the time that we can get it through. We didn't

get it through last time. It always surprised a lot of people, when I chaired this Committee, how many times Barbara Boxer and I agreed, and we got a lot of things done that we couldn't have otherwise, if it hadn't been for a close friendship. I could never sell her, though, on this one, so she opposed that. This time, I think, that is going to happen.

It bothers me, when I look at countries like China and Russia, to see that they are advancing ahead of us at this time. New technologies are out there. We know we can reach them. And this is what we have to pass to make sure that it does happen, so I am very enthusiastic about this. And I agree with you, Senator Carper, that it is a lot fun when we can work on issues that we agree on, so let's get it done.

[The prepared statement of Senator Inhofe follows:]

Senator Barrasso. Thank you very much, Senator Inhofe.

Senator Inhofe. One other comment I want to make. There are several members over here on this side that are also on the Commerce Committee, so we will be going back and forth, so you know why we are doing this at the same time.

Senator Barrasso. Any other cosponsors like to make a statement? Senator Whitehouse.

STATEMENT OF THE HONORABLE SHELDON WHITEHOUSE, A UNITED STATES
SENATOR FROM THE STATE OF RHODE ISLAND

Senator Whitehouse. I would be delighted to, Chairman. Let me first say that I believe I am now in the position, as Ranking Member on the subcommittee with Senator Capito, and I look forward to working with her to move this legislation quickly forward through the Committee, and, of course, with our Chairman and Ranking Member.

I want to particularly thank Senator Inhofe and Senator Crapo, who are the two opening cosponsors on the Republican side, along with myself and Senator Booker. Senator Fischer is here, and I am delighted that she has joined us as a cosponsor of this legislation; and, of course, Chairman Barrasso is now a cosponsor of this legislation. So I think we have a good opportunity to move forward and get it done.

To me, one of the elements of this that is most attractive is the potential down the road for advanced nuclear technology to begin to direct its attention to our existing nuclear waste stockpile and find a way to turn it from a massive and unbooked liability for this Nation into an asset for this Nation. If that scientific achievement can be reached, all of our work will not have been in vein and very good things will have been done.

Mr. Chairman, I would just like to close by recognizing Dr.

Ashley Finan, who is here from Jamestown, Rhode Island, a particularly beautiful part of our State, and I am very pleased to have her here and thank her for her work advising us on this legislation.

Thank you, Chairman. Thank you to the Ranking Member.

[The prepared statement of Senator Whitehouse follows:]

Senator Barrasso. Thank you very much, Senator Whitehouse.

Thank you, Dr. Finan, for being here as well.

Senator Fischer.

STATEMENT OF THE HONORABLE DEB FISCHER, A UNITED STATES SENATOR
FROM THE STATE OF NEBRASKA

Senator Fischer. Thank you, Mr. Chairman, for convening this hearing. I am very pleased to be able to cosponsor this Act. At a time when we see it is hard for us to agree on things, it is nice to be part of a bipartisan effort.

I am especially pleased with the addition of the new uranium recovery provisions that strengthen the bill and provide benefits to my State. We have a nuclear plant in the southeast corner of Nebraska and we have a uranium mine in our western panhandle.

So this bill will make regulatory reviews more efficient and costs more predictable without compromising safety. It also enables the licensing of advanced technologies, which can revitalize our industry and ensure that nuclear energy is a robust energy source for decades to come.

So I am glad to be here today, Mr. Chairman. I thank you again for the hearing. I am eager to hear what the Committee will have for consideration of the bill. Thank you.

[The prepared statement of Senator Fischer follows:]

Senator Barrasso. Thank you, Senator Fischer.

Senator Whitehouse. May I ask for unanimous consent?

Senator Barrasso. Senator Whitehouse, yes, please.

Senator Whitehouse. Senator Lamar Alexander is another Senator who is keenly interested in nuclear advancements, and he and I wrote together an op-ed at the end of last year, and I would like to ask unanimous consent that that editorial piece by the two of us be included in the record of this hearing.

Senator Barrasso. Without objection.

[The referenced information follows:]

Senator Barrasso. I also ask unanimous consent to submit a statement from Senator Crapo, a long-time member of this Committee, into the record. Without objection.

[The referenced information follows:]

Senator Barrasso. We will now turn and hear from our witnesses. I would like to start with Maria Korsnick, who is president and CEO, Nuclear Energy Institute.

Thank you so much for joining us.

STATEMENT OF MARIA KORSNICK, PRESIDENT AND CEO, NUCLEAR ENERGY
INSTITUTE

Ms. Korsnick. Thank you very much, Mr. Chairman. Good morning. I am Maria Korsnick, President and CEO of the Nuclear Energy Institute. And on behalf of the nuclear energy industry I want to thank the Committee for considering the Nuclear Energy Innovation and Modernization Act. We are very pleased that this bill is being reintroduced and are grateful for the opportunity to testify about the important matters that it brings today.

Our operating nuclear plants are the backbone of the U.S. electric system and a critical part of our Nation's infrastructure. Nuclear energy is the largest and most efficient source of carbon-free electricity in the United States. We currently have 99 reactors in 30 States that produce 20 percent of our Nation's electricity and approximately 63 percent of our carbon-free electricity. Nuclear produces electricity 24/7, regardless of weather, and with all its fuel onsite for 18 to 24 months.

Nuclear energy facilities are essential to the Nation's economy and to the local communities in which they operate. Collectively, the nuclear industry contributes about \$60 billion every year to the U.S. economy, supports over 475,000 jobs, and produces over \$12 billion a year in tax revenue, both Federal

and State.

I am proud to report that since I last testified before this Committee last year, a new reactor has begun to operate in Tennessee. And, as you know, an additional four reactors are under construction, two in Georgia and two in South Carolina, and these are expected to come online in 2019 and 2020. The current nuclear fleet is a significant contributor to the Nation's infrastructure.

The newly constructed plants will likely provide valuable electricity for 80-plus years, and future nuclear innovations in the form of a variety of advanced design reactors are being developed to meet the needs of our society well into the next century.

But, for that to happen, the industry must be able to rely on a safety-focused, efficient, and technically expert regulator. That requires strong and focused leadership from the Nuclear Regulatory Commission.

Because the Senate is responsible for confirming qualified candidates to serve on Federal agencies, we wish to emphasize the importance of maintaining a five-member NRC board. The work of this agency should be conducted as Congress intended, with five commissioners. As the Commission currently has two open seats and potentially faces the lack of a quorum by the end of June, we do urge the Senate to act swiftly on Administration

nominations.

We commend the bill's sponsors for taking the NRC's untimely, somewhat outdated and unnecessarily costly, regulatory process. The need to reform has become more pressing as companies are beginning to submit the NRC applications for certification of small modular reactors and development of advanced non-light water reactors are looking for their deployment within the next decade.

For years, the industry has raised concerns regarding the NRC's fee structure, only to be told by the NRC that its hands are tied by the current law. This bill makes several long-overdue changes to the NRC's fee recovery structure. It repeals the 90 percent fee recovery requirement and replaces it with a more predictable, transparent, and accountable fee recovery process that also ensures that the agency continues to be sufficiently funded to carry out its important safety mission. The legislation would create greater accountability and transparency by requiring the NRC to expressly identify annual expenditures anticipated for licensing and for other activities requested by applicants.

The legislation also would help drive greater efficiency in the NRC's operation. In turn, it would drive down annual fees by limiting the corporate support to 28 percent. The industry supports this provision and we believe there is an opportunity

to reduce this percentage even further.

Complementing the limit on corporate support, the bill would cap annual fees for operating power reactors at the fiscal year 2015 levels. We commend this approach and we strongly believe that the cap should apply to all licensees, including uranium recovery and other fuel cycle facilities.

The bill also affirms Congress's view that this Country can, and in fact should, be a leader in advanced reactor technology. The bill directs the NRC to think differently about reactor licensing. It requires them to accommodate light water reactors, small modular reactors, and advanced non-light water reactors; in short, an all-of-the-above approach.

This bill directs the NRC to resolve the central issue standing in the way of innovation. In sum, we need to start planning today if we are going to meet the enormous demand for U.S. technology at home and abroad.

On behalf of the nuclear energy industry, I would like to thank Chairman and Senators Whitehouse, Inhofe, Booker, Crapo, Fischer, Capito, and Manchin for their commitment to innovation and to retain clean, reliable, and constant nuclear electricity. We look forward to continuing to work with you and your staff as the legislation progresses through the Congress, and I encourage you to enact the legislation expeditiously. Thank you.

[The prepared statement of Ms. Korsnick follows:]

Senator Barrasso. Well, thank you very much for your thoughtful testimony.

Dr. Finan.

STATEMENT OF DR. ASHLEY E. FINAN, POLICY DIRECTOR, NUCLEAR
INNOVATION ALLIANCE

Ms. Finan. Thank you, Chairman Barrasso, Ranking Member Carper, and distinguished members of this Committee. Thank you for holding this hearing and for giving me the opportunity to testify. My name is Ashley Finan, and I am Policy Director for the Nuclear Innovation Alliance, a nonprofit organization dedicated to leading advanced nuclear energy innovation.

The NIA was established by a cross-cutting group of innovators, academics, environmental organizations, industry groups, and other experts and stakeholders who believe that advanced nuclear energy is needed to ensure a better future. The world will double or triple its energy demand in 30 years, driven by the emergence of a middle class in the developing world and the need to bring electricity to 1.4 billion people who lack it today. At the same time, many analyses point to the pressing need to drastically reduce global carbon emissions if we are to avoid the worst impacts of climate change, and clean air is essential to human health.

A more rapid expansion of nuclear power is a vital part of the solution. In the United States and elsewhere, dozens of innovative start-up companies are pioneering advanced nuclear designs that offer opportunities for increased safety and

affordability, resistance to proliferation, and a reduction in nuclear waste. These designs can revolutionize the nuclear industry and revitalize U.S. exports with products that take advantage of the latest manufacturing and competing technology, that are competitive in markets across the globe, and that exceed the expectations of customers and the public. But the transition from design to commercialization and deployment, both in the U.S. and globally, has been slow.

Current NRC regulation confronts the licensing of advanced technologies with two major challenges. First, NRC approval calls for enormous front-loaded investment during a protracted development and licensing phase, without a staged structure to provide applicants with clear, early feedback on an agreed schedule. Second, current regulation primarily evolved to oversee light water reactor technologies. It must be adapted to the features and performance characteristics of advanced reactors, which rely on substantially different fuels, cooling systems, and safety strategies, and use novel operating approaches.

Over the past three years, the NIA has been developing strategies to facilitate the efficient, cost-effective, and predictable licensing of advanced nuclear power plants in the U.S. These strategies are based on consultations with nuclear innovators, safety experts, former NRC staff and commissioners,

members of the financial community, and other nuclear industry stakeholders. We compiled the results of some of our work into a report called *Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing*, which was issued in April 2016. The report has been provided to the Committee and is available to the public on the NIA website. It discusses in much greater detail the points that I am touching on today.

To address the LWR-centric nature of the current regulations, a more technology-inclusive approach is needed. A risk-informed, performance-based licensing approach will allow the NRC to review a diverse set of advanced reactor technologies. This would incorporate both modern methods of risk assessment and traditional deterministic methods to provide an exhaustive safety review. The Nuclear Energy Innovation and Modernization Act, or NEIMA, provides for the NRC to do work in this area without impacting the costs incurred to the existing plants.

To address the investment challenge, the NIA recommends that the NRC offer a staged approach, one that would be more aligned with private sector development of innovative technology using a licensing project plan, topical reports, and other existing mechanisms; and one that would offer clear and early feedback to investors and developers through an optional conceptual design assessment. This approach maintains the rigor

and high standards of the NRC and facilitates the development of safer nuclear technology that produces less waste, or even consumes it.

This approach can be achieved using existing regulatory tools at the NRC, with some adjustments on the development of additional guidance. The NRC has already begun doing this work, and has made considerable progress in the past year, but they have done so with extraordinarily limited resources. NEIMA authorizes the NRC to do the crucial work to further develop and implement this staged licensing process with dedicated funding.

When NEIMA was first introduced in this Committee in 2016, the bill was subjected to useful critiques and several concerns were raised and addressed. It ultimately passed out of Committee with strong bipartisan support. The bill under consideration today is stronger for that and I hope that the same support will be evident in 2017.

This is an important bill that will enable the NRC to develop the rigorous, technology-inclusive regulatory infrastructure to support the review of advanced nuclear energy technologies without diluting funds used to regulate operating plants. It also allows for immediate adjustments that will provide a more efficient, predictable, and effective process. The Nuclear Energy Innovation and Modernization Act is needed to enable progress in advanced nuclear energy.

Thank you for this opportunity to testify. I would be pleased to respond to any questions you might have today or in the future.

[The prepared statement of Ms. Finan follows:]

Senator Barrasso. Thank you very much for your testimony,
Dr. Finan.

I am glad you could join us today. I would like to next
turn to Dr. Tina Back, who is Vice President of Nuclear
Technologies and Materials at General Atomics.

Welcome.

STATEMENT OF DR. TINA BACK, VICE PRESIDENT OF NUCLEAR
TECHNOLOGIES AND MATERIALS, GENERAL ATOMICS

Ms. Back. Chairman Barrasso, Ranking Member Carper, thank you very much for the invitation to appear here today. I also thank the bipartisan group of Senators for introducing the Nuclear Energy Innovation Modernization Act, NEIMA, and for their interest in advanced nuclear reactors.

General Atomics is a high technology company that has long history of innovation in nuclear energy, which is detailed in my written testimony. Our long-term vision is embodied in GA's advanced reactor concept, the Energy Multiplier Module, or EM2. It has arisen from RD&D, Research, Development, and Demonstration, which has informed and shaped our beliefs of what nuclear innovation can achieve.

In the near-term, the vision is brought into sharper focus through projects such as Accident Tolerant Fuel, ATF, and Moly 99. ATF makes existing reactors less subject to a Fukushima-like event and more economically viable. The Moly 99 project establishes a domestic source of a medical isotope. Ultimately, both grew out of EM2 research and development and, in return, both deepen the skills and understanding needed to make EM2 a reality.

It might be helpful to explain why we believe nuclear power

is critical for the energy future and the national defense of the U.S.

Nuclear power is the largest source of baseload clean energy available to our Nation.

At present, there are no U.S.-owned commercial vendors of nuclear reactors. Furthermore, the supply chain of nuclear grade materials and components has either gone offshore or gone out of business. This is in stark contrast to vigorous nuclear industries in China, Russia, and Korea. Unless the U.S. is able to stimulate its near-dormant nuclear industry, we will be one of their future customers.

On the bright side, there is a strong, nascent effort in U.S. private industry to innovate nuclear technologies. NEIMA will help us do that. There are many concepts that require different materials and technologies to advance beyond the light water reactors of today, all of which need NRC approval. The NRC is an important and necessary agent in ensuring nuclear power remains safe.

If the U.S. is to proceed, it will require the support of our Government through regulatory support like that proposed in NEIMA and also through financial support of R&D. It may also benefit from mechanisms like public-private partnerships to foster new generations of nuclear scientists and domestically-held intellectual property.

For the U.S. to be a leader in nuclear energy, General Atomics believes our Country must do what it does best, bring the ingenuity of the people to bear on creating new ways to produce nuclear energy safely, cleanly, and at much lower cost.

So what exactly are nuclear reactors that are advanced? Advanced reactors are those that improve over existing reactors in the following four core objectives: they must produce significantly cheaper and cleaner electricity; be safer; produce significantly less waste; and reduce the risk of proliferation.

These seven improvements identified in NEIMA are consistent with these core objectives. We believe every worthy advanced reactor concept must address these four core objectives jointly. It is not sufficient to address one at the expense of the other three.

My written testimony provides details on how EM2 leverages engineered ceramic materials and leapfrog technologies to meet these four core objectives.

As with any new reactor design, this one will require extensive interactions with the NRC. Ideally, interactions would occur early enough to inform the initial design and produce a safer reactor design. Then, when applying for a license, this early effort would pay off many times over.

Radically new concepts employing new technologies require upfront investments involving some risk. Some investments may

not pay off, and even those that are successful could require at least 10 years to produce any revenue. While General Atomics has already invested more than \$40 million in EM2, these commercial realities make it very difficult to justify early costs to engage the NRC.

If the Committee's objectives are to stimulate development of advanced reactors and technologies, then we suggest it would be relatively inexpensive to involve NRC in the early phase of development for potentially high impact. We suggest the Committee authorize the appropriation of \$5 million at first, growing to \$15 million over five years, to provide the NRC services. To trigger funding, a relatively low cost-share of 3 percent could be required.

Thank you for your interest, and I hope that you can all come to San Diego and visit our facilities. There you could see our science in action and understand why we at GA are so optimistic about the future of advanced nuclear reactors. We are at the cusp of some significant scientific discoveries that are within the reach, with a bit of Government support.

I would be pleased to respond to any questions.

[The prepared statement of Ms. Back follows:]

Senator Barrasso. Well, thank you very much, Dr. Back, for your thoughtful testimony. We appreciate you being here.

I would like to next turn to Dr. Edwin Lyman, who is the Senior Scientist for the Union of Concerned Scientists Global Security System.

Dr. Lyman, thank you for joining us today.

STATEMENT OF DR. EDWIN LYMAN, SENIOR SCIENTIST, UNION OF
CONCERNED SCIENTISTS GLOBAL SECURITY SYSTEM

Mr. Lyman. Thank you. Good morning. On behalf of the Union of Concerned Scientists, I would like to thank Chairman Barrasso, Ranking Member Carper, and the other distinguished members of this panel for the opportunity to testify today on NEIMA and its potential impacts on nuclear safety and security in the future.

UCS puts rigorous, independent science to work to solve our planet's most pressing problems. We are neither pro- nor anti-nuclear. But we do believe that nuclear power must meet high standards of safety and security if it is to be a reliable option in the future.

This Saturday marks the sixth anniversary of March 11, 2011, the day when a massive earthquake and tsunami in Japan triggered the triple core meltdowns at the Fukushima Daiichi nuclear plant. We know when the disaster started, but we cannot predict when it will end, because its legacy will affect the Japanese people for decades to come.

Today, the direct economic impact is estimated at almost \$200 billion, approximately 80,000 people remain displaced from their homes, contaminated water continues to flow from the site into the sea every day, and the interiors of the three damaged

reactors are so intensively radioactive that even the robots sent in to explore are quickly disabled by the radiation.

The accident had a significant impact on Japan's use of nuclear power. It now only has three operating reactors, and it pays handsomely for imported natural gas to meet its electricity demand. A similar accident in the U.S. would almost certainly compromise the future of nuclear power in this Country.

Fukushima serves as a graphic reminder of the consequences of complacency. The nuclear industry and its regulators seriously underestimated the risk from natural disasters and did not adopt safety measures strong enough to mitigate those risks, so the urgent need to ensure such a nuclear disaster does not happen again provides the context for my remarks today.

UCS testified on an earlier version of this bill last year. The current version of the legislation has some changes that we believe have improved it, and, as a result of those changes, we do not oppose the bill. But neither do we support it, because we still find its basic approach problematic from a safety and security perspective. We also question the need for the legislation. We don't believe it is going to be effective in actually facilitating the deployment of advanced reactors.

One of our main concerns is the promotion of a "risk-informed" licensing strategy. We do not believe that risk-informed licensing is appropriate for new and novel designs.

The computer models used to calculate risk need to be thoroughly validated by comparison of results with actual plant operating experience before you can rely on them to do licensing, and such experience is not available for new reactor concepts.

To focus licensing on new reactor designs is to introduce an unacceptably high degree of uncertainty in the process. So in this light we appreciate that the current version of NEIMA requires that NRC develop strategies for implementing risk-informed licensing only where appropriate. And this phrase effectively provides the NRC with full discretion to confine the use of risk-informed licensing to those areas where it determines it is appropriate, and it is our expectation that there will be few, if any, aspects of advanced reactor licensing where they will make that determination.

There is also a question about which designs may clearly fall under NEIMA's definition of "advanced reactor." I agree with Dr. Back that advanced reactors should improve upon the current generation in a whole variety of different ways, and that there should not be tradeoffs of one improvement for another.

But, in our assessment, none of the advanced reactor designs that are currently under discussion, at least non-light water reactors, actually will achieve that. Liquid metal-cooled fast reactors, high-temperature gas-cooled reactors, and molten

salt reactors all introduce new and novel safety and/or security issues relative to light water reactors that may ultimately outweigh any improvements they provide. And this is also true for small modular light water reactors like NuScale.

For example, deployment of any advanced reactor that requires reprocessing and separation of plutonium or other weapon-usable materials will increase the risks of nuclear terrorism and nuclear proliferation, and that includes any reactor that claims they can consume spent fuel for electricity. So I would really recommend the Committee look deeper into what it means to actually consume spent fuel.

The Transatomic Power reactor is an example. The company promoted the idea that its molten salt reactor could consume spent fuel, and actually they had to backtrack recently when it turns out their analysis was wrong.

This isn't to say that TAP is necessarily a failure, but it illustrates the development of advanced reactors cannot be rushed and that early optimism may well be tempered by later results.

It takes a long time and a lot of money to develop advanced nuclear reactors, and a number of studies have demonstrated that. NRC licensing is not the chokepoint or the bottleneck in that process; it is the need to develop the necessary technical basis to convince the regulator that a reactor design is safe.

And you can't short-circuit that process, so that is the main reason why we are concerned about the emphasis of this bill in trying to accelerate or bypass the critical safety functions of the agency

I will conclude there, and I appreciate and welcome your questions. I apologize for exceeding my time. Thank you.

[The prepared statement of Mr. Lyman follows:]

Senator Barrasso. Well, thank you very much for being with us, Dr. Lyman. Thank you for your testimony.

I would like to next turn to Allison Bawden, who is the Acting Director for Natural Resources and Environment with the Government Accountability Office. Thank you very much for joining us.

STATEMENT OF ALLISON BAWDEN, ACTING DIRECTOR FOR NATURAL
RESOURCES AND ENVIRONMENT, GOVERNMENT ACCOUNTABILITY OFFICE

Ms. Bawden. Chairman Barrasso, Ranking Member Carper, and members of the Committee, thank you for inviting me to discuss GAO's work on the Department of Energy's management of excess uranium.

The Department of Energy regularly undertakes sales and transfers of uranium from its excess inventory. This inventory largely resulted from years of Government enrichment activities prior to 1992 and is considered a national asset.

DOE has a responsibility to effectively manage the excess uranium inventory on behalf of the American people, who paid for it in the first place.

When DOE conducts transactions in uranium, it is legally obligated to ensure these transactions will not result in adverse material impacts to uranium markets and that it receives reasonable compensation for its uranium.

A portion of DOE's excess uranium inventory is in the form of depleted uranium tails, which historically have been considered waste. However, under certain market conditions, tails may have value. For example, tails can be profitably re-enriched when the price of natural uranium is high, because the re-enrichment bypasses the early stages of the nuclear fuel

cycle, including mining of uranium ore.

Today I will discuss findings from GAO's prior work on three aspects of DOE's management of its excess uranium inventory. I will also comment on how provisions of the Nuclear Energy Innovation and Modernization Act address legal concerns we have raised.

First, DOE has contracted with a private firm for market impact studies to help it determine whether planned uranium transactions will result in adverse material impacts to uranium markets. The Secretary of Energy is legally required to make these determinations.

In 2014, we found the DOE could not be assured of the quality and reliability of two market impact studies because, despite requirements to do so, DOE did not take steps to address their technical quality and the studies did not include sufficient methodological information to assess the reasonableness of their conclusions. Both studies, however, concluded that DOE's transactions would not have an adverse material impact on domestic uranium markets.

We recommended that DOE take steps to ensure the quality, credibility, and transparency of any future uranium market impact studies, but DOE neither agreed nor disagreed with this recommendation.

Second, even though DOE is legally required to receive

reasonable compensation for its material, in May 2014, we found that DOE did not have guidance for valuing tails. We also found that DOE has inconsistently valued tails when it has sold or transferred them. For example, in 2005, DOE charged a price for tails. But in 2010 DOE transferred tails to a company without charge, despite an estimated value for the transferred material of up to \$300 million.

In May 2014, we recommended that DOE develop consistent and transparent valuation methods that maximize the value the Government derives and provides predictability for uranium markets. DOE disagreed with this recommendation.

There continues to be commercial interest in purchasing DOE's tails, which we last valued in June 2014 at about \$1 billion.

Third, since 2006, we have concluded that DOE's uranium transactions have, in some cases, violated Federal law. Our legal opinion is that DOE likely does not have authority to sell or transfer tails because of specific prohibitions imposed by amendments to the Atomic Energy Act.

We have suggested that Congress consider clarifying DOE's legal authority to sell or transfer tails. Also, in reporting on certain transactions where DOE has paid for services with uranium, we concluded that DOE's legal authority to conduct barter is unclear and that DOE violated the miscellaneous

receipts statute. This statute requires an official or agent of the Government receiving money from any source on the Government's behalf to deposit the money into the Treasury.

We suggested that Congress consider clarifying DOE's authority to conduct barter and to retain the proceeds from such barter.

Provisions included in the Nuclear Energy Innovation Modernization Act would address the legal concerns GAO has raised. The bill clarifies DOE's authority to transact in depleted uranium tails and provides DOE with authority to barter. The bill does not authorize DOE to retain the proceeds from barter.

The bill also addresses concerns we raised about assuring quality for market impact studies by requiring them to undergo peer review.

This concludes my statement, and I look forward to your questions.

[The prepared statement of Ms. Bawden follows:]

Senator Barrasso. Well, thank you very much. I appreciate all of you being here. We are going to proceed with questions at this time, and I would like to start with you, Ms. Bawden, if you would.

First, I wanted to commend you and commend your team for the good work that you have done in bringing to light the Department of Energy's mismanagement of the public stockpile of excess uranium. I want to thank you also for the technical help that you and your team have provided to me and to Senator Markey as we drafted these provisions.

In your testimony, you explain that Federal law requires the Department of Energy to assess whether its forthcoming sales and transfers of excess uranium would impact the uranium market.

For years, the Department has relied on a contractor to assess whether the Department's sales and transfers of excess uranium would impact the market, but your team has found that the Department has not taken steps to ensure that the contractor performs quality analysis of that market.

In the process, the Department has ignored the terms of its own contract and its own information quality guidelines, and I think this is critically important.

On Monday, the Casper Star Tribune in Casper, Wyoming ran a front-page story entitled State Uranium Operators Are Facing a Global Glut. The State uranium operators facing a global glut.

We need to know whether and to what extent the Department's proposed sale or transfer of excess uranium will hurt America's uranium producers. So my question to you is what should the Department do to assess the quality of its contractor's work?

Ms. Bawden. There are many actions DOE could take to ensure that it fully understands the basis for its conclusions included in its secretarial determinations that uranium transactions will not have an adverse material impact on the market. First and foremost, we have recommended that DOE take steps to technically evaluate the studies for which it contracts to ensure the reliability of the conclusions of those studies.

We have also recommended that another way the Department could evaluate the quality of those studies is to put them through peer review.

We have also recommended that the studies should include sufficient information on their methodology and their assumptions so that others can assess the veracity of those studies' conclusions.

Senator Barrasso. Could I just follow up? How would this bill improve the quality of the market impact analysis that the Department prepares for itself or contracts others to prepare for it?

Ms. Bawden. The bill includes provisions that require the studies to be subject to peer review, and that is consistent

with our recommendation to the Department.

Senator Barrasso. Thank you. Thank you very much.

Ms. Korsnick, in 2018, my home State of Wyoming is going to become an NRC agreement State, which, as you know, allows Wyoming to assume responsibility for regulating uranium recovery. When that happens, the total number of uranium facilities that the NRC oversees is going to shrink from 11 to 3. So that means that there are only going to be 3 facilities left to shoulder all the costs of the NRC Uranium Recovery Office.

You noted in your testimony how the decline in the number of NRC licenses increases the fee burden on those licensees who are remaining. Do you believe this problem is a result of a faulty fee recovery system?

Ms. Korsnick. Yes, that is a concern for us. It is very similar to when plants decommission, as an example, the same burden is raised on the other plants that continue to operate. So that is why, in this bill, there is a cap structure that is established, which we think directly applies to this concern and would help ameliorate that effect.

Senator Barrasso. Terrific. The performance in the report and reporting provision in our legislation directs the NRC to expressly budget for the funding necessary to complete license reviews requested by the applicants and licensees. The bill

also directs the NRC to establish transparent schedules to complete each requested review along the way.

So would you please describe the benefits of these provisions toward improving the timeliness and the predictability of the reviews?

Ms. Korsnick. We think that is very important. Right now, the process is much less predictable from a licensee perspective in terms of the amount of time that the NRC would need to review products, etcetera. So we think that this helps improve that transparency and the predictability from a licensee perspective. It is a step in the right direction.

Senator Barrasso. Thank you very much for your comments.

Senator Carper.

Senator Carper. Mr. Chairman, I notice a number of the guys up here on the dais are wearing red ties and some of the folks in the audience are wearing red as well, and today is a day where we specially recognize the contributions that women continue to make in even greater ways.

I think Senator Inhofe mentioned earlier today that about 20 years ago he was the chairman of the subcommittee on Clean Air and Nuclear Safety, and held the first oversight hearing, I think, for NRC that had been done in maybe 10 years. It has been interesting to see the lineup of the witnesses 20 years ago. My guess is it looked a little different then.

We are happy to see all of you, and thank you for your contributions and those who you represent in a very important way.

I want to start off and ask my first question. There are a lot of things in the legislation that we are here talking about that I think commend it to all of us, but what might be one thing that each of you would change in the bill? What would be maybe one thing you would like to see changed in the legislation?

We will just start right here. Thank you.

Ms. Korsnick. One thing that we would like to see changed from what is?

Senator Carper. Everything I do I know I can do better. I have not written the perfect bill yet, and my guess is this one probably is not perfect either. Maybe one thing that you would like to see changed as we go forward.

Ms. Korsnick. I think there are some provisions in the bill relative to baffle bolts and some emergency planning zone issues that we feel have been addressed and were not necessarily needed for the current bill. That would be one example that we think that would be something that could be removed.

Senator Carper. All right, thank you.

Dr. Finan? Do you pronounce your name Finan?

Ms. Finan. Finan, yes.

Senator Carper. Good. Thanks.

Ms. Finan. Thank you.

Senator Carper. I never want to get to the end of the hearing and find out we have been mispronouncing your name for the last two hours.

Ms. Finan. Okay.

I think something could be added to make the bill stronger. One thing that would be helpful is if the research and test reactors were able to recover more than 50 percent of their operating costs through providing services like irradiation and tests and power and electricity or heat. That would potentially make the case for private funding of demonstration projects stronger and reduce the amount of Government matching funds that might be needed there. So I would suggest that as a possible addition.

Senator Carper. All right, thank you.

Dr. Back? Not Back. It looks like Back, but is pronounced Back.

Ms. Back. Thank you very much. Yes.

You know, I would like to stress the fact that innovation actually brings advantages that you can't always foresee, but one of them in the case of advanced nuclear reactors is to reduce the cost and to actually foster innovation. So I would like to see, in this bill, maybe a strengthening of the ability

to look at cost-share from an industry point of view. As I pointed out, it takes 10 years or more, potentially, for technologies to give some kind of payoff. That is much longer than any private company will take on, and so we are not asking for a free ride, but a fair look at the cost-share and the contribution, especially early in the phase for the NRC regulations, would be a huge help to all of the companies that are working on advanced reactors.

Senator Carper. All right, thanks, Dr. Back.

Dr. Lyman, if you have an idea you would like to share with us, please do. One improvement you would like to see made in the legislation.

Mr. Lyman. Thank you for your question. UCS believes that the NRC does need regulatory reform, but it would be in the direction of strengthening safety and security, rather than weakening it. In particular, the post-Fukushima reforms that the NRC has enacted do not go as far as we would like. In particular, the Commission rejected a recommendation of its own task force to reform the regulatory structure to increase the defense in depth, that is, extra layers of protection in regulations. So, you know, as part of the larger package, we would like to see an enhancement of NRC's regulatory framework to account for defense in depth in its regulatory decisions in a more formal way.

Senator Carper. All right. Thanks, Dr. Lyman.

Allison Bawden.

Ms. Bawden. Thank you.

Senator Carper. Let me say we so appreciate the work that you and your colleagues at GAO do for us and applaud your efforts on behalf of our Country. Thank you. But go right ahead.

Ms. Bawden. We appreciate it. Thank you.

I don't know that I would characterize this as something GAO would like to see changed, but we have suggested that the Committee could consider using a percentage-based cap in the bill for the amount of uranium the Department of Energy is authorized to transfer, rather than a hard cap. We have suggested that to the Committee. It may provide additional flexibility.

Senator Carper. All right, thanks.

One last question for Dr. Back. It has been, I think, about a year since the Obama Administration announced efforts to assist the research development and deployment of advanced nuclear reactors. Could you just give us a quick update on how things are going, please?

Ms. Back. Sure. I would be happy to do that.

We have been very appreciative, industry has been very appreciative of opportunities that now are available to get some

grant funding. Those have not been large, but there have been some that we have been able to take advantage of, and that has helped us develop some of these critical technologies that are allowing much higher temperature resistance, superior neutron irradiation tolerance; and those kinds of efforts have led to beginnings of standards that are being developed to treat accident-tolerant fuel, as well as future materials that are able to withstand much greater temperatures and much greater conditions, harsh conditions in the reactor.

So those areas we would like to see more of, but we are very appreciative of what exists. It has helped in the crosscutting, looking across all the reactors. But those opportunities are few and far between.

Senator Carper. All right, thanks.

I am going to slip out right now. I will be back. We have another simultaneous hearing going on in Homeland Security, but very much appreciate you being here, your thoughtful testimony, and your responses.

Senator Inhofe. [Presiding.] Thank you, Senator Carper.

Ms. Korsnick, we are in kind of a situation now, and you have heard me talk about this before, that the last 10, 15 years we have seen the workload or proposed workload in anticipation of growth in nuclear energy go up and down and up and down. Now, it was Reagan that said there is nothing closer to life

eternal on the face of this earth than a government agency once formed. Well, the same thing is true with the expansion of an agency. When the workload of this agency looked like it was going to be going up, we prepared for that and then it didn't happen. And there are a lot of political reasons why it didn't happen. I am thankful that I think we have overcome those now.

In the year 2000, the NRC got its work done with 2,800 people and \$470 million. Now, with 3,300 people and twice the amount of money, \$905 million, it oversees six fewer reactors, half as many as the materials, licenses and reviews anticipated. The GAO commented on this. They said by 2011, however, it had become clear that the projected growth had not materialized. NRC's budget and its regulatory fees, however, have not declined since that time.

So what is your thought on that? I know a lot of people on this side of the table are thinking, well, the stakeholders are going to be paying for this more than just Government. But, nonetheless, that is a fact that we have anticipated, growth. And, of course, it didn't happen and yet Government just grew. What are your thoughts about that?

Ms. Korsnick. Well, I agree with your sentiments, Senator. We do understand why the NRC staffed-up. They did staff-up significantly, as you suggest, and if you look at the details for the bill, the cap is capping it at a 2015 level, which we

think is a high watermark, if you will, so more than sufficient for the agency.

Senator Inhofe. Well, I wasn't really referring just to this bill. I am just saying that this is history now. This has happened. We didn't shrink any when our workload was considerably reduced in the past.

Now, I am concerned about the caps, and that was addressed by the Chairman in his questions. And I think it is a good idea to go ahead and get on record where we are going to be at that time, where we anticipate. Do you think that under 512, that the caps are realistic? I want to get on record now and say that we are going to be able to do it within those caps?

Ms. Korsnick. Absolutely. I think that there is clearly room for the agency to be more efficient than it is today. They have done some work in their Project Aim. I would say this bill institutionalizes some of the thinking that they are doing under Project Aim, and I think the caps within the bill are clearly achievable.

Senator Inhofe. Okay. That is good to hear, and we will get that on the record.

You know, as we watch, I mentioned in my opening statement the concern I have over the fact that we are not operating in a vacuum, there are other countries that are maybe even passing us up. I would like to have any one of the witnesses respond to

where do you think we are right now with China and Russia.

Why don't we start with you?

Ms. Korsnick. I guess I will start with that. I would tell you that there are 60 reactors being built around the world today, and two-thirds of those reactors are being built by Chinese and Russian design, and I think that is a significant concern that we, in the United States, need to take a look at the leadership level that we want to play in a world conversation relative to nuclear. It is not only that we have the technology and the best designs; we have the best standards on how to operate these reactors. And when you get engaged in the conversation about these reactors being operated in other countries, those standards and those nonproliferation requirements go with it, and that is something that is significant, should be very significant to us.

Senator Inhofe. Yes.

Anyone else want to comment on that, as to where we are with our competition? Yes, ma'am.

Ms. Back. I would just like to add, also, that in, for instance, China, they are pursuing every kind of advanced reactor in R&D and hopefully, from their point of view, to a demonstration plant, and the challenge with this is that the governments, for instance, Japan also, are sponsoring the research that is being done. So it is very difficult to compete

at a fair level.

Senator Inhofe. Yes, that is a good comment.

Any other comments?

Mr. Lyman. Yes, I appreciate the opportunity. I do agree with Ms. Korsnick that domestic U.S. standards, including NRC regulations, are the gold standard, and that is why we believe it is very important to maintain those standards and not engage in a race to the bottom. So of Russia and China, you know, Russia is the country that brought us Chernobyl, and my understanding is that China's own regulatory process, including the process for qualifying fuel, is not nearly as rigorous as the United States. So I think we need to maintain those standards, and that is the best selling point we would have.

Senator Inhofe. I think that is good. I don't want to race to the bottom, either, but I think it is important for us to talk about the fact that there is competition out there and other countries are doing things more aggressively than we are. So I think we are all in agreement on that.

Senator Whitehouse?

Senator Whitehouse. Thank you, Chairman.

First, can I say I am delighted that we have been joined by Senator Booker, who is my co-lead sponsor on our side.

Let me ask, first, Ms. Korsnick, is there value to the carbon emissions-free nature of nuclear generated power? And,

if so, are nuclear power plants compensated for that value?

Ms. Korsnick. There is absolutely value, and, no, they are not compensated for it.

Senator Whitehouse. I consider that to be kind of a market deformation. How does that market deformation work out in practice in the nuclear market?

Ms. Korsnick. So the challenge we have today is that the marketplace just values electricity. It values the capacity and it values the product, but it doesn't value whether or not you have a carbon-free nature or if you have any other impact to the environment. And as you know, from a clean air energy, as we look at nuclear, you know, there are asthmas, issues in terms of health for people and there are also impacts on the environment, things like acid rain. So nuclear power is very environmentally friendly; doesn't produce any of those. In the marketplace we have today, that is just simply not something that is valued. So many of the States are using individual solutions and out-of-market solutions right now that they are using to value that, and that is becoming a challenge for the marketplace, and I know that is something right now that we are working with our members to see what it is that we can do to, in effect, come up with a more holistic solution.

Senator Whitehouse. Well, I look forward to working with you. I think Chairman Alexander has a similar concern. And if

there are ways we can find to compensate safely operating nuclear plants for the carbon-free nature of their power, that creates, I think, a level playing field for nuclear power, which is now disadvantaged by the fact that it gets no benefit for that.

My other question is similarly an accounting question. Very often accounting is policy. As I understand it, we don't have a liability on the books of the United States for the out-year cost of dealing with our stockpiles of nuclear waste. If we were a company and we had that liability, we would have to report it to our shareholders, and management would take a look at that liability and say, oh my gosh, that is a real drag on earnings, that is a real out-year risk for our shareholders. We better pay attention to that; we have to figure out what to do. We might even pay somebody to figure out how to reduce that liability, because there would be value in reducing the liability.

When we don't adequately account for the liability we have of all the nuclear waste we have stockpiled, then there is no economic rationale for spending money to try to move to the point we talked about earlier, which is is there a technology out there, or is there the potential for a technology out there, that could rid us of the liability for our nuclear waste stockpile by actually figuring out, through innovation, how to

turn it from a liability into an asset, and find a way to turn it into a safe nuclear fuel.

Would you comment on the liability accounting of all of this and how that acts out in your world?

Ms. Korsnick. Yes. I guess I would just frame it by saying that all of the used fuel is being safely stored today. It is not a technology problem; it is a political problem that we need to appreciate and make decisions on where we want to ultimately store this fuel. And as you heard earlier today, what we consider a challenge today, or trash today, or used fuel today, in the future I am sure we will look at it as a resource. So what you consider a liability today, depending on new technology, can quickly become an asset for the future.

Senator Whitehouse. And last question to Drs. Finan and Back, who are technical experts here. Is that a prospect worth pursuing?

Ms. Finan. Absolutely. And many of the innovative companies today are pursuing that. So I think we need to be supportive of them so that they can achieve that goal.

Senator Whitehouse. Dr. Back?

Ms. Back. Yes, I agree. Many people do consider the waste at the back end. When we were looking at EM2 and designing the reactor, we took that into consideration to be able to use the spent nuclear fuel in light water reactors regenerated and

reformed into a fuel that the EM2 reactor could use. And in doing that you are gaining back all of the energy that would usually just put stored in waste and just sit there and not be reused, so we are not putting more effort into taking new natural resources, but we are actually using the waste as fuel.

Senator Whitehouse. Thank you, Chairman. My time has expired.

Senator Inhofe. Thank you, Senator Whitehouse.

Senator Rounds. Thank you, Mr. Chairman.

Ms. Bawden, I would like to follow up on what Senator Whitehouse was just talking about. In your GAO report you actually identify the fact that there are tailings and so forth that are the property of the United States Government today, and that there appears to be a commercially viable alternative to simply storing them and that there has been an interest in purchasing those tailings. Could you share a little bit about your report and what you are finding actually in today's marketplace with regard to those tailings?

Ms. Bawden. Thank you for your correct. The last time we valued the Department of Energy's inventory of tails was in June 2014, and we put that value at about \$1 billion. We have reported over the years that sometimes certain types of tails may be able to be re-enriched, and when that occurs basically the tails are used as the feedstock for enrichment, rather than

natural uranium that has been converted. That has occurred on several occasions, re-enrichment has occurred, and most recently the Department of Energy issued a press release stating that there is commercial interest in purchasing a significant amount of the Department's inventory.

Senator Rounds. So there has been a private entity which has made an inquiry to our Department requesting the opportunity to purchase tailings, correct?

Ms. Bawden. That is correct.

Senator Rounds. And at the same time we don't have a process in place in which we can facilitate the negotiation of the sale of that in any type of a regulated manner, is that a fair way to put it?

Ms. Bawden. So we have had a legal opinion in the past that says we do not believe the Department of Energy has authority to transact in tails. The Department has disagreed with that legal opinion, and the bill before us today does address that issue.

Senator Rounds. Thank you. Let me ask another question. In your May of 2014 report you recommended that for each uranium transaction that it conducts, that DOE should publicly identify the legal authority that it relies on for that transaction. You went on to indicate that there were times in which there had been transfers of uranium, a product owned by the Federal

Government, that had been delivered to a third party that we apparently had a contract with and we owed money to. And instead of paying the bill with cash, we bartered it out by giving them uranium instead, and that they were then allowed to sell the uranium and that was our way of completing the transaction through DOE.

Can you talk a little bit about what that does to the accounting process and keeping track of where the money goes in an asset of the Federal Government that has been converted at this point?

Ms. Bawden. It is confusing. So what we have said in the cases of those transactions that we reviewed that we believe there was a miscellaneous receipt statute violation, and that the Department of Energy should have deposited in the Treasury the net proceeds of the sale of that uranium. It did not, and that continues to be a legal disagreement between GAO and DOE.

Senator Rounds. Do you have any idea as to the size of that transaction in terms, if we converted it to cash like we would normally do if we were going to have a transaction that could be followed, what size was that transaction?

Ms. Bawden. Well, there have been several of those transactions. We looked at the first in a legal opinion we issued in 2006 and then there were others that we looked at in a report in 2011. I don't know the current value of that, but we

would be happy to look into that for the record.

Senator Rounds. Would it be fair to say that if a department such as DOE wanted additional resources that they could utilize, they can sell an asset of the United States Government, basically fuel, they can sell it to a third party or transact it to a third party, rather than paying cash, which would be part of their budget, and they then have additional excess cash available to do what they want with or to cover other expenses as they see fit?

Ms. Bawden. The Atomic Energy Act and amendments to it does authorize DOE to transact in certain types of uranium. But what we believe is not allowed is DOE's authority to retain the proceeds from those transactions. And in these cases that is what we believe DOE has done, and that is why we included an opinion that said there was a miscellaneous receipts statute violation.

Senator Rounds. In other words, what they should have done is deposited it back with the United States Treasury.

Ms. Bawden. That is correct. And not having done so, they would have supplemented their appropriation.

Senator Rounds. Are you aware of any other department that transacts business like this that is currently allowed to keep the resources that we could follow? I know in your recommendation you suggested actually that rather than simply

slapping their hands for doing it, you suggested that we amend the laws in place today so that they could do that in the future.

Ms. Bawden. We suggested that the lobby clarified one way or the other. There are examples across the Government where Federal agencies are allowed to retain proceeds from various things, but I personally don't know of any Federal agencies that transact in this way.

Senator Rounds. Thank you.

Thank you, Mr. Chairman.

Senator Inhofe. Thank you, Senator.

Senator Markey.

Senator Markey. Thank you, Mr. Chairman.

Ms. Korsnick, before we discuss next generation reactors, I have a question about how we can ensure that the current nuclear fleet is secure against terrorism. The 2005 Energy Policy Act includes a provision which I authored that mandates that the Nuclear Regulatory Commission conducts security inspections at U.S. nuclear power plants. The reason I built that in, obviously, is the terrorist attack on 9/11, where two planes were hijacked from Logan Airport that flew into the World Trade Center. So my goal was to make nuclear power plants more secure.

The inspections must include force-on-force exercises where

a mock adversary terrorist force conducts a simulated attack on a power plant to probe potential gaps in the plant's security. These exercises allow the NRC to ensure that nuclear power plants are adequately protected against terrorists or other bad actors.

The alternative, having plant operators run their own exercises, would not only violate the law, but it would create a clear conflict of interest and undermine public safety.

In the past, the Nuclear Energy Institute lobbied the Nuclear Regulatory Commission to get rid of its force-on-force exercises in favor of exercises conducted by the owners of the power plant. In effect, this would have nuclear power plant operators inspecting themselves.

In December I wrote to the NRC to explain that implementing such a proposal would not only be dangerous, but also illegal. In response to my letter, the Nuclear Energy Institute stated publicly that it did not support getting rid of the NRC's force-on-force exercises.

But at a recent public meeting, the Nuclear Energy Institute appears to have shifted its position yet again and now says that it might support getting rid of NRC-run security evaluations in favor, instead, of letting the owners of the plant do their own inspections.

Could you clear this up? Which side of that issue is the

Nuclear Energy Institute on?

Ms. Korsnick. I can share that we are currently conducting these force-on-force exercises. I am familiar with those. I know that there has been some work with the industry working with the NRC to see if we could do these in a more efficient way, rather than the way that they had been conducted.

Senator Markey. Do you support that the Government ensure that it is done independent of the owner of the plant, or do you support letting the plant operator do it? Which position do you take? There are two different positions here just in the last couple of months.

Ms. Korsnick. What I am familiar with is that it is done independently. I will let you know that --

Senator Markey. Independently of?

Ms. Korsnick. That there is an independent force that conducts these, that the NRC observes this independent force on this force-on-force exercise. That is how it is done today. I do know that there are folks that are looking at our security right now.

Senator Markey. So you support the continuation of NRC-run force-on-force exercises, is that correct?

Ms. Korsnick. That is correct. That is what we do today. I do know that there are people looking --

Senator Markey. Do you support that position being

continued?

Ms. Korsnick. I do support that, but there are folks that are looking at it. If, in the future, they come up with a recommendation, we will evaluate it, but that is how it is currently being done today.

Senator Markey. Well, the reason that we have the goal of having the plant operator not inspect itself is the same reason that you don't have take-home exams in school, that not only do you take it at home, but then you give yourself your own grade. There would be a disproportionate number of A-plusses that students would give to themselves for the work which they were doing. So you need an independent way of looking at the safety issues, especially post-9/11, post-Tsarnaev brothers in Boston, as well, on Marathon Monday.

So I urge you very strongly, Ms. Korsnick, to have the Nuclear Energy Institute adopt the position which you did at the end of last year, that there should be independent inspections to make sure that these plants can withstand a terrorist attack, and it is not just done by the plant owners themselves, who will want to have, necessarily, a stake in lowering the cost that they would have for trying to protect these plants.

So I can't urge you strongly enough that we learn this lesson in Boston, on 9/11, and then with the Tsarnaev brothers. They are coming; they have plans. Nuclear is at the top of

their list; nuclear weapons coming in from overseas, nuclear power plants in the United States. If they don't have the kind of security that protects against a successful terrorist attack, then we are going to see them try to penetrate the loose standards that some of these power plant owners will put in place.

So I thank you, Mr. Chairman, and I yield back the balance.

Senator Inhofe. Thank you, Senator Markey.

Senator Fischer.

Senator Fischer. Thank you, Mr. Chairman.

Ms. Bawden, I would like to follow up a little bit on Senator Rounds' questioning that he had with you. In your testimony, you mention the miscellaneous receipts statute. Can you please expand on the purpose of the statute and how it protects Congress's power of the purse under the Constitution and why the American public should care whether the Department of energy violates that law?

Ms. Bawden. Essentially, the miscellaneous receipts statute requires that any money the Government receives be deposited in the Treasury. When that doesn't happen, an agency has essentially augmented its appropriation or used money that Congress didn't give it, and this circumvents Congress's power of the purse, which, as you stated, is its constitutional responsibility.

In the cases that we have looked at with respect to uranium transactions the Department of Energy has carried out, DOE paid for certain services in uranium rather than paying for them with appropriated funds, and in our legal opinion did so without authority.

Senator Fischer. So what are the consequences if the Department has violated that statute?

Ms. Bawden. It is difficult to determine the consequences. Miscellaneous Receipts Act violations can be resolved if Congress were, for example, to retroactively approve what the Department did or for the Department of Energy to adjust its books to reflect the uranium that it essentially provided as an obligation against its budget authority. It has not done either of those things. So it is possible, if the Department of Energy obligated more money than it was appropriated, that it could be viewed as having an Anti-Deficiency Act violation, which does carry with it penalties, civil and criminal penalties.

But we believe that Congress could ask DOE for more information about this issue to really try to understand its scope. For example, Congress could ask DOE to provide the total value of the uranium it has traded and look at that with respect to its obligational authority. There are also appropriations levers that could be used.

Senator Fischer. So Congress does have some tools to be

able to address this.

Ms. Bawden. Yes.

Senator Fischer. And do you think they are appropriate at this time or do we need to look at augmenting them?

Ms. Bawden. I haven't looked at that issue.

Senator Fischer. Okay. Thank you.

Dr. Finan, I understand that there are several advanced reactor technologies that need uranium enriched up to 20 percent, and this is higher than the standard 5 percent enrichment currently used in operating reactors. Can you tell me more about the situation?

Ms. Finan. Sure. Thank you for the question, Senator.

There are many of the advanced reactor companies who will need to use enriched uranium that is low enriched, but is between 5 and 20 percent, and currently we don't have a domestic supply chain for that fuel because there hasn't been a demand. So that is essentially the situation. It is possible that they could obtain the materials internationally, but that is not the preferred option.

Senator Fischer. So it is not available right now in the commercial market?

Ms. Finan. It is not.

Senator Fischer. And is the Department of Energy's uranium surplus, is that the only source that we have?

Ms. Finan. It is the only domestic source currently.

Senator Fischer. Domestic. Which is the preferred method that we should be looking at, right?

Ms. Finan. Right, right. So it would be a very promising way to provide a bridge for those early movers to have the fuel that they need to do their development work before commercial enrichment capacity is established in the U.S.

Senator Fischer. Thank you very much.

Ms. Korsnick, to follow up on the line of questioning we just had here, how long would it take to establish a commercial fuel supply with the enrichment necessary to meet the needs of the advanced reactors that we are looking at?

Ms. Korsnick. For that higher enrichment, very much what Dr. Finan just said, we would look to the down-blending of the highly enriched uranium as sort of a stopgap measure, and we would need that until enough of a market develops that there would be a commercial opportunity. Once there is investment at a commercial level, we are estimating probably in the neighborhood of 7 to 10 years, but that is after the decision has made to pursue it. So I want to be careful there. It is not 7 to 10 years after people start needing it; it is after somebody has made a commercial commitment to actually pursue it. And in the meantime we think down-blending the HEU is the best approach.

Senator Fischer. And it is appropriate that the Department would be able to supply that, do you think?

Ms. Korsnick. It would. I think we need to look at this current bill and some caps that were put in place. We would think that the caps would not apply to the down-blending.

Senator Fischer. And in the bill before us, S. 512, it directs the NRC to examine the feasibility of extending the duration of uranium recovery licenses, and your testimony states that you believe 40 years would be appropriate. Can you explain why?

Ms. Korsnick. Yes. It is very commensurate with other facilities, we think, the 40-year timeframe. For example, when you license a reactor, that comes in a 40-year license. And the risk associated is much less with the facilities that we are talking about. So we think it is very commensurate with the risk that a 40-year license would be very appropriate.

Senator Fischer. Thank you very much.

Thank you, Mr. Chairman.

Senator Barrasso. [Presiding.] Thank you, Senator Fischer.

Senator Booker.

Senator Booker. Thank you very much, Mr. Chairman. And let me just say, to begin with and echoing the comments of Senator Whitehouse, how grateful I am that we have a tremendous

bipartisan bill together. It really is a testimony to this Committee and our ability to work together, and I just want to thank Senators Inhofe, as he walks out, and thank you, sir, always for your leadership, and Barrasso, Capito, Fischer, as well as Senator Duckworth and Manchin, who are now all cosponsoring what I think is a very strong bill. In fact, I think it is an urgent bill.

Nuclear energy, right now, is critical, if not vital when you look at the larger energy picture in the United States of America. Not only is it from the perspective especially from us Democrats here, about the challenges, crises we are facing from the bleaching of coral reefs to, as was mentioned already, the extraordinary high asthma rates in communities like mine. But it is also urgent when it comes to the global security perspective and the competition we are seeing in nuclear energy, and what is happening with those scientists who are many ways being developed more so in China or Russia than here in the United States.

Right now we all know that nuclear energy provides a very, very critical aspect of our non-carbon-producing power. We did the right thing in a very important negotiation in 2015, when we extended tax credits for wind energy and solar energy and, as a result of having 7 years of predictability, we saw a boom in investment in this area, literally creating thousands and

thousands of more American jobs. And it was the right thing to do, especially if you look at, as Senator Whitehouse was saying, the impact of carbon and the cost of carbon. But we did not include nuclear energy as a result.

Now, the crisis we have is the fact that if you look at wind and solar, we still have nuclear power, baseload, critical baseload power, which now compromises about 20 percent of the total U.S. electricity generation and more than 60 percent of our Nation's carbon-free electricity. It is a powerful component. And to have these plants closing down and having us move, as a Nation, away from nuclear energy really threatens our ability to do carbon-free, to reduce our carbon-producing, polluting-producing energy sources.

So right now in the United States, though, the good news is that there are dozens of private sector companies that are moving forward and making billions of dollars in investments in advanced nuclear designs that could lead to the next generation of reactors. I confess, when I first read about advanced nuclear, I thought I was reading science fiction and not science fact, because these reactors are far more safe to not have a lot of the challenges or problems; actually eat the spent nuclear fuel of current generation reactors.

So we really need long-term policies that are going to support the existing fleet, but also support the development and

upscale of advanced nuclear technologies. So that is what the urgency is right now.

I think some of the issues that Senator Markey was bringing up are critical. We need to always be doing everything safely. But if we are going to move forward and embrace a carbon-free future, we are not going to get there quick enough relying on solar or wind; nuclear has to be a critical part of it. And, again, looking at the critical global security issues and competition issues, this is a space that we don't want to give the advantage to other nations.

So I want to thank everyone who joined together on trying to design a bipartisan bill. It creates a regulatory regime that still focuses on safety, but also focuses on creating a regulatory environment for us to lead. And my hope is, I think what Senator Whitehouse was hinting at, is we start looking at valuing the carbon contributions or, I should say, the non-carbon contributions of nuclear as well as thinking of ways to create tax policy in the way we did with solar and wind in this space.

But very quickly I would like to just put a question to Dr. Finan on a concern I have about the first-of-the-kind technologies, people that are moving in this advanced nuclear space that is really, I think, critical right now and exciting. There is an issue for the first-of-the-kind technologies that

there is a significant design review costs in this space, both pre-application and post-application. These costs can be higher and less predictable than for subsequent projects. So I want to know, Dr. Finan, do you see this as a problem and can you talk about how the DOE matching grant program in this bill could really help solve that problem?

Ms. Finan. Yes. Thank you for the question. Many of the advanced nuclear companies have cited these review costs as a major challenge to their commercialization. I think that the grant program will help to address that, as similar programs have for the AP 1000 and for the NuScale project.

Senator Booker. So this is a first step. But looking at the future, this really exciting technology in the nuclear space, are there things that we can do to expand on the DOE grant program in this bill and make it actually more effective, if you were sort of advising us?

Ms. Finan. I think that there are. The current language authorizes that that grant program can be used to defray NRC fees. You could expand that to allow it to be used for applicant costs in preparing and pursuing the applications, as has been done in the SMR program; and that might be more effective.

Senator Booker. Thank you very much. And then there are clearly these economic reasons, which I have discussed, why we

want to develop these next generation nuclear technologies, or safety reasons why we want to embrace these next generation nuclear reactors here in the United States, but can you talk about some of the other reasons why this is so critical and what risks we face if we don't allow these technologies? What is exciting you about it and what are the risks for not moving forward?

Again, I feel like a nerd now when I go around sort of talking about the exciting next generation nuclear technologies, so I am hoping that you can confirm me so I can clip this part right here and my friends don't think I am weird for talking about it so much.

[Laughter.]

Ms. Finan. Absolutely. Well, the U.S. has been a leader in nuclear energy since the dawn of technology, and we are actually starting to cede that leadership, as has come up a couple times today. Many would argue we have ceded it to Russia and to China and others, but we have an opportunity here with this future before us to seize that role back and to really regain that leadership role so that we have influence on non-proliferation discussions and on best practices and safety and environmental issues globally. And I think that is a key thing that we will lose if we don't maintain leadership here.

Just one other point is that if we don't support our

domestic innovators, some of these technologies might not be developed at all, or they could be supplanted by designs developed elsewhere, where they don't necessarily prioritize safety the way that we do here.

Senator Booker. And if you could just clarify for me, in terms of, again, Senator Whitehouse is one of the leaders on this issue of trying to create a carbon-free future in energy. To get there quickly, what is the role that nuclear must play if we are going to get there in 10, 15, 20 years?

Ms. Finan. Nuclear needs to play an enormous role. We have a huge increase in energy demand globally that we are going to see, and we can't keep those people from having energy. We need to have everyone have energy abundance for human health and economic growth, and nuclear really is available and ready to play a role in providing that energy globally, without any carbon emissions or criteria pollutants.

Senator Booker. And so from India, which is still embracing coal power plants left and right, China still starting new coal power plants left and right, if we get this technology right, if America leads on it in this space, we can really be the leaders in proliferating and really helping to stop this continued reliance on dirty fuel.

Ms. Finan. Right. We can bring great opportunity to developing countries so that they can have clean, abundant

power, but also help our economy here at home with abundant exports of our technology.

Senator Booker. And is the safety of advance nuclear excite you as much as me? Does it?

Ms. Finan. Absolutely. I think that one of the biggest amazing things about advanced nuclear is the prospect of being able to have a plant that does not have impacts outside the site boundary in an accident. I think that is a critical characteristic for advanced nuclear plants to meet.

Senator Booker. Thank you very much. Please, more caffeine in your next hearing so you can be as jazzed as I am about this.

[Laughter.]

Senator Booker. And, Dr. Back, really quick, I am excited about the work that you and your team are doing over at General Atomics. In your testimony, you touched on advanced reactors can be safer than existing technologies. Could you just elaborate on that safety as the last point? Thank you.

Ms. Back. Yes. This gets to your excitement about new technologies. I mean, we start with a fiber that is a silicon carbide fiber. We make it into a weave and then we solidify that by depositing silicon carbide in between. That makes something that is called a silicon carbide composite that is much more resistant to the neutron radiation and also can go to

more than two times the temperature of metal zircaloy, for instance.

So that fundamentally changes the game for safety because you can not only avoid accidents in areas where you had meltdown in Fukushima of the fuel and the fuel rod, but also you reduce the generation in hydrogen so you don't have explosions like at Fukushima. Also, that allows you to burn the fuel more efficiently; you can go to higher temperature. That allows you to generate more electricity from the same amount of heat. So, for instance, for EM2, we can generate 60 percent more energy from the same amount of heat.

And there are simple things with technology where you can borrow and build on other technologies, for instance, moving from a steam generator to a gas turbine also jumps you enormously from light water reactor plant is sort of bounded by 33 percent efficiency. When you use gas turbines, you can jump up to 53 percent for our particular design. There are other designs that use gas turbines, but also make other advantages in technologies that allows you to burn fuel more or, in the case of safety, which I shouldn't forget, we started EM2 before Fukushima happened, but it turns out the silicon carbide material that we use is exactly used. It is important for light water reactors for the same reasons it is for EM2, which is that it is more resistant at temperature and you can avoid these

problems that happen at Three Mile Island and Fukushima. These would not have been problems where you would have to walk away from the reactors.

Senator Booker. Thank you very much.

Thank you, Mr. Chairman.

Senator Barrasso. Thank you, Senator Booker.

Senator Capito.

Senator Capito. Thank you, Mr. Chairman.

And thank all the witnesses.

I would like to address both my questions, really, to Ms. Korsnick. In the GAO report on the NRC's fee recovery process, one industry stakeholder indicated a lack of understanding as to how the fees actually relate to the NRC's budget. You talked a lot about this in your written statement. Another noticed a mismatch between the activities in the NRC budget and the activities the staff actually performs.

So are the structural problems with the NRC's fee recovery a recent development or has the industry had longstanding concerns about the fee structures?

Ms. Korsnick. We have actually had longstanding concerns, and I know we have had conversations that date back, I don't know, to the early 1990s, I believe, talking about the concerns that we expressed. We do think that this bill is a step in the right direction in terms of creating more transparency and

making it much more clear in terms of where money is being spent. You mentioned a report. There was also an Ernst & Young report that was done in terms of the amount of money that the NRC spends on their corporate costs, so through the provisions in this bill I think there is more clarity in terms of how much money would actually be spent on those corporate costs, which is something that is of much interest to the industry.

Senator Capito. I guess a very simple question, when I was reading some of the background on this issue, in terms of corporate costs, is that another name for administrative fees? Do you know what those corporate costs are that they are devoting, what is it, 32, 33 percent of their budget to?

Ms. Korsnick. It is a wide range of things; human resources, administrative costs, building fees, for example, where the offices are located. There are information systems costs, etcetera. So it is a variety.

Senator Capito. It is a variety. Okay.

So you just mentioned that you think that S. 512 would go a long ways toward the transparency. I have the GAO report here, which recommends greater transparency. So you are satisfied that this is necessary to get that transparency and equity that you think would make this fee structure much more fair and transparent?

Ms. Korsnick. Absolutely. Step in the right direction.

Senator Capito. Well, thank you. S. 512 also directs the NRC to expressly identify the funds necessary to work on reviews requested by licensees and applicants, and I understand that one of the issues is, as plants decommission, it then gets the last man standing, fees go up. Could you talk about that a little bit?

Ms. Korsnick. Yes. And that is why the provision in the bill relative to the cap is important to us, because, as we spoke earlier to your point, as plants decommission, it raises the price, if you will, on the plants that remain, so the cap structure that is put in in this provision in this bill would help ameliorate that effect.

Senator Capito. Could you say affirmatively that this wouldn't compromise any safety or security issues around any of the plants?

Ms. Korsnick. Absolutely. And the reason I would give you for that, first of all, the level that it is capped at is the 2015 level, which is a high watermark in terms of the amount of money; and in the same token, if there is some, I will say, unforeseen event that for some reason the NRC would feel the need to go higher than the cap, there is a provision in the bill for them to make that appeal in that case. I would find that, obviously, very remote, but there is a provision in the bill should that be necessary.

Senator Capito. Right. Thank you very much.

Senator Barrasso. Thank you, Senator Capito.

Senator Harris.

Senator Harris. Thank you.

To Ms. Bawden, as you know, the San Onofre Nuclear Generating Station in San Diego, California was nationally scrutinized, beginning in 2012, for concerns over the radioactive leaks and potential fire concerns, and I can tell you, living close to that community, many families, many children very concerned about the health consequences of what happened there. And the Nuclear Regulatory Commission then began its investigation, which ultimately led to the decommissioning, as you probably know, in 2013, of the station. Still, there are concerns that of the almost 3.6 million pounds of radioactive nuclear waste that was left behind, that there could be significant risk to the 65,000 residents of the San Clemente area and its surrounding communities.

So from the GAO's perspective, has the Nuclear Regulatory Commission sufficiently overseen what is going on in that area and in particular the work of Southern California Edison and its process for handling the nuclear waste?

Ms. Bawden. I appreciate that question. Unfortunately, I am not GAO's expert on NRC regulation. I came today --

Senator Harris. What have you heard around the office?

[Laughter.]

Ms. Bawden. That is a great question. No, I would be happy to provide the details on GAO's work for that for the record.

Senator Harris. Okay, I would appreciate that. And as soon as possible, because, obviously, it is a big issue for the folks who are there.

Ms. Bawden. Absolutely.

Senator Harris. In addition, GAO issued four reports between 2003 and 2011 which cited the Commission's regulations were "too weak" in their ability to ensure safety and security for the nuclear power plants, and also the concern about their ability to monitor the underground pipe leaks and their ability to enforce fire protections, all issues that apply to many places but, in particular, San Onofre, from my perspective.

Do you think that there are existing regulations that the Commission should strengthen or others that the Commission should consider before we start having a discussion about expediting licenses to advanced nuclear energy projects?

Ms. Bawden. Again, I very much appreciate your question and I will provide a full response to it for the record.

Senator Harris. Okay. And thank you.

Ms. Back, one of my general concerns about how nuclear waste is disposed of is that even if there is some of it that

remains, it presents a serious challenge and harm to the health of the people in that community. Last year, in an interview with the San Diego Tribune, you stated that General Atomics' new Energy Multiple Module, which you have mentioned, EM2, could decrease the amount of nuclear waste by 97 percent, which is laudable, compared to a traditional nuclear reactor. So although, of course, that is encouraging, what will completely eliminate the nuclear waste that is produced?

Ms. Back. That is a tough challenge, but the way that we reduce the amount of waste is we I don't want to say burn, because you are not really making a flame, but you are using up the fuel, you are consuming the fuel when you start to generate heat which then turns into electricity. If you generate at higher temperatures and you generate or you run the fuel for a longer time -- in EM2 we use the fuel for 30 years -- then you can burn up, if you will, the radioactive elements that are having long life radioactive decay, also short life. But if you then use that fuel and reconstitute it and then take it through the reactor again, then you can burn more. After multiple cycles is how you get to a 97 percent decrease.

Senator Harris. So what about that remaining 3 percent? Let's talk about that.

Ms. Back. So that remaining 3 percent, there is still some part you will have to put into a geological disposal. That will

be much, much smaller volume. If you look at the amount of volume from reducing it to 97 percent less, it is hardly comparable.

Senator Harris. So what do you imagine the future will look like in terms of our ability, based on the research and the science that we are engaged in, what could it possibly look like that we would be able to completely eliminate that remaining 3 percent? What would need to happen?

Ms. Back. I think in the end you still have to dispose of it as a geological waste. So there will be some small amount that you will still have to dispose of.

Senator Harris. Do you foresee that incrementally we will get to the point that we will at some point reduce that number to 2 percent and 1 percent, or have you determined that 3 percent is pretty much the end? Pardon the pun.

Ms. Back. No, I am never going to second-guess science; there are too many discoveries that have happened.

Senator Harris. Of course.

Ms. Back. And new technologies that maybe are able to do something in the future that we can't imagine now. But today I would say that that 3 percent is going to have to go into a geological waste. But I think that should be kept in contrast with the huge amount of waste that you see generated for other power sources. So this is an extremely efficient use, where you

are taking a large atom, uranium, it is splitting, you are getting out energy.

You know, the footprint of a nuclear reactor, for instance, compared to a solar array, which basically we can't get States that will give us a large enough amount of surface area because it is just not possible; the technology is not able to compensate. So replacing that 20 percent of nuclear energy that is going to be retired, I personally can't see a way to do that right now. So, to me, nuclear has to be a part of the diverse mix of energy sources. I think it is also good for the Nation, for national security, and this is, I think, something that we, as a Country, have to make a decision to invest the money and the technology to really be able to make these hurdles.

I mean, if you look at the comparison of, I have used this before, but it is just too simple to see. If you look at your telephone from the 1950s and you look at your iPhone today, I mean, you could never have imagined that it could grow by leaps and bounds there. Nuclear technology has not really fundamentally changed since the 1940s and 1950s, when it was developed, so I think probably there is not a person in this room that couldn't imagine that you could make improvements and make them safely. I mean, we value the NRC. We believe that they should exist and we believe they should be regulated, and we think that advanced reactors can fit within that envelope

easily. We have to be given a chance and it takes time to prove these things out, but that doesn't mean that we shouldn't start now.

Senator Harris. Thank you.

Senator Barrasso. Thank you very much, Senator Harris.

Senator Duckworth, thank you for being a cosponsor. If you would like to have some additional time to make an opening statement as well as the questioning, please feel free.

Senator Duckworth. Thank you, Mr. Chairman.

Well, I would like to thank the Chair and Ranking Member for convening today's hearing. I also want to commend Chairman Barrasso for your leadership in developing this legislation in a transparent and bipartisan fashion. I am very proud to cosponsor this bill that seeks to modernize how we regulate the nuclear industry.

My constituents get a significant amount of energy from nuclear sources. Illinois's 11 reactors, the most of any State, generate half of the State's electricity. We also have 3-D activated reactors.

But that is only half of the story. These facilities are major job creators in my State. Illinois's nuclear energy facilities employ nearly 6,000 high skilled workers and, on average, each reactor has an annual payroll of \$40 million a year, and Illinois facilities pay almost \$300 million in State

and local taxes. These are good jobs, and my mission in the Senate is to protect them and the communities that they support. So I thank the Chairman for this bill.

I would like to begin my questioning by just saying a lesser known fact, but one that we take special pride in, is that Illinois is home to Argon National Laboratory, one of our Nation's crown jewels of scientific research and a leader in developing nuclear technology. In fact, our current nuclear technology is a product of the hard work performed by Argon researchers in Illinois.

The folks there, about 3,300 researchers and scientists, are leading the Nation's development of fast reactor and fuel recycled technologies, and if Congress fulfills our commitment to fund this program, Argon will fulfill its promise to improve the affordability of nuclear power, enhance safety and security, and minimize radioactive waste, as we have been discussing already.

Dr. Finan, you mentioned in your testimony that start-up companies are pioneering nuclear designs that offer safer and more affordable nuclear technology options. In your view, what are the top nuclear innovation benefits of our investment in DOE national laboratories, such as those made at Argon, particularly when it comes to materials development, advanced chemistries, reduced nuclear wastes, and super-computing capabilities? Can

you talk about some of the things that are exciting that are happening right now that really depend on the DOE laboratories?

Ms. Finan. Absolutely. The national labs are really invaluable and irreplaceable partners to these nuclear innovators. Not only, as you said, do they develop many of the technologies that this work is based on now, but these innovators are working hand-in-hand with experts at the national labs, including Argon and Oak Ridge in Idaho, all of those places, to do their materials work and to do their super-computing. They are using the experimental facilities at those labs that aren't available elsewhere, and, really, it is enabling them to move forward in a way that the private sector couldn't do alone. So the labs play a critical role in all of those areas.

Senator Duckworth. Is there any particular technology that is being developed that you find especially exciting that is a partnership with private organizations?

Ms. Finan. I think one of the key technologies being developed or worked on and furthered is fast reactor fuels, which are really being developed in partnership with the labs and the private companies, and that is an important synergy, where the fuels really couldn't be developed on their own in the private sector.

Senator Duckworth. Thank you.

I believe deeply in scientific research and remain committed to advance in innovation. I also know that R&D on its own will not make the lives of Illinoisans or Americans better by itself. In order to fully capitalize on our investments in next generation nuclear technology, we have to make sure that those jobs associated with them stay at home. So could you speak a little bit as to how you think we could ensure that U.S. components manufacturers and manufacturing workers, what kind of a role do they plan in the development of manufacturing of SMRs and other advanced nuclear technologies, the folks who are the subs and who are making the components?

Ms. Finan. Sure. You know, I think it is important to note that several U.S. companies are already turning to other countries to be their main partners in licensing and demonstrating their technologies. And when they do that and go that route, they are much more likely to use manufacturing in those countries where they are looking for their demonstrations to be built. So I think the best way that we can support more manufacturing here in the States is to really support the innovators' ability to be licensed and to demonstrate their technologies here in the U.S., and I think that S. 512 goes a long way towards assisting that. We also need to support the supply chain here to make sure that the manufacturing is available for those technologies.

Senator Duckworth. Thank you.

Ms. Korsnick, how can advanced reactors and innovation contribute to overcoming the economic challenges that current nuclear power plants are facing in States like Illinois?

Ms. Korsnick. Well, if we were to look ahead in the future, you know, 30 or 40 years, I see a grid that is supported by advanced nuclear in strong partnership with, say, wind and solar for a clean energy future. And by doing that, these advanced reactors, they produce more than just the electricity that we are all interested in; they are partnering with other systems, say, high temperature, steam that maybe another technology might need to use. So you can imagine these reactors of the future supporting desalinization plants or supporting, again, other technologies that are in need of this high pressure steam, for example.

So I see the design very different than just reactors that are there and supporting of just an electric grid. It will be more of an integrated view.

And, also, as you look at these advanced reactors, they are not all the large reactors that we think of today and benefit today from; they are reactors that are a 1 or 2 megawatt size, a 50 megawatt size, as well as the large size. So you can then see a variety of deployments, right? Think of some remote locations out in the middle of the desert or out in the middle

of, say, Alaska, that maybe you only need a couple of megawatts or maybe you want a couple of megawatts that you put together that you are now able to have in this remote location. Maybe it only needs fuel every 10 to 15 years. Well, that is very helpful in some of these remote locations.

We talked about the fact that the world needs energy. But some places in the world are relatively remote. So being able to provide this technology in a case where you don't have to refuel it very often, also very significant. So we really look ahead to see a very dynamic future. Our challenge is what can we do today to spur that future to a reality.

Senator Duckworth. I really see nuclear as a consistent source of fuel in that coalition with wind and solar and all of the other sources, because it is always there.

Ms. Korsnick. Absolutely.

Senator Duckworth. Thank you.

I yield back, Mr. Chairman.

Senator Barrasso. Thank you very much.

At this time I would like to ask unanimous consent to submit for the hearing record three letters in support of the bill, one from Mr. Ed Wallace of GNBC Associates, Mr. Jay Faison of ClearPath Action, and Mr. Josh Freed of the Third Way.

[The referenced information follows:]

Senator Barrasso. Senator Carper.

Senator Carper. Thanks, Mr. Chairman.

Thanks again to all of you for joining us today and for your testimony. I think we feel encouraged on much of what has been said.

Dr. Lyman, in his comments when he was speaking earlier today, reminded us of Fukushima and the horror and havoc that it has created for a place in Miyagi Prefecture, a place which is a sister state of the State of Delaware. I have been there before and have a great affection for Miyagi and the people who live there.

I am going to ask a question for the record, but I am going to tell you what it is now and we will ask it for the record. There are a number of lessons we needed to learn; the Japanese needed to learn from Fukushima: What went wrong? Maybe what went right, but mostly what went wrong. I am not going to ask you to respond right now, but I am going to be asking for the record. In terms of what went wrong, what have we learned? What are we doing differently here in this Country? Maybe what more do we need to do in order to fully realize and gain from the lessons of something very bad that happened?

I would like to say sometimes out of something bad something good comes, and my hope is that certainly is the case

here.

The other thing I want to ask, one of our witnesses before this Committee once talked about if you could take all the spent fuel from nuclear power plants in this Country and stack them up on a football field, Mr. Chairman, it would fill up a football field and go up into the sky not a couple of miles, but it would go up into the sky for some distance. And some of you probably know the answer to that question. Does anybody know how high it would be today? Anybody know? I don't know.

Ms. Korsnick. I think the estimate is 20 yards. It is not very tall.

Senator Carper. It is not that far.

Ms. Korsnick. No. If you used all of your energy personally that you got for your entire lifetime, and you got it from nuclear power, that waste would fill a 12 ounce can of soda.

Senator Carper. Thank you.

Ms. Korsnick. So the volume is not very large.

Senator Carper. I am encouraged by what Dr. Back told us about 97 percent spent fuel being really burned up or consumed.

Whether it is 20 yards or however high that pile of spent fuel rods goes in that football field, do we have the ability to derive additional energy from that spent fuel? I know a lot of it is in casks and so forth, but is it gone forever and just has

to sit around for tens of thousands of years, or is there some potential to derive energy from it going forward?

Ms. Korsnick. Oh, we can absolutely. There is about 95 percent of the energy left in that spent fuel; it has just been transitioned to a different isotope, if you will. There is technology available around the world today in reprocessing. As you may know, France reprocesses fuel.

Senator Carper. I have been there.

Ms. Korsnick. And that is how they tap into that additional energy, because you then make that available, if you will, for a different source. And some of the technologies that these folks here are talking about are other ways that they can tap into the use of that energy

Senator Carper. All right.

Do you have any closing statement, any briefly closing thought that comes to mind before we conclude that might be helpful for us? Anybody? Please. Just very brief.

Mr. Lyman. Yes. I would just like to go back to this issue that keeps coming up about consuming spent fuel, about reprocessing. You know, I appreciate Senator Booker's enthusiasm for these technologies, but I do believe that many of them still are in the science fiction stage, and it is not clear that throwing a lot more money and time after them is going to realize their promise.

Reprocessing is dangerous, it is dirty, and it is expensive. Other countries have had terrible experience with it and they are dealing with the legacy. The French company AREVA, is practically bankrupt, or it is bankrupt, and a large part of that has to do with its reprocessing activity. So reprocessing is not a solution for nuclear waste.

And my concern is that a focus on the pipe dream of trying to burn up or consume spent fuel is distracting from developing systems where you increase uranium utilization on a once-through basis, and one example of that was the original TerraPower reactor that was being developed by the company Bill Gates sponsored. The promise of that type of system is that you can achieve the goals that people who claim are for reprocessing without having to actually process the spent fuel, extract plutonium, and securing the safety liabilities associated with that process.

So our recommendation as the main direction for innovation should be to pursue once-through cycles where you can get some of the purported benefits of reprocessing without separating plutonium, which is a proliferation and terrorism risk. And I would really hope that you would look into those issues in your reconsideration of whether it is really feasible or practical to burn up spent fuel.

Senator Carper. My time is about over.

I am going to ask, for the record, I will ask our other witnesses to respond to what Dr. Lyman has said. And we appreciate you raising those points.

I will close with this thought. We know climate change is real. We only have to look at what has happened this winter on the east coast and California, where they got more rain in a couple of weeks than they have gotten in years, and stuff like that. So it is apparent that it is real.

The question is what do we do about it. About two-thirds of the carbon-free electricity being produced in this Country comes from nuclear, and that is a good thing, and we need to figure out how to come up with more carbon-free energy. But we need, at the same time, to keep in mind that nuclear has a lot to offer, and hopefully in the future even more.

Thanks so much.

Senator Barrasso. Well, thank you, Senator Carper.

Thanks, Senator Booker, for staying with us all the time.

Thank you all for your testimony. It was, I think, very beneficial to all of the members of the Committee. Some members who weren't able to be here for the whole time may submit written questions. I hope you will try to get those answers back to us.

The hearing record will remain open for two weeks. Thank you for being here. The hearing is adjourned.

[Whereupon, at 12:05 p.m. the committee was adjourned.]