S. HRG. 117–230

A LEGISLATIVE HEARING TO EXAMINE S. 2373, THE AMERICAN NUCLEAR INFRASTRUCTURE ACT OF 2021, AND S. 1290, THE STRANDED ACT OF 2021

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED SEVENTEENTH CONGRESS

SECOND SESSION

FEBRUARY 9, 2022

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COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED SEVENTEENTH CONGRESS

FIRST SESSION

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C O N T E N T S

EXAMINING PROGRAMS AT THE ECONOMIC DEVELOPMENT ADMINISTRATION

WEDNESDAY, FEBRUARY 9, 2022

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee, met, pursuant to notice, at 10:05 a.m. in room G50, Dirksen Senate Office Building, Hon. Thomas R. Carper (chairman of the committee) presiding.

Present: Senators Carper, Capito, Whitehouse, Markey, Duckworth, Kelly, Padilla, Inhofe, Sullivan, Ernst.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Good morning, everyone. I am pleased to call this hearing to order.

Welcome, one and all. Our hearing today is focused, as you know, on two pieces of bipartisan nuclear energy legislation. Senator Capito and I meet almost every week, in person or virtually, with our staff directors, both minority and majority. We talk about, among other things, a hearing schedule, which we hold hearings on. I want to thank Senator Capito for suggesting that we have at least one hearing early this year that focuses on the major source of carbon-free electricity in this Country of ours, and that is nuclear power.

Today we are going to reexamine the American Nuclear Infrastructure Act. This legislation is sponsored by our Ranking Member, Senator Capito, along with Senators Whitehouse, soon to be a grandfather, Senator Crapo, Senator Booker, and our former Chairman, John Barrasso. We are also going to discuss the sensible, timely relief for American's Nuclear Districts Economic Development—there has to be an acronym in that. Senator Duckworth, what would be a good acronym for a bill like that?

Senator DUCKWORTH. It is called the STRANDED Act.

Senator CARPER. Whoever came up with that, I take my hat off to them. I am not big for acronyms, but this is a good one: Sensible Timely Relief for America's Nuclear Districts Economic Development, the STRANDED Act, for short. It will become clear as we go through this what we mean by stranded. Thank you for introducing legislation, along with Senator Collins and for leading us on this important, important issue.

As we consider the merits of both bills, we are fortunate to have an expert panel of witnesses joining us. We want to thank each of you for your willingness to be part of this discussion.

The numbers don't lie. As I said earlier, nuclear energy is by far the largest source of reliable, clean energy in our Country, generating over half of our Nation's carbon-free electricity. Nuclear power plays a critical role in our efforts to address the climate crisis, while also creating economic opportunity. Right across the Delaware River from us in Delaware are a couple of nuclear power plants. I think each of them employ close to 1,000 people, well-paid, highly trained work force.

So that in today's hearing is an important opportunity to explore how we can help the U.S. energy industry safely develop the technologies that are necessary to lead our climate goals, while also lowering energy costs and boosting economic development across our Country.

With regard to the American Nuclear Infrastructure Act, my hope is that we can buildupon and improve the Nuclear Energy Innovation and Modernization Act which became law in 2019, as you may recall, thanks to bipartisan work of this committee, including people sitting on either side of me. That Act required the Nuclear Regulatory Commission to create a new regulatory infrastructure for the next generation of nuclear power. This new structure is moving us closer to making advanced nuclear power a reality in this Country, and doing so without jeopardizing safety but actually enhancing safety.

The Nuclear Regulatory Commission is not only on time when it comes to meeting its statutory requirements to develop a new framework for licensing advanced reactors, the Commission is currently ahead of schedule. I understand they are ahead of schedule by as much as 3 years, which is very impressive.

With that thought in mind, I think we ought to be careful not to make unnecessary changes to the regulatory process that could undermine this progress, as long as they continue to make this kind of progress ahead of schedule. Still, it has been difficult for the NRC to operate under the constraints that the Nuclear Energy Innovation and Modernization Act requires.

In December, NRC Chairman Hanson testified before this committee and expressed concerns about the impact of budgetary caps on the agency's ability to hire the work force of the future and take on the challenges of licensing advanced reactor technologies. We know that for the NRC to do its job effectively, including processing license applications in a timely manner, the NRC must be adequately resourced.

As we work to improve this legislation, I would like for us to ensure that the NRC has the support it needs to continue its safety message and to hire the best and brightest needed to work on the next generation of nuclear reactors, which I believe we badly need in this Country of ours. I know a number of members of our committee on both sides of the aisle agree with that.

While the next generation of nuclear technology presents opportunities for clean energy and job creation, I am also all too aware of the economic difficulties facing many nuclear facilities today, and the challenges that closing a facility can create for surrounding communities and the families that live in those communities, not unlike auto factors and other advanced manufacturing facilities.

We lost, in our State, about 10, 12 years ago, we lost two auto plants. At one time, they employed as many as 3,000 people in each plant. We lost them both at the bottom of the great recession. We know how devastating that can be for the families, and for the communities and for the State. We have seen that in Delaware firsthand.

The loss of highly skilled, good paying jobs oftentimes leads to smaller tax bases, to reduced revenues for local businesses, and to depressed housing values. At the same time, these communities are also unfairly burdened with the cost of nuclear waste storage.

Senator Duckworth's STRANDED Act would benefit those communities that are working to move past the legacy of their decommissioned nuclear plants and to create a brighter, more prosperous future for their residents. As my colleagues have oftentimes heard me say, I believe on of the primary roles of government is to help create a nurturing environment for job creation and job preservation. I think everybody on this committee agrees with that.

The STRANDED Act would do just that. I commend Senator Duckworth and her staff for their commitment to these communities, and her work on this bipartisan bill. She will be speaking following Senator Capito's opening remarks.

In closing, I believe we have an opportunity to help our Nation's nuclear energy industry transition into the future, while reducing carbon emissions and creating economic opportunities at home as a result. As we make that transition, it is imperative that we prioritize safety and equity.

We look forward to hearing the unique perspectives of our witnesses today. Before I turn to Senator Capito of an opening statement, let me just close with this thought. There are a number of the members of the committee, particularly Senator Duckworth, who served our Country in uniform with great courage and great sacrifice. I spent a few years of my life in the Navy, used to chase, from airplanes, nuclear submarines. As a father, I remember taking a Boy Scout troop down to Norfolk Naval Station about every 3 years. We would visit ships, submarines and aircraft carriers, including the Teddy Roosevelt.

I will never forget, we had about 25 Scouts 1 weekend, about a decade ago. We met with the captain of the ship up on the bridge. The captain of the ship welcomed the Scouts warmly. We had about 25 Scouts, maybe a half dozen or so Scout leaders.

I will never forget what he said to the Scouts. He said, the Teddy Roosevelt is 1,000 feet long. The boys went, oohh. The Teddy Roosevelt is, I think he said 40 stories high. And the Scouts went, oohh. And he said, and the Teddy Roosevelt has about 5,000 men and women who serve on the ship. And the Scouts went, oohh. And then he said, the Teddy Roosevelt has something like 75 aircraft and helicopters on board. And the Boy Scouts went, oohh. And then he said, the Teddy Roosevelt stops to fuel once every 25 years. And the adults went, oohh.

The lats time we lost an American sailor aboard a nuclear-powered ship, submarine, or aircraft carrier, never. We have never lost one. We can do this stuff safely, and we have shown that in the Navy and other ways as well.

Senator Capito, thank you so much for your leadership in this arena, and for letting me be your wingman on what I think is an incredibly important issue.

Senator Duckworth, I will turn to you right after Senator Capito. Thank you.

OPENING STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Senator CAPITO. Thank you, Mr. Chairman. I want to thank the witnesses for being with us here today, both in person and virtually. I am looking forward to this hearing.

We know, as the Chairman has said, that nuclear energy is an integral part of a clean energy system, a reliable one. It generates carbon-free power around the clock for up to 2 years before you even need to refuel. I guess it is the same with an aircraft carrier, only 25 years is much longer.

Nuclear energy must remain a part of America's diverse energy portfolio now and in the future. State and local governments are realizing the benefits of preserving and expanding the use of nuclear energy.

Last year, Illinois extended its law to keep the State's existing nuclear power plants online. Other States with no existing nuclear reactors, such as Wyoming, Kentucky, and Montana, are opening the door to deploy new nuclear plants. Just last week, the West Virginia legislature voted to allow new nuclear development in our State, and our Governor signed that bill into law yesterday.

Nuclear energy can provide a tremendous potential opportunity for economic growth, particularly communities impacted by the closure of coal plants that still have developed sites and transmission assets that could accommodate new generation. In this way, development of nuclear energy would build on West Virginia's long history of providing baseload energy that fuels our economy.

Congress should build on previous bipartisan legislation to continue to promote safe use and development of nuclear energy nationwide. That is why I introduced the American Nuclear Infrastructure Act with our Democrat lead, Senator Whitehouse, along with Senators Barrasso, Booker, and Crapo. Since introduction, Senators Graham and Manchin have also joined as cosponsors.

The committee passed substantially the same legislative text last year, I believe, with bipartisan support by 16 to 5 in this committee. I thank Senator Whitehouse for his leadership on nuclear issues and his partnership on this legislation.

Current events serve as a reminder of the importance of this bill. International turmoil threatens to disrupt our nuclear fuel supply chain. New England generated a quarter of its electricity by burning fuel oil during a cold snap just last month. That follows the closure of two of New England's three nuclear plants in recent years.

Meanwhile, China continues to build new nuclear reactors. China is poised to overtake France as the world's second largest operator of nuclear power plants. This legislation would strengthen America's international nuclear energy leadership, supporting deployment at home and making us more competitive in markets abroad.

The bill incentivizes the deployment of advanced nuclear technologies for innovative purposes, it modernizes outdated nuclear re-

striction, it encourages using advanced manufacturing and construction techniques to build nuclear power plants safer, faster, and cheaper.

I look forward to working with Chairman Carper and other members of this committee to advance this legislation as we have other bipartisan legislation already in this Congress.

On a separate but related note concerning this committee's oversight efforts, in order to realize nuclear energy's economic national security and environmental benefits, the Nuclear Regulatory Commission must be prepared to review and approve advanced nuclear designs and licenses in a timely and collaborative manner to get new generation assets onto the field. EPW members on both sides have extensively supported efforts to develop and deploy these new nuclear technologies.

Signed into law in 2019, the Nuclear Energy Innovation and Modernization Act which this committee developed directed the NRC to review and update the agency's practice to efficiently consider new reactor applications. Over the last few years, members on both sides of the aisle on this committee, myself included, have repeatedly asked the NRC is the Commission needs any additional authorities or resources for its advanced regulatory work. In December, I asked NRC Chairman Hanson whether the Commission is currently prepared to review license applications under the existing regulatory framework. He assured me that the Commission was ready.

Yet approximately 1 week later, the NRC staff denied the only application actively under review to construct and operate an advanced reactor. This decision is concerning and clearly does not align with what the chairman told me. I recognize that the licensing process is a two-way street that requires an engaged applicant as well as an engaged NRC staff.

Congress has provided substantial public investment to assist the deployment of these new technologies. Nuclear innovators and entrepreneurs need to be confident that the NRC will review applications in a timely, predictable, efficient, and affordable manner. That is why I asked the GAO to assess NRC's preparedness to review and approve advanced nuclear applications. GAO's review should also consider the Commission and senior NRC staff's process to oversee these licensing reviews.

Additionally, Commission leadership is critically important to successfully managing these important projects. I have said before, leadership is strengthened when the Commission operates with a full complement of five members. For more than 7 months, the Commission has operated with only three members. I again urge President Biden to promptly put forth a bipartisan pairing of qualified individuals to fill these vacancies. Chairman Carper and I have joined in that request.

Thank you, Mr. Chairman, for holding this important hearing. With that, I would yield back.

Senator CARPER. Senator Capito, thank you for that statement, and for your leadership. We like to work across the aisle on all kinds of issues, and this is certainly one that we have and continue to do so. It is important that we do.

Senator Duckworth, my mom raised my sister and me to believe in practicing the Golden Rule, treat other people the way we want to be treated. When I look at the work that you have done on STRANDED in other communities, whether they be coal communities, whether they have lost economic opportunity, we have a moral obligation to help them, put ourselves in their shoes. Your legislation really has built on that premise. Thank you. You are recognized. Thanks for your leadership.

OPENING STATEMENT OF HON. TAMMY DUCKWORTH, U.S. SENATOR FROM THE STATE OF ILLINOIS

Senator DUCKWORTH. Thank you, Mr. Chairman. Thank you to Chairman Carper and Ranking Member Capito for holding this hearing on my bipartisan bill, the STRANDED Act. My cosponsor, Senator Collins, is not on the committee, but she sends her support of the STRANDED Act and our need to get this bill passed and these communities the support that they need.

As this committee will learn today from my constituents in the city of Zion, Illinois, there is a desperate need to pass the STRANDED Act as soon as possible. However, our bipartisan proposal is not a new or radical idea. We are simply seeking to fulfill a promise Congress made 40 years ago, four decades ago, when it passed the Nuclear Waste Policy Act of 1982. I was still in high school.

This law recognized that we need to safely dispose of and store nuclear waste in the interim. The Federal Government has a responsibility to help communities the decommissioning of a nuclear power plant. Specifically, Congress authorized assistance payments to help stranded communities to mitigate the social and economic impacts of being stuck with spent nuclear waste.

Yet to this day, communities like Zion have not received their assistance. Instead, the city of Zion has lost hundreds of jobs and millions in tax revenue, and has been deprived of the valuable lakefront property that could be the base of future economic growth. That was never the deal.

The Federal Government and nuclear industry promised communities like Zion that in exchange for their patriotic efforts to help our Nation generate zero-emission power, they would not only receive jobs and economic growth, but ultimately, the nuclear plants would be decommissioned, the waste safely removed, and the land returned for future use.

Now, I recognize that a long-term storage solution will not be solved overnight. However, that is no excuse to abandon my constituents in Zion and Americans throughout the Country. The social and economic impacts of having an industry leave overnight are brutal, no matter the industry. But when a company abandons a community and leaves behind 2.2 million pounds of toxic spent nuclear waste sitting on 90 acres of lakefront property on Lake Michigan, the impact is simply devastating.

This situation is not unique to Illinois. I have a chart here. As indicated on this map, the congressional Research Service has identified 80 sites, that is eight-zero sites, that store nuclear spent fuel around the Country. Additionally, 25 of those sites are geographi-

cally distinct nuclear sites that have been furnished by litigation settlements and court judgments. This is no way to do business.

The U.S. Economic Development Administration's Nuclear Closure Communities, NCC, Initiative, provides some support. But in its current form, the help is only for new construction or development projects. Of course, for stranded communities like Zion, financing new construction is of little use when the very stranded nuclear wastes have resulted in their loss of tax base, jobs and land needed to keep the lights on. It is a downward spiral.

I hope to offer a substitute amendment to the STRANDED Act during a future markup that will build on the EDA's NCC program by improving it to provide the type of support communities like Zion desperately need now. The STRANDED Act contains three pillars. First, the non-competitive economic impact grants will provide financial assistance to local government where a nuclear power plant is located. The affected local governments are eligible to receive amounts valued at up to $15 per each kilogram of spent nuclear fuel stored in the affected community, a payment framework established under the Nuclear Waste Policy Act of 1982. We are not even using 2022 dollars. We are pegging this at the rate set in 1982 of $15 per kilogram.

Second, the Innovative Solution Prize Competition will award prizes for proposals for affected communities to carry out alternatives to nuclear generating sites and waste sites, giving them another chance at economic development through innovative proposals.

Finally, this bill would create a stranded nuclear waste task force to conduct a study on existing public and private resources for these affected communities, and develop immediate and long-term economic adjustment plains tailored to the needs of each of the affected communities. We cannot rely on communities to give us power then leave them to be our active nuclear dumpsters.

The U.S. Government must help these communities that powered our lives to survive another day. Passing the STRANDED Act would be a first step toward fulfilling a commitment we made to these patriotic communities long ago.

Of course, the inspiration to write the STRANDED Act stemmed from a visit to the city of Zion during my first year in the Senate. I am honored that the Mayor of Zion, Billy McKinney, is here in support of the hearing, and to have David Knabel, the city's administrator and director of accounts and finance, here as our witness to give stranded communities like theirs a voice.

Mr. Knabel was born and raised in Zion, Illinois, and knows first-hand how stranded nuclear waste negatively impacts surrounding communities. After graduating from the University of Wisconsin Parkside in 1999, followed by a CPA certification in 2008, Mr. Knabel went on to obtain 14 years of experience in public accounting. Throughout his 10 years working for the city of Zion, he has championed several high-profile projects to assist Zion with its financial needs and worked hard to address the impacts of a nuclear power plant closure by working with legislators across the Country, the results of which will be a template for other communities to use for nuclear waste storage, evaluation and redevelopment.

Mr. Knabel and Mayor McKinney, while this is a less than ideal situation, we are so fortunate to have you here today to share your story with us. I look forward to hearing Mr. Knabel's testimony on behalf of the city of Zion. Thank you both for being here.

Thank you, Mr. Chairman, and I yield back.

Senator CARPER. Senator Duckworth, thanks so much for your leadership on this, and for bringing in one of our witnesses. As an aside to my colleagues, city of Zion, I read that and thought, that could be in Israel. In Delaware, if you get off I–95 in Delaware, take Route 1 and head for our beaches, one of them is Rehoboth, which means room for all. When you go through another little town, it's called Little Heaven. So we could have a panel with somebody from Little Heaven, the city of Zion, and it would be almost like a revival.

Senator Whitehouse asked for a chance to say some words here. I am happy to recognize you, Sheldon. Go ahead.

OPENING STATEMENT OF HON. SHELDON WHITEHOUSE, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

Senator WHITEHOUSE. On a biblical theme, let me just say that Rhode Island has Galilee, where our fishing port is located.

Senator CARPER. This just gets better and better. Amen.

[Laughter.]

Senator WHITEHOUSE. Thank you, Chairman.

Our current climate goal of net zero by 2050 may or may not be adequate. But whether it is adequate or not, we are not going to get there without nuclear energy. Advanced nuclear reactors are safer, they can operate longer without refueling, they can run on spent nuclear fuel, very important consideration.

Senator CARPER. Would you say that last part again? That is worth emphasizing.

Senator WHITEHOUSE. They can run on spent nuclear fuel. They have a smaller geographical footprint that makes them easier to deploy. They can be standard design for safety. And in some cases, they produce high temperatures that can be used for separate industrial processes.

I support the Nuclear Regulatory Commission in establishing a regulatory framework for advanced reactors by engaging with stakeholders to create a useable and workable final rule. Putting an advanced reactor through the current licensing process is like putting a Tesla through a regulatory procedure that requires the testing of its carburetor.

I introduced the ANIA bill last July with Senators Capito, Barrasso, Booker, and Crapo. As the Ranking Member, Senator Capito, the Republican lead on this bill mentioned, Senators Manchin and Graham have joined us.

I would also note the positive development that the Bipartisan Infrastructure Law created a program to support existing nuclear generators, which suffer competitive disadvantage because they get no revenue for the carbon-free benefit that they provide.

ANIA further supports investment in our current fleet, and in future technology. I will emphasize again the importance of a focus on repurposing spent fuel. We cannot overlook that potential benefit.

ANIA includes prizes for the first reactors licensed by NRC in three different categories. One of these categories is for a reactor that can productively re-use spent nuclear fuel. ANIA helps local communities affected by nuclear closures and assists with cleaning up legacy abandoned mining sites on tribal lands.

I will close by providing a personal hello and thank you to Armond Cohen, one of our witnesses today, who is coming to us from London. Armond and I worked together back in the 1980's on the first conservation-based electric rates for an American utility, Rhode Island's own, then-little Narragansett Electric, now lost in the enormous national grid system. We did good work together way back when, and I am delighted that he is here with us today.

Thank you, Chairman.

Senator CARPER. Thank you. Thanks for your steadfast leadership on this. It has been so important.

The 1980's, did you say?

Senator WHITEHOUSE. We were first.

Senator CARPER. That was when you were Young Sheldon.

[Laughter.]

Senator WHITEHOUSE. Yes, that would be then.

Senator CARPER. Still young.

I think that does it for our members' statements. Now we are going to turn to our witnesses.

Our first one is Mr. Knabel. Do I have that pronounced correctly, Mr. Knabel?

Mr. KNABEL. You do have that. Thank you very much for that.

Senator CARPER. Today I think Mr. Knabel is joined by Armond Cohen. Armond is the Executive Director of the Clean Air Task Force. Maria Korsnick is the President and Chief Executive Officer of the Nuclear Energy Institute. And Jeremy Harrell is the Chief Strategy Officer at ClearPath Action. We are delighted that you have all joined us, in some cases live and in person, other cases virtually.

Mr. Knabel, if you would lead us off, that would be great. Please proceed with your testimony. Your entire testimony will be made part of the record. Please proceed, thank you.

STATEMENT OF DAVID KNABEL, DIRECTOR OF ACCOUNTS AND FINANCE, CITY OF ZION, ILLINOIS

Mr. KNABEL. Thank you, Chairman Carper, Ranking Member Capito, and distinguished members of the committee. On behalf of Mayor McKinney, our city council, our community and all communities in our situation, I appreciate your time today.

The city of Zion is located on the shores of Lake Michigan in northeast Illinois, just minutes from the Wisconsin border. It is home to 24,655 people. It was also home to the Zion Nuclear Power Station from 1974 to 1998, where it provided power to Chicago and the northern corridor of Illinois. The plant brought thousands of jobs to the community, contributed heftily to the local economy and was crucial to the foundation that helped the city thrive during those years.

Residents of Zion, myself included, grew up with the two cooling towers being in their family photos at the beach and part of the city's skyline. It was just a part of life in Zion. We trusted that

those responsible for the plant were monitoring the risks and keeping us safe. We accepted that the plant was part of our landscape, knowing that the jobs kept food on the table of Zion residents and many others. We understood that the plant kept the lights on at tens of thousands of homes extending far beyond our city's borders, and it was for the greater good.

Unfortunately, that came to an abrupt end when ConEd decided they could not justify the necessary safety upgrades to continue to produce competitively priced power, and decided to permanently close the plant. The community was totally blindsided, as this was well in advance of the slated expiration of the license in 2013.

Almost overnight, the plant closed, the jobs disappeared, and the lakefront and city were permanently blighted. Those who had been part of our city for decades were gone, and we were left wondering if those who had watched out for us would continue to do so, whether those from beyond our borders who had benefited from the risk the city had taken would be there to help us in our time of need. Would anyone care that we were left as a nuclear waste storage site?

Now, over two and a half decades later, with 2.2 million pounds of nuclear waste sitting in our city only 400 yards from the shore of Lake Michigan, we now know that answer. At the time of closure in 1998, the Zion Nuclear Power Station provided almost $19 million annually in property taxes to support the local schools, city services, and other governmental entities that the public relied upon. The historical value and taxes collected are shown in Attachment 1 provided.

The plant made up over half of our entire tax base. When that foundation disappeared from our tax base, it did nothing to reduce the costs of education of our students, nor did it reduce the costs of our police, fire, rescue and infrastructure. The service demands of the public remained steady.

Therefore, the tax burden that was largely paid by the plant instead now shifted to the residents and businesses resulting in an immediate 30 percent increase in their tax bills. There was little to no value in the now vacant plant and there was no opportunity to replace that tax base with redevelopment on what would normally be 90 acres of lakefront property as shown in Attachment 2 provided.

This resulted in a cycle, which continues to this day, of property values dropping as a result of taxes significantly increasing. Property values became so depressed that large landlord groups were buying 40 to 50 homes at a time to rent out. Many of these groups failed to maintain these properties while they collected cash-flow, and then moved on to the next. At the peak, over 60 percent of our housing stock were rental properties, which is triple that of a healthy community.

The demand on our schools and city services skyrocketed while our resources continued to dwindle. The tax rate over the 20 years since closure almost tripled while the plant was decommissioned and the waste remains on our lakeshore in the heart of our community.

That brings us to where we are today, with over 2.2 million pounds of nuclear waste stranded in our backyard next to the lake

that provides drinking water for over 10 million people, the location of which shown in Attachment 3.

Ours is not an isolated case. There are over 30 reactors that have been or are in the process of decommissioning and another 56 currently operating in 28 States. Many of the Senators on the Committee are or will be facing this exact same issue.

It is clear that a resolution to nuclear waste storage needs to be addressed, but that is not for me to address the solution, nor is it the issue before us today. That answer has been debated for decades, however until a decision is reached, we are the end solution. We have become, against our will, a nuclear storage site, and the community of Zion has been irreparably damaged without recognition and without compensation.

We humbly ask that Congress help us to start to repair those damages with this legislation. This is not a new concept for Congress. As Senator Duckworth mentioned, the Nuclear Waste Policy Act of 1982 was passed with strong bipartisan support and recognized that there should be impact assistance payments to units of local government to "mitigate social or economic impacts occasioned by the establishment and subsequent operation of any interim storage site."

Congress acknowledged again in 2020 that assistance was essential to nuclear closure communities with the adoption of the EDA Nuclear Closure Communities program. However, that program required us to inflate our budget with matching dollars that we don't have for projects that would not address our inability to compete and recover.

We have become very good at being fiscally responsible and do not want to spend funds unless it would address the crisis we are facing. The STRANDED Act of 2022 fixes these limitations and provides us that opportunity by permitting us to address the inequities in our local tax base and begin to dig out of the hole that the plant closure put us into.

We are not asking for a handout but rather to just be able to survive. We are a prideful city and want to be self-sufficient.

However, over 20 years of fighting this battle alone has left it impossible to do so. Our goal is to utilize this funding to address our tax base issues and make it possible to compete to attract residents and businesses to our community and begin the rebuilding process. All of these plants across the United States produce nearly 20 percent of the Country's electrical needs. We ask that while the people of the Nation might not acknowledge us when their lights turn on, that they do remember us before ours turn off forever. It is for the greater good.

Again, I appreciate your time today.

[The prepared statement of Mr. Knabel follows:]

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"Historic Past - Dynamic Future"

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Residents of Zion, myself included, grew up with the two cooling towers being in their family photos at the beach and part of the City's skyline. It was just a part of life in Zion. We trusted that those responsible for the plant were monitoring the risks and keeping us safe. We accepted that the plant was a part of our landscape knowing that the jobs kept food on the table of Zion residents and many others. We understood that the plant kept the lights on in tens of thousands of homes extending far beyond our City borders. It was for the greater good.

Unfortunately, that came to an abrupt end when ComEd decided that they could not justify the necessary safety upgrades to continue to produce competitively priced power and decided to permanently close the plant. The community was totally blindsided as this was well in advance of the slated expiration of their license in 2013. Almost overnight, the plant closed, the jobs disappeared and the lakefront and City were permanently blighted. Those who had been part of our City for decades were gone and we were left wondering if those that had watched out for us would continue to do so. Whether those from beyond our borders, who had benefited from the risks the City had taken, would be there to help us in our time of need. Would anyone care that we were left as a nuclear waste storage site? Now, over two and a half decades later, with 2.2 million pounds of nuclear waste sitting in our City only 400 yards from the shore of Lake Michigan, we now know the answer.

At the time of closure in 1998, the Zion Nuclear Power Station provided almost $19 million annually in property taxes to support the local schools, City services and other governmental entities that the public relied upon. The historical value and taxes collected are shown in Attachment 1. The plant made up over half of our entire tax base. When that foundation disappeared from our tax base, it did nothing to reduce the costs of education of our students, nor did it reduce the costs of our police, fire, rescue and infrastructure. The service demands of the public remained steady. Therefore, the tax burden that was largely paid by the plant instead shifted to the residents and business resulting in a 30% increase in tax bills. There was little to no value in the now vacant plant and there was no opportunity to replace that tax base with redevelopment on what would normally be 90 acres of lakefront property as shown in Attachment 2. This resulted in a cycle, which continues to this day, of property values dropping as a result of taxes significantly increasing. Property values became so depressed that large landlord groups were buying 40-50 homes at a time to rent out. Many of these groups failed to maintain

these properties while they collected cash flow, and then moved on to the next. At the peak, over 60% of our housing stock were rental properties, which is triple that of a healthy community. The demand on our schools and City services skyrocketed while our resources continued to dwindle. The tax rate over the 20 years since closure almost tripled while the plant was decommissioned and the waste remains on our lakeshore in the heart of our community.

That brings us to where we are at today, with over 2.2 million pounds of nuclear waste stranded in our backyard next to the lake that provides drinking water for over 10 million people, as shown in Attachment 3. Ours is not an isolated case. There are over 30 reactors that have been or are in the process of decommissioning and another 56 that are currently operating in 28 States. Many of the Senators on the Committee are or will be facing this same issue. It's clear that a resolution to nuclear waste storage needs to be addressed, but that is not for me to address the solution, nor is it the issue before us today. That answer has been debated for decades, however until a decision is reached, we are the end solution. We have become, against our will, a nuclear storage site, and the community of Zion has been irreparably damaged without recognition and without compensation.

We humbly ask that Congress help us to start to repair those damages with this legislation. This is not a new concept for Congress as the Nuclear Waste Policy Act of 1982 was passed with strong bipartisan support and recognized that there should be impact assistance payments to units of local government to "mitigate social or economic impacts occasioned by the establishment and subsequent operation of any interim storage capacity". Congress acknowledged again in 2020 that assistance was essential to nuclear closure communities with the adoption of the EDA Nuclear Closure Communities program. However, that program required us to inflate our budget with matching dollars that we don't have for projects that would not address our inability to compete and recover. We have become very good at being fiscally responsible and do not want to spend funds unless it would address the crisis. The STRANDED Act of 2022 fixes these limitations and provides us that opportunity by permitting us to address the inequities in our local tax base and begin to dig out of the hole that the plant closure put us into.

We are not asking for a handout but rather to just be able to survive. We are a prideful City and want to be self-sufficient. However, over 20 years of fighting this battle alone has left it impossible for us to do so. Our goal is to utilize this funding to address our tax issues and make it possible to compete to attract residents and businesses to our community and begin the rebuilding process. All of these plants across the United States produce nearly 20% of the Country's electrical needs. We ask that, while the people of the nation might not acknowledge us when their lights turn on, that they remember us before ours turn off forever. It's for the greater good.

Zion Nuclear Power Plant Historical Rate/Taxes/EAV			
Tax year	Tax rate	Taxes billed	EAV
1970	6.34%	518	8,170
1971	6.59%	5,676	86,110
1972	6.99%	3,242,913	46,380,329
1973	6.46%	2,512,467	38,910,750
1974	6.59%	3,932,754	59,641,404
1975	6.76%	7,190,547	106,353,305
1976	6.43%	10,495,501	163,125,592
1977	6.85%	11,921,521	174,052,041
1978	6.99%	12,361,362	176,818,223
1979	6.82%	12,604,388	184,841,631
1980	7.18%	11,939,505	166,265,220
1981	7.35%	10,720,797	145,940,606
1982	7.24%	11,187,048	154,453,236
1983	7.35%	15,248,160	207,345,118
1984	7.72%	11,696,530	151,588,000
1985	8.07%	12,624,976	156,462,710
1986	9.18%	14,358,583	156,462,710
1987	8.90%	15,331,258	172,358,155
1988	9.09%	15,638,044	171,997,847
1989	8.96%	15,951,005	178,044,484
1990	8.69%	14,960,723	172,219,676
1991	8.51%	11,939,505	140,382,192
1992	8.28%	17,035,616	205,818,730
1993	8.01%	17,479,722	218,142,039
1994	8.20%	19,230,911	234,466,114
1995	8.29%	19,035,446	229,702,497
1996	8.50%	19,639,319	231,077,997
1997	8.720%	19,511,995	223,763,355
1998	8.592%	18,692,144	217,549,052
1999	8.713%	18,282,071	209,825,220
2000	9.23%	13,144,463	142,456,515
2001	10.56%	8,140,751	77,061,257
2002	10.86%	3,983,453	36,673,289
2003	11.01%	2,202,800	20,000,001
2004	10.89%	1,632,900	15,000,000
2005	10.81%	1,080,900	10,000,000
2006	10.90%	1,090,200	10,000,000
2007	10.73%	1,072,900	10,000,000
2008	10.85%	1,273,848	11,739,455
2009	10.93%	1,312,915	12,015,332
2010	11.79%	1,427,153	12,106,827
2011	13.77%	1,641,883	11,921,029
2012	16.70%	1,531,307	9,172,251
2013	16.70%	8,140,751	48,761,612
2014	19.51%	3,983,453	20,417,492
2015	21.21%	2,202,800	10,387,760
2016	21.46%	1,632,900	7,610,406
2017	19.97%	1,241,494	6,218,069
2018	17.58%	980,438	5,575,742

Lake County, Illinois

Override 1

Lake County, Illinois

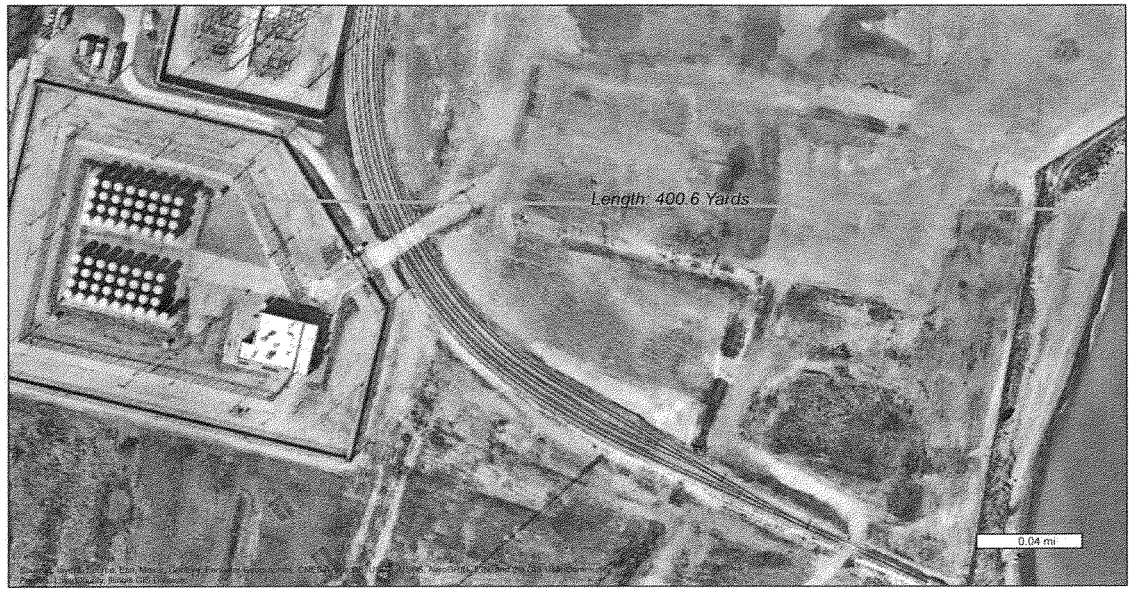
LakeCounty

N

Map Printed on 2/7/2022

Disclaimer. The selected feature may not occur anywhere in the current map extent. A Registered Land Surveyor should be consulted to determine the precise location of property boundaries on the ground. This map does not constitute a regulatory determination and is not a basis for engineering design. This map is intended to be viewed and printed in color.

Lake County, Illinois



Lake County, Illinois

LakeCounty

Map Printed on 2/7/2022

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Override 1

Tax Parcel Information

Disclaimer: The selected feature may not occur anywhere in the current map extent. A Registered Land Surveyor should be consulted to determine the precise location of property boundaries on the ground. This map does not constitute a regulatory determination and is not a base for engineering design. This map is intended to be viewed and printed in color

Senate Committee on Environment and Public Works
Hearing Entitled, *"A Legislative Hearing to Examine S. 2373, the American Nuclear Infrastructure Act of 2021, and S. 1290, the STRANDED Act of 2021."*
February 9, 2022
Questions for the Record for David Knabel

Chairman Carper:

1. In its current form, the American Nuclear Infrastructure Act of 2021 (ANIA) will provide funding for community advisory boards to "foster communication and information exchange" with former reactor site owners and members of the community. Similarly, the STRANDED Act would establish a "Stranded Nuclear Waste Task Force" to develop short- and long-term economic plans for stranded waste communities. Please describe in detail how Zion would leverage these entities to assist in the community's economic recovery.

   A: The task force would be crucial to help identify resources that may be available to the City of Zion. Due to severe cutbacks over the years, the City of Zion does not have the staff or resources to stay abreast of all programs that may be advantageous. This task force would be a much-needed tool to help broaden our reach to make sure we are taking advantage of everything available to try and dig ourselves out of the hole we have been sinking into. The primary tool we would utilize is educating the task force of our needs utilizing our 2040 comprehensive plan which was compiled with a variety of experts and community input.

2. Illinois recently enacted the Climate and Equitable Jobs Act, comprehensive energy legislation to invest in clean energy and associated future workforce needs, including job training efforts for energy transition communities. Is Zion able to benefit from this legislation, and if not, how can the assistance provided through the STRANDED Act work in tandem with legislative efforts at the state level, like the Climate and Equitable Jobs Act?

   A: Unfortunately, the Act which hopes to preserve nuclear reactors and jobs is a little too late for Zion as those jobs have been gone for decades and the plant is completely dismantled at this point, leaving just the waste. That being said, it would be a great story if the site was repurposed for green energy purposes, whether solar or natural gas, and brought green jobs back to the community. That would require significant capital investment and an economically feasible business model. Our biggest hurdle in attracting business has been our tax rate due to the demolition of our tax base from plant closure and inability to redevelop due to the waste. Without addressing the tax base, businesses will never consider Zion due to the tax burden inflicted on them as a result of the closure. Additionally, the 90-acre site on the lake is adjacent to the nuclear waste. We will not give up however and the plan would be to utilize the assistance provided through the STRANDED act to offset and reduce the tax burden and tax rate of the community to a level that is at least competitive to be able to attract those developments. The assistance is the first step to allowing us to compete with other communities to attract that business.

3. What amount of funding would Zion need to return to stable footing and be in a position to invest redevelopment?

   A: Our tax rates are almost double that of other communities due to the economic spiral that has occurred over the 20+ years since plant closure. Translating that to dollars, community wide we would need approximately $25 million annually to alleviate that burden. This doesn't take into account the deficits that have been incurred whilst trying to survive, but we are not even considering that in this legislative proposal. The $15 million proposed would be leveraged with other economic development tools (Enterprise Zone designation that we have obtained, and Tax Increment Finance Districts) to maximize the impact and get us back on a path to recovery.

4. Please provide the Committee further detail on why current federal economic support programs are inaccessible to Zion and why the authorizations in the STRANDED Act are necessary for Zion.

   A: The majority of other economic support programs have two components that, whether individually or together, prevent us from accessing them for the benefit of Zion. The first is that they by in large are only for new projects or developments. We are in such a crisis for survival that we don't even have the luxury of thinking about new projects. The analogy I give to people is that we are trying to figure out how to put food on the table for our families and the current programs are to address our leaky roof. We can't get to the point of even worrying about the roof when we're just trying to survive. That being said, we do take advantage of those when possible, but it doesn't stop the bleeding, just puts us in a better position if we are lucky enough to get to that point in our planning. The second hurdle is that a majority of these programs require local matching funds. With a $2 million annual operating deficit, there is no way to justify adding matching funds to our budget for programs that don't preserve the necessary public health services that we are desperately struggling to provide. With police and rescue calls tripling in the recent decade, we can't justify accelerating the layoff of public safety employees to the level to address our deficit much less add to it as these programs would require.

Senator CARPER. Mr. Knabel, thanks a million for coming here today, and Senator Duckworth, thank you for inviting him to join us and speak.

Now we are going to turn to Maria Korsnick. Maria is the President and Chief Executive Officer of the Nuclear Energy Institute. Maria, you are recognized. Take it away, thank you.

Ms. KORSNICK. I think Armond Cohen is next.

Senator CARPER. OK, thank you. In that case, Maria, we will wait for you for a few minutes.

Armond, Executive Director of the Clean Air Task Force. Please proceed, Armond, thank you.

STATEMENT OF ARMOND COHEN, EXECUTIVE DIRECTOR, CLEAN AIR TASK FORCE

Mr. COHEN. Thank you, Mr. Chairman, Ranking Member, and thank you, Senator Whitehouse, for the shout-out. You have been a great leader on clean energy issues.

I would note that when we worked together 30 years ago on energy efficiency, climate change wasn't really front and center like it is today. What is so interesting is that even in the 18 months since I testified before this committee last, there has been enormous change in recognition of the problem of climate change. Countries representing about 90 percent of world GDP and CO2 emissions are now committed to varying degrees to a net-zero energy system to be achieved over the next few decades.

Actually, regardless of what happens in Washington, more than half of the U.S. electricity sales taking place today are taking place in States or in utility service territories that have a net-zero missions commitment by mid-century.

So you could say that is the easy part. Now, the hard part is how do we actually achieve those goals in time, and at an affordable cost.

Nuclear energy could be a very significant contributor to the success of meeting those goals. In our view, it could indeed be essential. It can serve as a powerful complement to increasingly inexpensive renewable energy and energy storage, by providing zero-carbon electricity and heat, with 90 percent plus availability year-round, independent of season and weather. Nuclear energy also provides energy in a relatively compact land area which is increasingly important in a crowded world.

In addition to providing electricity to power the grid, nuclear can also power high temperature electrolysis to help provide zero-carbon fuels, like hydrogen, which today serves about 80 percent of world energy demand. Interestingly, also in the last 18 months, the value of nuclear energy has become increasingly recognized across the Country by opinion leaders and by the general U.S. public, as is supported by some of the polling and thought leadership pieces that are contained in my testimony.

That said, there are many challenges to a meaningful scale-up of nuclear from tens of gigawatts a year to hundreds of gigawatts a year, which is what we are going to need if it is going to make a meaningful contribution to climate change mitigation. Costs need to come down, deployment has to speed up. Key issues around nuclear waste disposal need to be resolved.

And advanced reactor designs can help on all those fronts. But so can just best practices in manufacturing business model and licensing, as well as novel deployment strategies like utilizing and repurposing existing fossil fuel mining and electricity productionsites as Senator Capito referred to.

Now, also in the last 2 years, Congress has done enormous good in this area with bipartisan legislation like NIECA, NEIMA, the 2020 Energy Act, Infrastructure Investment and Jobs Act of last year, but more needs to be done.

In my testimony I highlight four areas for improvement in addition to making nuclear a real option. First of all is providing incentives for cost-effective scale-up of multiple units of advanced nuclear energy designs beyond initial demonstration to achieve scale and lower costs. That is important. Demonstrating first of kind is good, but to really get the scale and cost reductions that we need, we are going to really need to build in series. That is what every nation which has had a successful low-cost nuclear energy program has demonstrated.

Second, we support licensing processes that are appropriate for advanced reactor designs, both in the U.S. and activities or licensing activities that will support diffusion of U.S. design reactors globally. Third, we need to fundamentally reset U.S. nuclear spent fuel policy in the direction of community-driven, consent-based siting policies. Recently, Finland and Sweden have demonstrated that you can cite a permanent nuclear waste repository if you take this consent-based approach. We are going to need to take a step back and figure out how to do that in this Country.

Then finally, we can look at the possibility of using existing retired or retiring fossil fuel sites for siting advanced nuclear.

So those are four immediate areas for attention. I am happy to discuss further in Q&A. Once again, I really appreciate the opportunity to testify remotely. This was a business plan that had been planned some months ago. So I appreciate your accommodation to let me testify by video.

Thank you.

[The prepared statement of Mr. Cohen follows:]

Testimony Before the United States Senate Environment and Public Works Committee

Legislative Hearing to Examine S. 2373, the Advanced Nuclear Infrastructure Act (ANIA) of 2021 and S. 1290, the Sensible, Timely Relief of America's Nuclear Districts' Economic Development (STRANDED) Act of 2021

ADVANCED NUCLEAR ENERGY: VALUE, REQUIREMENTS, THE ROLE OF POLICY

Testimony of Armond Cohen, Executive Director, Clean Air Task Force

February 9, 2022

Mr. Chairman, Ranking Member, and Distinguished Members of the Committee:

My name is Armond Cohen and I am Executive Director of the Clean Air Task Force (CATF), an environmental organization founded in 1996. CATF is a global nonprofit organization working to safeguard against the worst impacts of climate change by catalyzing the rapid development and deployment of low-carbon energy and other climate-protecting technologies. With 25 years of internationally recognized expertise on climate policy and a fierce commitment to exploring all potential solutions, CATF is a pragmatic, non-ideological advocacy group with the bold ideas needed to address climate change. CATF has offices in Boston, Washington D.C., and Brussels, with staff working virtually around the world. I appreciate the opportunity to testify today.

I will share CATF's thoughts on why clean firm power sources like nuclear energy could contribute meaningfully to managing global climate change, what would have to happen for nuclear energy to do so, and some immediate federal policy opportunities to support that possibility.

I. The value of clean firm electricity sources such as nuclear energy in addressing climate change

After thirty years of debate, it is becoming clear that the question is not whether we need to address climate change, but how. Since I last addressed this committee in August of 2020, there has been a momentous shift in public policy. Countries representing roughly 90% of world GDP, populations and CO2 emissions have committed to varying degrees of formality to reaching net

zero carbon emissions over the next few decades.[1] Zero carbon electricity is generally regarded as key to eliminating global carbon emissions, and more than half of U.S. electricity sales today are taking place in states or utility service territories that are committed to net zero emissions by mid-century, as shown in Figures 1 and 2 below:[2]

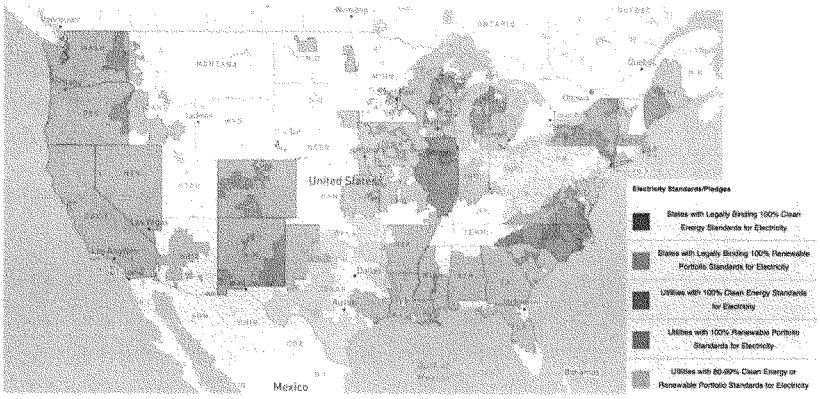

Figure 1: 100% carbon free electricity commitments by state and utility service territory

[1] See https://zerotracker.net/.
[2] Both figures taken from Clean Air Task Force, "State and Utility Decarbonization Commitments," https://www.catf.us/2020/10/state-and-regional-decarbonization-commitments/

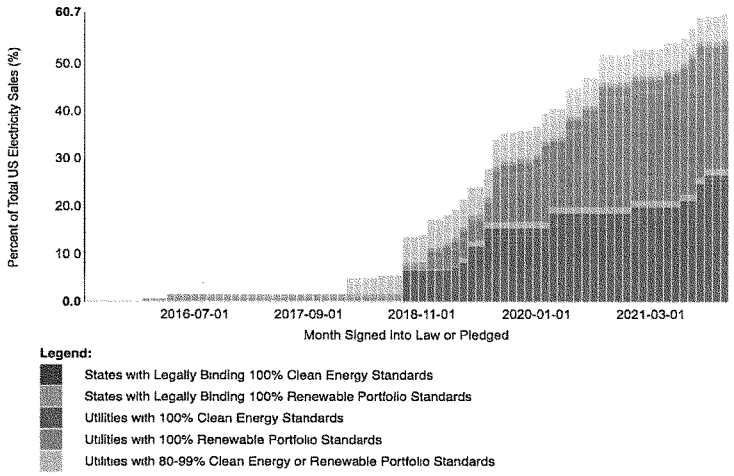

Figure 2: Percent of U.S. electric utility sales covered by zero carbon or similar pledges

Now comes the hard part: how do we actually achieve those goals in time and at an affordable cost?

Cost

A good part of the answer lies in the increasingly availability of low-cost wind and solar energy and energy storage, which today provide about 10% of U.S. electricity, and growing. Most economic studies, including ones commissioned by CATF, show that future lowest-cost decarbonized electric systems will be powered substantially, if not predominantly, by those sources. However, the same studies, whenever comparing various energy portfolio mixes, invariably conclude that the lowest costs are achieved by having a substantial fraction of energy provided by electricity sources that are available 24/7/365, regardless of season or weather.

Sometimes dubbed "clean firm power," such generating sources can include geothermal energy, hydrogen combustion, gas with carbon capture, and nuclear fission.[3]

A recent literature review[4] of such studies in the U.S. commissioned by CATF shows that lowest cost decarbonized power systems include an average of 35% clean firm power, including nuclear energy, as shown in Figure 3 below.

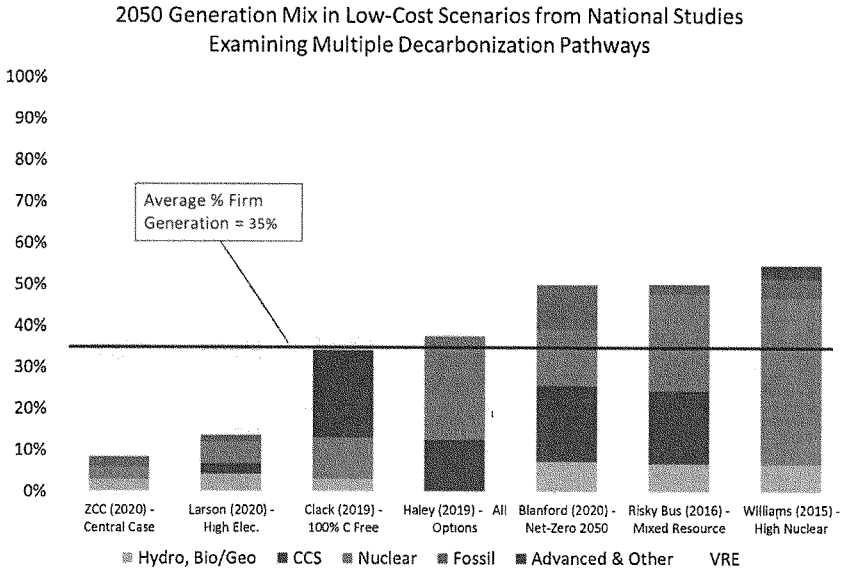

Figure 3: "Clean firm" power shares across U.S. studies. Source: see footnote 4.

[3] And possibly, in the future, fusion energy, not discussed here. But see Clean Air Task Force, "Fusion Energy," https://www.catf.us/work/advanced-nuclear-energy/fusion-energy/

[4] See The NorthBridge Group, "Review and Assessment of Literature on Deep Decarbonization in the United States: Importance of System Scale and Technological Diversity" (2021). https://www.catf.us/wp-content/uploads/2021/06/NorthBridge_Deep_Decarbonization_Literature_Review.pdf

An October 2021 study[5] of a carbon free U.S. power systems by noted researcher Chris Clack reached a very similar result: the system is dominated by wind and solar, but contains a significant fraction of power from clean firm sources such as gas with CCS, and nuclear energy, even with an optimally designed transmission grid that maximizes all distributed energy sources such as rooftop solar energy and storage. (See figure 4 below)

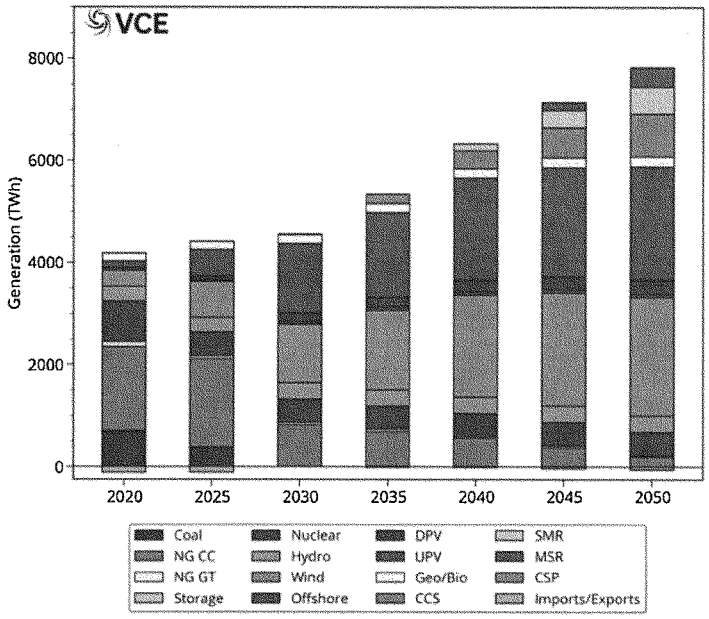

Figure 4: Optimal electricity shares in a zero carbon U.S. grid. ("SMR" is small modular light water reactors, and "MSR" is "molten salt reactors"). Source: see footnote 5.

[5] See Vibrant Clean Energy, "A Plan for Economy-wide decarbonization of the United States," (October 2021) https://www.vibrantcleanenergy.com/wp-content/uploads/2021/10/US-Econ-Decarb_CCSA.pdf

Similarly, a recent state-level study[6] of California by researchers at Stanford University and Princeton University, and the research firm E3, concludes that, when clean firm sources are allowed into the system, they supply 40-50% of annual power, as shown in Figure 5, including very high shares of nuclear energy:

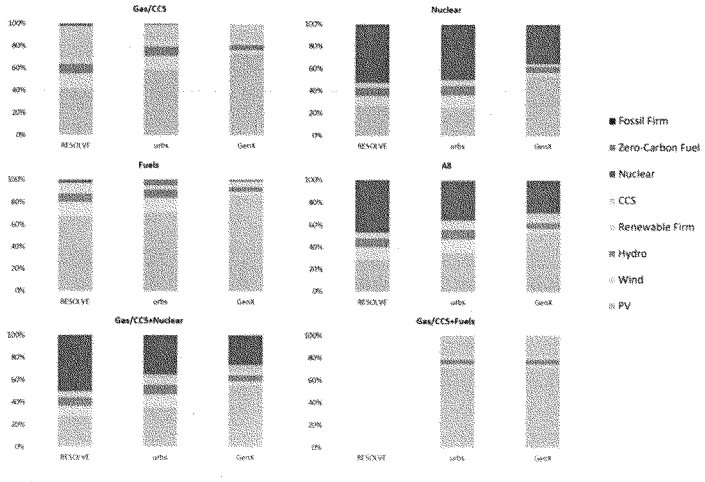

Figure 5: Shares of California power in a 100% zero carbon grid, varied by scenario. The "All" scenario allows nuclear, hydrogen and gas with CCS to compete. Source: see footnote 6.

What accounts for these large shares of clean firm power, with renewable energy becoming so inexpensive on a commodity basis? The central fact about wind and solar – versus firm

[6] JCS Long et al,, California Needs Clean Firm Power and So Does the Rest of the World, https://www.edf.org/sites/default/files/documents/SB100%20clean%20firm%20power%20report%20plus%20SI.pdf

resources – is that they are variable by ***week*** and ***season*** as well as days, as shown below in Figure 6 with data from the United States:[7]

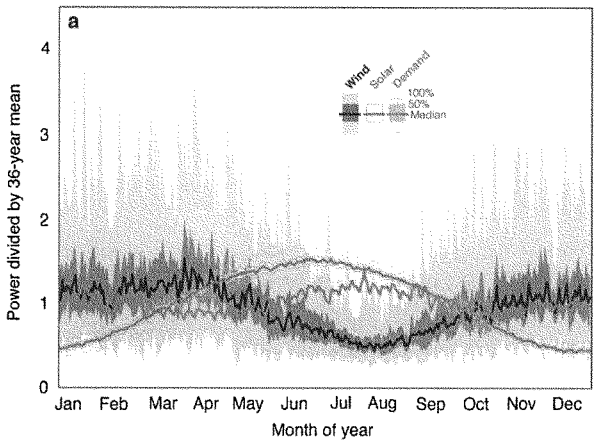

Figure 6: Seasonal variability of wind and sun versus relatively constant demand. Source: see footnote 7.

Compensating for this weekly and even seasonal variability on a large scale without firm generating resources would require one or more of the following physically and economically challenging strategies:

1. Building substantially more capacity than is required to meet peak demand and curtailing its output during times of high production.
2. Investing in expensive storage, much of it used at a low capacity factor.

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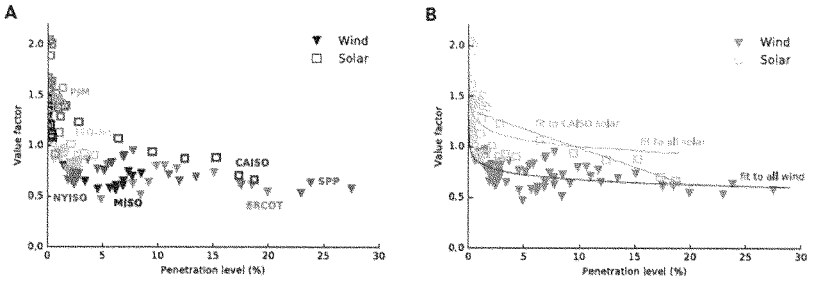
[7] Tong, D., Farnham, D.J., Duan, L. *et al.* Geophysical constraints on the reliability of solar and wind power worldwide. *Nat Commun* **12,** 6146 (2021). https://doi.org/10.1038/s41467-021-26355-z

3. Having robust demand flexibility that allows for wide-spread, consistent, and frequent shifting of demand (e.g. reduction of factory output at times of low wind or sun).
4. Developing a vastly integrated, interregional transmission network.

As long as the wind and solar proportion of the system is small, the variability can be readily managed, and systems costs could even decline. As penetration of these resources increases as a proportion of electric system supply, however, the above strategies need to be employed, causing costs to rise substantially, and their value to plummet:[8]



Wind and solar value factors decline with increasing penetration

(A and B) VRE value factors generally decrease with penetration, but the path has tended to be convoluted (A). Despite the complexity, the relationship between value factors and penetration can roughly be described by a logarithmic function (B) though not for CAISO solar. Value factor refers to the ratio of wind or solar generation value to flat bock value. In this case, each value calculation includes both energy and capacity value. For solar, value is calculated for utility-scale plants, but the penetration level is defined by the sum of utility and distributed solar generation. See also Table S1.

Figure 7: Declining value of variable energy as shares increase, due to need for greater compensation for variability. Source: see footnote 8.

[8] From: Millstein, Dev, Ryan Wiser, Andrew D Mills, Mark Bolinger, Joachim Seel, and Seongeun Jeong. "Solar and wind grid system value in the United States. The effect of transmission congestion, generation profiles, and curtailment." *Joule* (2021)

Metrics like "levelized cost of electricity" for individual resources, often used to compare nuclear and variable renwables, are therefore misleading in this context: variable resources may appear to cost less per asset, but to ensure reliability at scale, the overall system costs of a variable renewable based system escalate dramatically, as shown in Figure 8 below:[9]

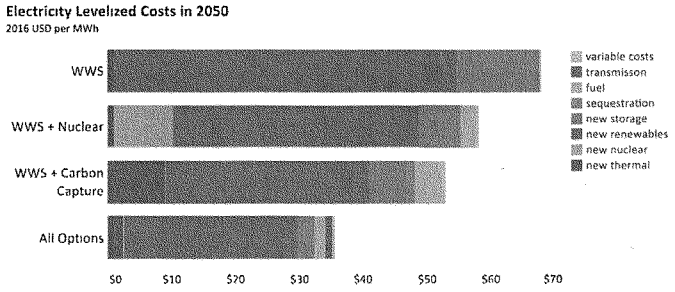


Figure 8: The cost of power systems with wind water and sun only ("WWS") versus WWS and clean firm sources. Source: see footnote 9.

In short, if we are to transition affordably to zero carbon power, we will need some mixture of clean firm sources such as nuclear energy to complement increasingly inexpensive, and potentially dominant, renewable energy. Whether nuclear energy can serve that function at scale is a question taken up below. But before turning to that question, we must address another reason to consider nuclear energy: space.

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[9] Evolved Energy Research, "Federal Policy for Low-Carbon, High-Renewables Electricity" (2020). https://www.evolved.energy/post/federal-policy-for-electricity-decarbonization

Space

While renewable energy offers great cost advantages, the scale at which it would need to be deployed without clean firm back up will pose serious feasibility challenges. Chief among these is land use. To illustrate the point, Figure 9[10] represents a hypothetical comparison of space required to supply all current electricity in the eastern U.S., as well as electricity to synthesize hydrogen to replace all liquid and gaseous fuels, by four energy sources: onshore wind, offshore wind, photovoltaic energy, and nuclear energy. While we would never choose to select only one energy resource, the figure does illustrate the relative land footprint required for each source:

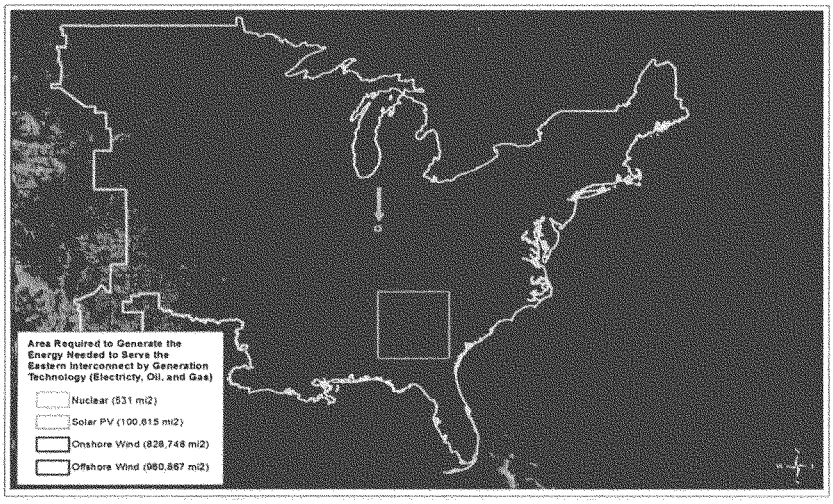

Figure 9: Comparison of land area required to supply all eastern U.S. energy with one source.

[10] Figure prepared by Lucid Catalyst for CATF (2021). Electricity, oil, and gas consumption estimates were sourced from the EIA, and conservative power density and capacity factor estimates from published literature and the National Renewable Energy Laboratory.

Recent studies looking at high variable renewable energy systems for the U.S., such as the one portrayed in Figure 10, also illustrate the large land areas required for energy infrastructure:

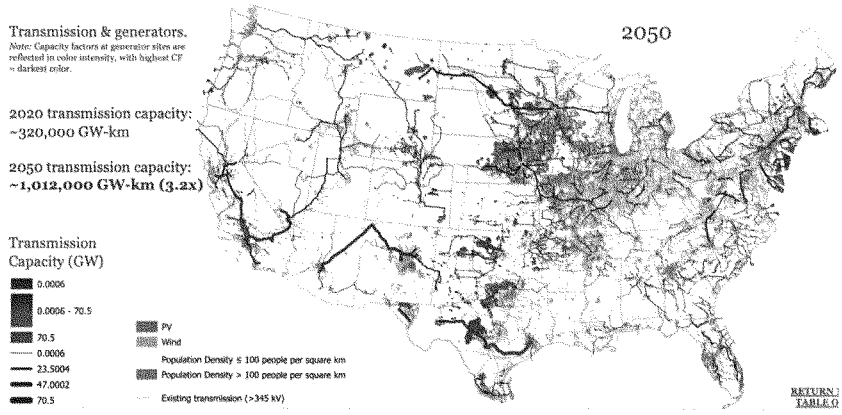

Figure 10: Land footprint for a U.S. electricity grid with 85% of energy supplied by wind and sun. Figure from Princeton University, Net Zero America Project, https://netzeroamerica.princeton.edu/the-report

In addition to large land areas required for generation, as variable renewable penetration increases, exponentially more transmission is needed to balance availability over long distances, as shown in Figure 11 below. In addition to the economic challenges of this transmission build-out, acquiring enough contiguous land for rights of ways would be difficult and would dramatically increase the land requirements of the system:[11]

[11] NREL "Renewable Electricity Futures Study. Volume 1: Exploration of High-Penetration Renewable Electricity Futures" https://www.nrel.gov/docs/fy12osti/52409-1.pdf

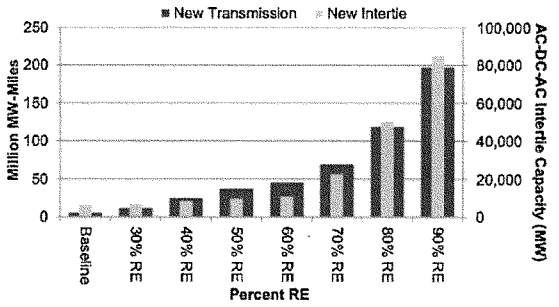

Figure ES-8. New transmission capacity requirements in the baseline and exploratory scenarios

Existing total transmission capacity in the contiguous United States is estimated at 150–200 million MW-miles[35]

Figure 11: Transmission miles as a function of renewable energy shares to the U.S. grid. Source: see footnote 11.

While it is often assumed that there should be no problem siting this amount of clean energy infrastructure because "America is a big place," and that a high renewable system requires only "a couple percent" of U.S. land area, a closer examination reveals constraints. A recent analysis sponsored by CATF, the Environmental Defense Fund and the Nature Conservancy examined the possible locations for central photovoltaic solar arrays in California, after excluding areas that are legally off limits, under administrative protection, have high conservation value, or are simply not suitable for large scale solar development due to technical and economic factors. The remaining areas, shown in red in the map in Figure 12, represent about 5 million acres out of a land mass of 105 million acres in the state. Since the total requirement for solar energy buildout in a renewables-dominated system has been estimated at approximately 1 million

acres,[12] the solar requirement is therefore close to 20% of *practically available land* in California.

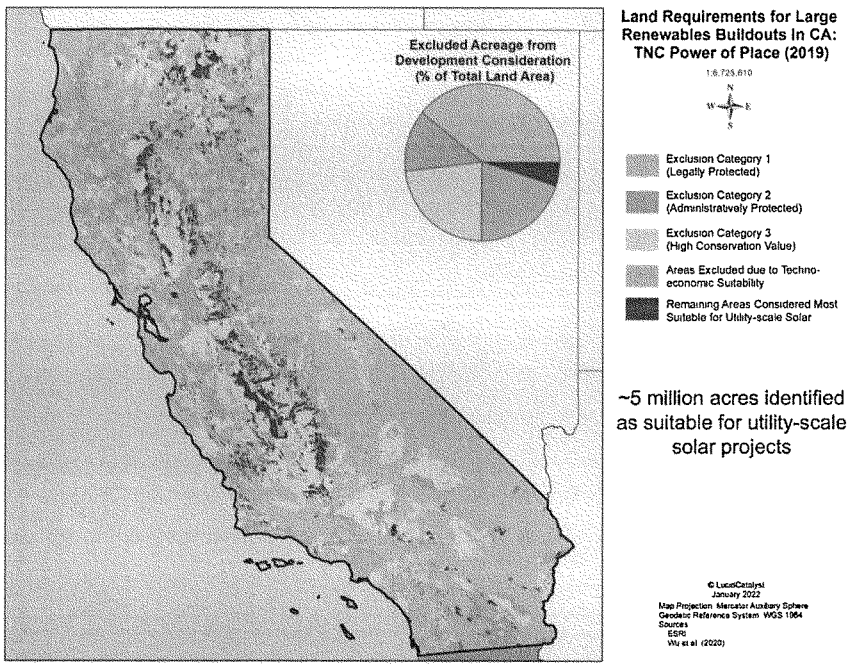

Figure 12: Land area available for utility scale solar energy development. From: Clean Air Task Force and Environmental Defense Fund, "California's Clean Energy Transition: Understanding Today's Challenges to Reach Tomorrow's Goals," Briefing for California Assembly staff, January 18, 2022.

[12] See source in Figure 10, with downscaled results for California.

This kind spatial requirement will pose challenges. Numerous recent press reports have documented a growing number of restrictive ordinances and citizen opposition. A recent comprehensive Columbia University survey report[13] concluded:

> In nearly every state, local governments have enacted policies to block or restrict renewable energy facilities and local opposition has resulted in the delay or cancelation of particular projects. Our research found 100 such local policies and 152 contested renewable energy facilities. ***Additionally, some of the states that have seen the most renewable energy development—such as Texas, New York, and Kansas—also have relatively greater incidence of opposition.*** This report demonstrates that "not in my backyard" and other objections to renewable energy occur throughout the country, and can delay or impede project development. (Emphasis added).

This suggests the problem may get worse, not better, as renewable deployment proceeds. Indeed, a recent analysis (see Figure 13 below)[14] documents that nations like Spain and Germany, which deployed wind and solar more extensively than the U.S., are experiencing an "S " curve in deployment rates, rather than the "hockey stick" deployment rates we would need to see to reach carbon goals:

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[13] Columbia University School of Law Sabin Center for Climate Change Law, "Opposition to Renewable Energy Facilities in the United States" (February 2021), http://blogs.law.columbia.edu/climatechange/2021/02/24/opposition-to-renewable-energy-facilities-in-the-united-states-new-sabin-center-report/comment-page-1/. See also S. Gross, "Renewables, Land Use and local Opposition in the United States" (January 2020), https://www.brookings.edu/wp-content/uploads/2020/01/FP_20200113_renewables_land_use_local_opposition_gross.pdf

[14] Cherp, Aleh, et al. "National growth dynamics of wind and solar power compared to the growth required for global climate targets." *Nature Energy* 6.7 (2021): 742-754.

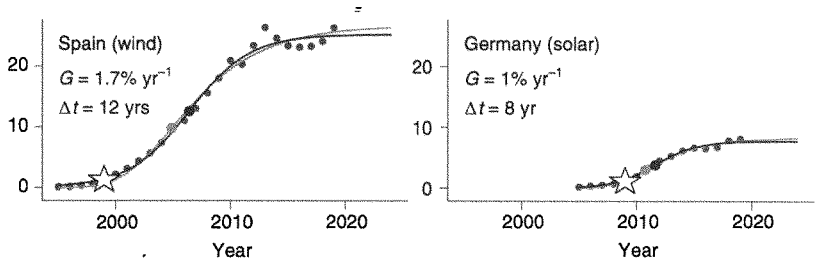

Figure 13: Wind and solar deployment rates in high renewables systems. Source: see footnote 14.

CATF is working hard with stakeholders in California and other states to develop planning, incentive and related approaches that can speed renewable energy and other clean energy development, but there is a risk that the scale of buildout required cannot be achieved in the few decades we have to solve the problem. Clean firm power with lower land use and transmission requirements could be a valuable tool to ensure we reach our goals. A comparison of the land requirements for a system with and without clean firm power in California in Figure 14, for example, suggests clean firm power, even in a renewable-dominated system, could reduce total land area requirements by a factor of three to ten and transmission mileage by a factor of 3:

Issue		With Clean Firm Power	Without Clean Firm Power
Costs for generation and transmission		~9 cents/kWh	~15 cents/kWh
California transmission and distribution costs are currently about 9 cents/kWh			
Solar and Wind Capacity		25–200 GW	470 GW
Entire US electric generating capacity is about 1,100 GW			
New Storage*	**New short-term battery capacity**	20–100 GW	160 GW
Largest battery facility now being built is 0.3 GW/1.2 GWh *CA expects to have 2 GW battery capacity in 2021*	**New energy storage**	100–800 GWh	1,000 GWh
Land Use		625–2,500 square miles	6,250 square miles
CA land area is about 164,000 sq miles			
Transmission		2–3 million MW-miles	~9 million MW miles
CA currently has about 15 million MW-miles of transmission			

**Energy storage beyond existing pumped hydro*

Figure 14: key system characteristics for a California zero carbon energy grid with and without clean firm power. Source: Long, Jane C.S., Ejeong Baik, Jesse D. Jenkins, Clea Kolster, Kiran Chawla, Arne Olson, Armond Cohen, Michael Colvin, Sally M. Benson, Robert B. Jackson, David G. Victor, and Steven P. Hamburg. "Clean Firm Power is the Key to California's Carbon-Free Energy Future." Issues in Science and Technology (March 24, 2021).

While this section of my testimony has focused on the electricity sector, nuclear energy also offers substantial opportunity for synthesis of zero carbon fuels such as hydrogen and

ammonia.[15] Indeed, since 80% of global energy is consumed as liquid and gaseous fuels rather than electricity, and we may not be able to electrify all sectors fully, nuclear-driven fuels production would be a critical option. The Infrastructure Investment and Jobs Act recognized this, in designating one of the funded hydrogen hubs to include nuclear hydrogen. Nuclear energy offers potentially three important attributes for large scale hydrogen production: greater efficiency of production via high temperature electrolysis using heat from high temperature reactors, a high capacity factor which will more efficiently utilize electrolyzers, [16] and a lower space requirement, as discussed above.

In short, clean firm energy like nuclear could be important, even essential, to achieve economy wide climate goals. But for nuclear energy to play a role at needed scale, we will need to see big changes.

II. Nuclear energy challenges and some possible solutions

Despite the promise of nuclear energy, its contribution to global electricity production has been stubbornly flat, as shown in Figure 15:

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[15] See Aurora Energy Research, Decarbonizing Hydrogen in a Net Zero Economy (September 2021) at https://www.urenco.com/cdn/uploads/supporting-files/20210927_Aurora_Hydrogen_Study_-_Decarbonising_hydrogen_in_a_net_zero_economy_-_Executive_Summary.pdf; Energy Options Network, Zero Carbon Hydrogen: An Essential Climate Mitigation Option (July 2020), at https://energyoptionsnetwork.org/assets/uploads/Hydrogen_Report_final_long_080320_v2.pdf?_cchid=45b2875b85350c341a53d50425c4e3a9 ; Bridging the Gap: How Nuclear-Derived Zero-Carbon Fuels Can Help Decarbonize Marine Shipping, Clean Air Task Force, August 2021, https://www.catf.us/wp-content/uploads/2021/08/NuclearZCFMarineShipping.pdf

[16] See Aborn et al, "An Assessment of the Diablo Canyon Nuclear Plant for Zero-Carbon Electricity, Desalination, and Hydrogen Production," at p. 86 et seq., https://energy.stanford.edu/publications/assessment-diablo-canyon-nuclear-plant-zero-carbon-electricity-desalination-and

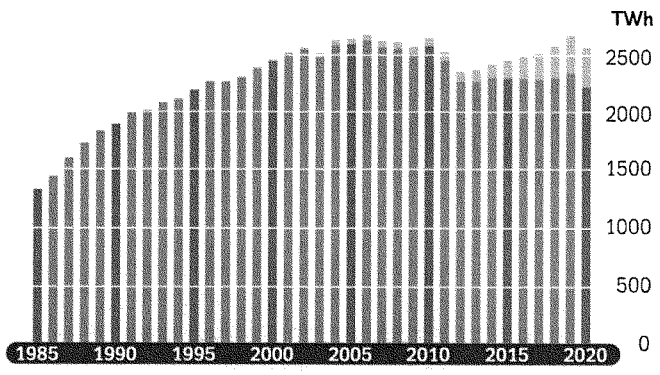

Figure 15: Annual global power production from nuclear energy (yellow bar portions represent China nuclear energy output). Source: M. Schnneider, "The World Nuclear Industry: Status Report 2021," https://www.worldnuclearreport.org/IMG/pdf/wnisr2021-hr.pdf

Foremost among the reasons for the global stall are the high cost and delays associated with recent American and European projects. The two are related, as delays result in additional interest costs during construction.

However, high cost and delay are not inevitable, as best construction and project management practices and the building of standardized multiple units have shown elsewhere. A recent study[17] for the UK-based Energy Technologies Institute analyzed the costs associated with more than two dozen large light water nuclear plants built over the last few decades. The first observation from the study is that nuclear costs have varied widely, by a factor of six, as shown in Figure 16 below:

[17] Energy Technologies Institute, "The ETI Nuclear Cost Drivers Project," Energy Technologies Institute (2018), https://d2umxnkyjne36n.cloudfront.net/documents/D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report_April-20.pdf

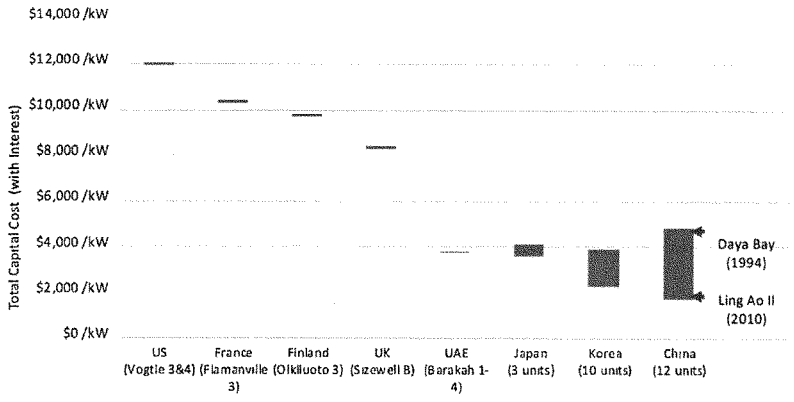

Figure 16: Variations in recent nuclear power plant costs. Source: see footnote 17.

The report, while showing Asian costs to be lower than OECD costs, decomposed cost drivers through a detailed scorecard method and found that ***the difference in unit costs was not primarily driven by differences in regulation or unit labor costs in Asia***, but rather by the efficiency of project management and other best practices. Specifically, top factors that led to higher costs included:

- The challenges of a delivery model that relies heavily on a bespoke "project" model that relies heavily on on-site construction of civil works (a substantial portion of which is necessary to contain water under high pressure) rather than upstream manufacturing and pre-assembly.

- Commencing construction with only a partially completed design.
- Doing "one off" projects rather than multiple builds, thus sacrificing learning by doing and economies of scale.

Conversely, attributes that led to lower cost units included the following factors:

- Design at or near complete prior to construction
- High degree of design reuse
- Experienced construction management
- Productive labor
- Experienced EPC consortium
- Experienced supply chain
- Detailed construction planning prior to starting construction
- Intentional new build program focused on cost reduction and performance improvement
- Multiple units at a single site
- "Nth of a kind" design

This argues for a fundamentally different U.S. strategy for nuclear energy commercialization and scale up. Historically, U.S. policy has provided support for R and D through first demonstration. This has resulted in repeat failures – "first of a kind, last of a kind for a generation" – because, inevitably, first units are most costly because they bear all the learning costs. A U.S. program to make nuclear real would emphasize standardization, support for multiple builds of the same design (not just first of a kind demonstration), high manufactured

content, design for cost, and an intentional focus on management of delivery for cost. These factors, as shown, could result in cost reductions even in current Generation III+ reactors of the kind being built in UAE.

Further cost reductions may be achievable through more advanced designs many of which rely on coolants other than water. Small modular light water reactors as well as microreactors offer opportunities for entry into new markets for nuclear energy, and potentially new revenue streams. Examples of some advanced nuclear plants[18] being developed in North America and around the world include but are not limited to those in the table below:

Coolant	Thermal Neutron Spectrum	Fast Neutron Spectrum
Water	Small Modular Reactor (SMR)	
Helium	High Temperature Gas-Cooled Reactor (HTGR) and Very High Temperature Reactor (VHTR)	Gas-Cooled Fast Reactor (GFR)
Liquid Metal	—	Sodium Fast Reactor (SFR), Lead-Cooled Fast Reactor (LFR)
Molten Salt	Fluoride-Cooled High Temperature Reactor (FHR), Molten Salt Reactor-Fluoride (MSR-fluoride)	Molten Salt Reactor-Chloride (MSR-chloride)

Figure 17: Advanced nuclear plant types. Source: see footnote 18.

Some advantages of these reactors:

- Fast reactors use more energetic neutrons to propel the reaction, potentially increasing fuel utilization and/or reducing back-end waste.
- Reactors operating with liquid metal coolant operate at high power density, therefore reducing overall radioactive material and size, due to the thermochemical properties of the coolant. Liquid metals also have higher boiling points (in the hundreds to thousands

[18]https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf?fbclid=IwAR09CR2mjhsZq6uh9cy2N0PDGSvbUUmy9zbaOp79mt_6OKfbcJMPeGRdYjU

degrees Celsius) and can reduce the risk and/or severity of a "loss of coolant" event such as occurred in the three major nuclear accidents to date.

- Molten Salt has a high boiling point, similar to liquid metal, but allows for fuel to be mixed in solution with coolant, in some designs, reducing overall volume.
- Gas cooled reactors can leverage existing gas technology, and some utilize more robust fuel designs such as TRISO.
- Many reactors cooled by substances other than water can operate at reduced pressures compared to existing reactors offering potential benefits such as decreasing the need for expensive high pressure containment.

Across the board, these advanced reactor concepts utilize passive safety characteristics, such as reduced pressures, higher coolant boiling points, and/or meltable release plugs that eliminate auxiliary equipment and improve economics while reducing accident probability as well as the consequences of accidents.

The value proposition of these advanced reactors could be substantial:

- Significantly lower capital and/or operational costs than existing plants
- Reduced material inputs
- Manufacturability or rapid deployment capability
- Passive safety systems and inherent safety strategies
- Ease of operation and maintenance
- Reduced emergency planning zones

- Reduced offsite impact during an accident and increased flexibility/scalability of siting
- Increased proliferation resistance, decreased waste production and/or actinide management capacity, and more efficient use of fuel resources
- Hybrid generation adaptability (e.g. hydrogen production, desalination, etc.) and/or load following

All of these attributes could lead to substantially lower capital, licensing and operating costs. A detailed study[19] of cost inputs to eight different advanced reactor offerings concluded that the levelized cost of energy from these designs was likely to average $60/MWH, with some as low as $40/MWH. These costs are well within the range of other firm generating capacity options in North America such as combined cycle gas, and even competitive with other zero carbon energy sources such as wind and solar (sources with much lower firm capacity value) in many parts of the country. The estimated cost spread is shown in Figure 18 below.

[19] Energy Innovation Reform Project, *"What will advanced nuclear power plants cost?" (2016),* https://www.innovationreform.org/wp-content/uploads/2018/01/Advanced-Nuclear-Reactors-Cost-Study.pdf

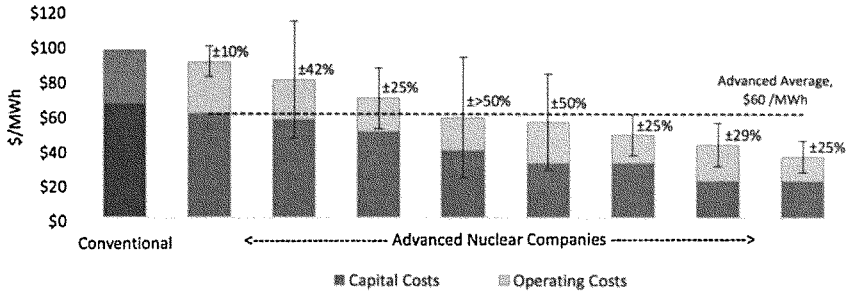

Figure 18: Advanced reactor cost estimates. Source: see footnote 19.

Another option to speed deployment of modern reactors in the U.S. at lower cost is to repurpose existing retired or retiring fossil fuel sites being used for mining, extraction, and electricity production, as is currently being pursued by Terrapower in Wyoming.[20] There are hundreds of such sites in the United States, as shown in Figure 19 below:

[20] https://www.terrapower.com/natrium-demo-kemmerer-wyoming/

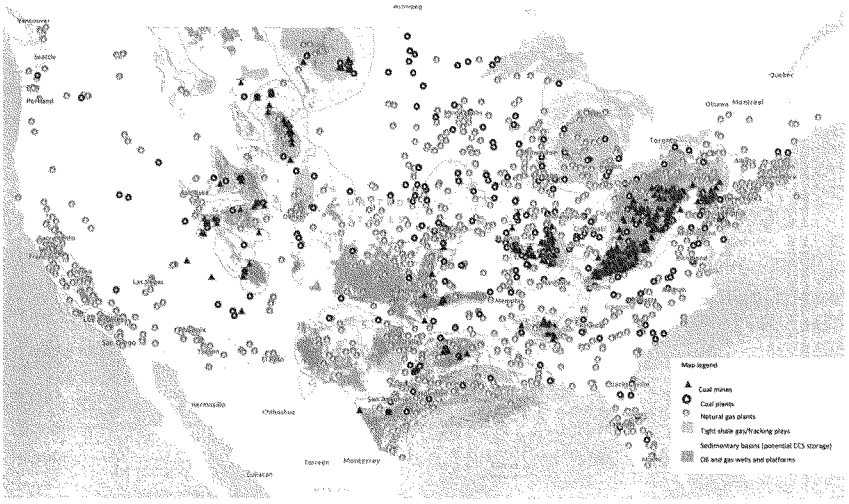

Figure 19: Existing U.S. fossil energy mining, extraction and power production sites. Source: https://atlas.eia.gov/pages/energy-maps

Site repurposing could reduce costs and speed deployment of modern nuclear energy systems by reducing site preparation requirements and utilizing existing transmission connections and infrastructure. In addition, many coal and mining communities may welcome such plants more than others, to preserve lost jobs and tax base. The Infrastructure Investment and Jobs Act (IIJA), as enacted, and the reconciliation package, contain some initial provisions that aim to capitalize on the opportunity for repurposing existing coal site:

- Authorizations for advanced energy manufacturing and recycling at or near retired coal mines and coal power plants (IIJA, Sec. 40209),
- Authorizations for clean energy demonstration on current and former mine land (IIJA, Sec. 40342)

- Increased adders for the clean energy investment and production tax credits if the facilities were built at or near retire coal mines and power plants. (Senate Finance Committee, Reconciliation Package Title (Sec. 126101(f)(11) and Sec. 126801 [45AA(g)(7)]]

However, a more comprehensive all-of-government strategy is needed to realize the potential. This approach would expand upon the provisions listed above and include additional support for remediation, feasibility studies, and demonstration.

III. Other policies to enable nuclear energy at scale

Two other federal policy initiatives could help to make nuclear energy a meaningful climate management tool: re-setting U.S. policy on spent fuel, and ensuring that the NRC is adequately supported in licensing innovative plants and performing reactor oversight while enabling developers to effectively navigate the licensing process.

Spent Fuel

Nearly everyone agrees that after forty years of deadlock, a serious re-set of federal spent fuel policy is required. It is not impossible to site a permanent geological repository for nuclear waste; other advanced industrial nations like Sweden[21] and Finland[22] have done so. But a substantial rethink will be required. CATF believes this will require a bottom-up approach in which state and communities are asked to identify their priorities and under what conditions

[21] https://www.dw.com/en/sweden-approves-plans-for-forsmark-nuclear-waste-storage-site/a-60584787
[22] https://www.forbes.com/sites/jamesconca/2021/05/31/finland-breaks-ground-on-its-deep-geologic-nuclear-waste-repository/?sh=525fcaf76103

they would host waste facilities, and for the federal government to respond; and that may require a wholesale change in program structure and approach, as was necessary in Sweden. [23] The Department of Energy's recent Request for Information on this topic[24] is welcome, and CATF intends to respond.

An Adequately Supported NRC and Functioning Licensing Environment for Advanced Reactors

There has been substantial debate around the financial structure for reactor safety oversight and licensing at the Nuclear Regulatory Commission. CATF believes it is paramount that the NRC has sufficient funding to license advanced reactors under existing regimes, develop new licensing pathways more suited for advanced rectors, as well as perform existing and future activities related to reactor and nuclear technology oversight. However, any accompanying fee structure should not raise insuperable or unnecessary barriers to advanced reactor companies, many of them thinly capitalized until their first project and stranded in the "valley of death." We believe there are serious risks for advanced reactor deployment if these balancing factors are not thoughtfully addressed.

Congress made recent laudable steps forward in the Nuclear Energy Innovation Capabilities Act of 2017 and the Nuclear Energy Innovation and Modernization Act (NEIMA) of 2019 in instructing the NRC to pursue risk-informed and performance-based regulatory pathways for

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[23] Kaiserfeld, Thomas, and Arne Kaijser. "Changing the System Culture: Mobilizing the Social Sciences in the Swedish Nuclear Waste System." *Nuclear Technology* 207.9 (2021): 1456-1468.

[24] https://www.federalregister.gov/documents/2021/12/01/2021-25724/notice-of-request-for-information-rfi-on-using-a-consent-based-siting-process-to-identify-federal

advanced innovative reactors. This will require considerable effort and reorientation of the NRC's approach, and in fact, CATF recently submitted comments[25] on the NRC's Part 53 strategy, in which we called for a reduced focus on prescriptive requirements, and instead, the development of a flexible process that can accommodate current practicable and future methods.

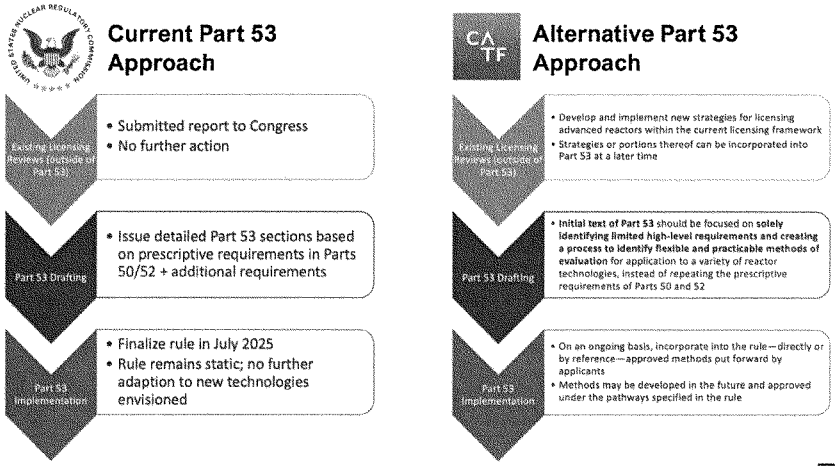


Figure 20: CATF recommended approach to advanced reactor licensing contrasted with current NRC approach.

This is not a light lift; however, we believe Congress and the NRC both recognize the need for more discussion, as well as action, as evidenced by:

- Discussion of legislation to advance licensing fee prizes, that provide fee relief to the first advanced reactor developers to achieve licensing success.

[25] "Comment of Clean Air Task Force in Response to the U.S. Nuclear Regulatory Commission's Proposed Rule on a "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors," 53https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML22011A284

- Discussion around and the introduction of HR 6154, the Accelerating Nuclear Innovation through Fee Reform Act.
- The recent Nuclear Regulatory Commission Report to the U.S. House and Senate on Recommendations and Improvement for Budgeting and Fees based on implementation of NEIMA.

CATF believes that Congress should strike an appropriate balance between the importance of sufficient funding for the NRC to carry out its duties while not stifling development of advanced nuclear projects by making the cost of licensing fees an obstacle for innovative reactor companies. In achieving this balance, we believe Congress should be guided by the general principles outlined in a recent report by the Nuclear Innovation Alliance[26] (see below):

1. **Expand public funding for advanced reactor regulatory infrastructure. Recent increases in off-fee funding at NRC have helped NRC prepare to review advanced reactor designs, but individual license applications are also innovation activities.** Large increases in non-fee funding are needed to develop the regulatory infrastructure to maintain NRC as a world- leading nuclear regulator.
2. **Significantly reform, modify, or replace the user fee cost recovery model to exclude or substantially reduce fees for new license applicants at NRC.** Multiple aspects of U.S. nuclear regulation bring benefits to the public and entities other than the applicant. Reduced fees, especially for new designs and innovative technologies, can reflect these broad benefits. Increasing the fraction of the NRC's budget that is funded from general revenues can incentivize more innovation, improve regulatory efficiency, and ensure the American regulatory environment remains competitive. If fees are not completely replaced, excluding pre-application, topical reports, and environmental reviews from fees can still bring substantial benefits. Alternative fee designs, such as fixed fees or deferred fees, could also offer flexibility compared to the current model.
3. **Alternatively, expand options for Department of Energy (DOE) funding of advanced reactor licenses.** Although the Nuclear Energy Innovation Capabilities Act authorized a program for DOE funding for advanced reactor licenses, it does not appear the program has yet funded AR licensing activities. While this would not fully address the challenges

[26] I note that I am a member of the Board of Directors of the NIA.

of the current NRC structure, Congress could consider funding this authorization, as well other measures such as licensing prizes, fee caps, flat fees, or fee deferrals.

IV. Conclusion

As social consensus emerges around the urgency of addressing climate change, so has public receptivity to nuclear energy as part of the solution toolkit. At the thought leadership level, consider the following recent opinion pieces in leading publications:

Financial Times
"The Climate Case for Nuclear Power" https://www.ft.com/content/0d0e300c-18da-449f-a545-100ab2dd207e

Bloomberg
"Nuclear Power Is More Important Than Ever" https://www bloomberg com/opinion/articles/2022-02-02/nuclear-power-is-essential-in-fighting-climate-change

The Economist
"The discreet charm of nuclear power" https://www.economist.com/leaders/2021/11/13/the-discreet-charm-of-nuclear-power"

"Will the climate crisis force America to reconsider nuclear power?" https://www.economist com/united-states/will-the-climate-crisis-force-america-to-reconsider-nuclear-power/21806194

Wall Street Journal
"A European Revelation on Climate" https://www.wsj.com/articles/a-european-revelation-on-climate-green-energy-nuclear-natural-gas-france-germany-11641228156

Washington Post
"Closing California's last nuclear power plant would be a mistake" https://www.washingtonpost com/opinions/2021/11/16/closing-californias-last-nuclear-power-plant-would-be-mistake/

"Germany is closing its last nuclear plants. What a mistake." https://www.washingtonpost.com/opinions/2022/01/01/germany-is-closing-its-last-nuclear-plants-what-disaster/

Herald Dispatch
"Editorial: WV should consider nuclear power as an option" https://www.herald-dispatch.com/opinion/editorial-wv-should-consider-nuclear-power-as-option/article_556d8f77-dad3-5aaa-88bf-eb79f2220580.html

Denver Gazette
"EDITORIAL: Colorado needs nuclear power, too" https://denvergazette.com/opinion/editorials/editorial-colorado-needs-nuclear-power-too/article_99be5a06-78ae-11ec-8977-63d6676fb60f.html

On the level of public opinion, consider these recent polls, which show a recent uptick in support for nuclear energy in the context of climate change awareness, most notably among Democrats (a greater than 50% increase in the last three years):

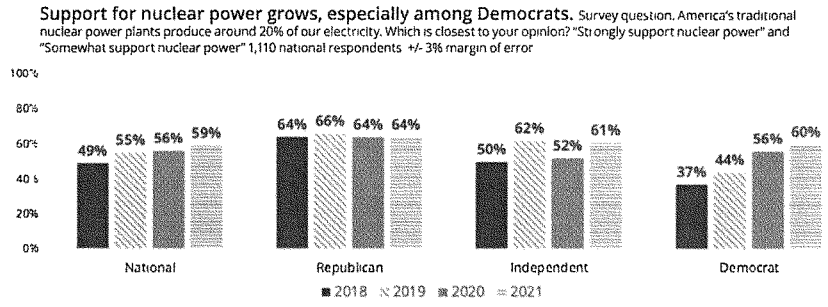


Figure 21: Source: EcoAmerica, "Energy Attitudes: Americans Support Clean Energy," https://ecoamerica.org/wp-content/uploads/2021/11/acps-2021_energy-attitudes-report.pdf

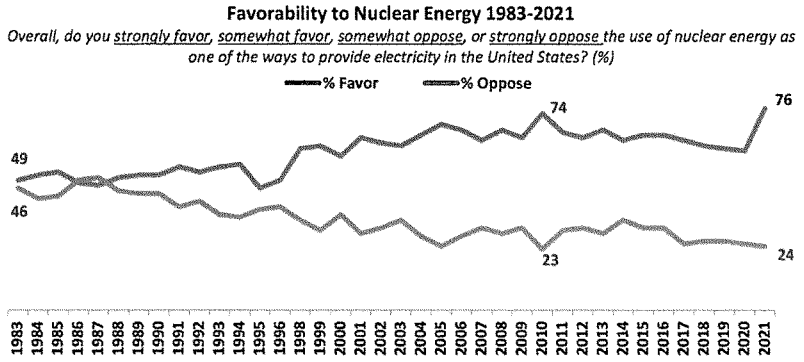


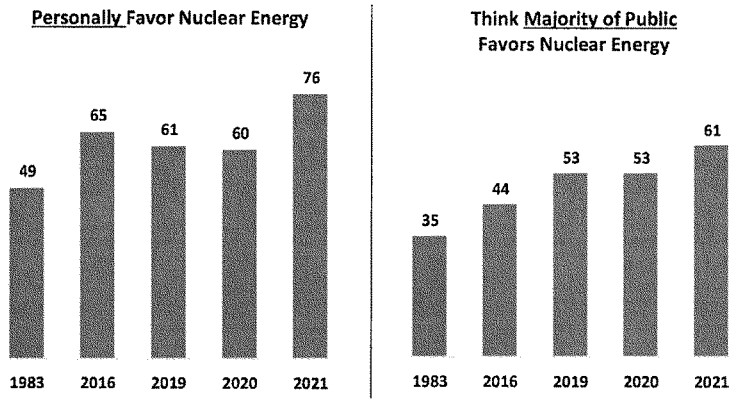
Figure 22: Bisconti Research, Inc., "Support for Nuclear Energy Grows with Climate Change Concerns" (June 2021)

http://www.bisconti.com/articles/Summary%20of%20May%202021%20Survey%20on%20Nuclear%20Energy.pdf

Most interestingly, some of the polling suggests that Americans are more favorable to nuclear energy than they ***think*** (erroneously) their fellow Americans are, which suggests room for cultural and political leadership on this topic to reduce barriers to its deployment:

Perception of Public Opinion More Favorable Now

Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity in the United States?
Do you think that the majority of people in your community favor or oppose the use of nuclear energy? (%)



Figures 23: Source: Bisconti Research, Inc., "Support for Nuclear Energy Grows with Climate Change Concerns" (June 2021)
http://www.bisconti.com/articles/Summary%20of%20May%202021%20Survey%20on%20Nuclear%20Energy.pdf

This suggests the time is ripe for nuclear energy to come back fully into the climate change strategy to complement our nation's remarkable successes with renewable energy. Policymakers must lead with bold new initiatives, building on the successes of the last few years. While many such initiatives are in development, we believe several are immediately actionable:

- Providing incentives for cost-effective scale up of advanced nuclear energy, beyond initial demonstration, to achieve scale and lower costs
- Supporting licensing processes and fee structures appropriate for advanced reactor designs both in the United States and for application of U.S. designs globally
- Fundamentally re-setting U.S. nuclear spent fuel policy by pursuing community-driven consent-based siting policies that have been successfully deployed to license permanent geological repositories in other advanced industrialized nations
- Expanding support for repurposing of retired or retiring fossil fuel sites for advanced nuclear

Thank you for your attention.

Senate Committee on Environment and Public Works
Hearing Entitled, *"A Legislative Hearing to Examine S. 2373, the American Nuclear Infrastructure Act of 2021, and S. 1290, the STRANDED Act of 2021."*
February 9, 2022
Questions for the Record for Armond Cohen

Chairman Carper:

1. Following the introduction of the American Nuclear Infrastructure Act of 2021 (ANIA), a Civil Nuclear Credit Program to assist existing reactors that are projected to close due to economic factors was included in the enacted Infrastructure Investment and Jobs Act (IIJA). The IIJA-established program authorizes and appropriates $6 billion through Fiscal Year 2026 for the Department of Energy (DOE) to implement the program. A similar program is included in ANIA, however, unlike the IIJA program, the provision included in ANIA would authorize a credit program to be administered by the Environmental Protection Agency (EPA).

    a. In your view, now that the IIJA has been enacted with a civil nuclear credit program administered by DOE, is a similar program administered by EPA needed?

    No. Now that the IIJA has been enacted with a civil nuclear credit program administered by the DOE, a similar program administered by EPA is not needed.

    b. What other policies that were not discussed at the hearing should we consider to bolster the safety and economic viability of our existing reactor fleet?

    A production tax credit, which is under consideration in the most recent version of the Build Back Better Act, for existing nuclear power plants would offer additional support that can bolster the safety and viability of our existing fleet.

2. What other policies that were not discussed at the hearing should we consider to support the development and deployment of advanced nuclear technologies, in particular accident tolerant fuels?

    The American Nuclear Infrastructure Act of 2021 (ANIA) includes prizes to incentivize the development of advanced nuclear reactors by covering licensing fees. Expanding these prizes by increasing the number of possible awardees and potential regulatory activities that they are awarded for, would incentivize further innovation and activity of advanced nuclear technology.

    Additionally, the Nuclear Regulatory Commission (NRC) has an important role to plan in the development and deployment of advanced nuclear technologies. However, the NRC functions best when composed of a full slate of five commissioners. While the current slate of three commissioners includes extremely appropriate and experienced individuals, and meets quorum requirements, the confirmation of two additional commissioners would ensure the NRC is well prepared to support development and deployment of advanced nuclear technologies, including accident tolerant fuel. Furthermore, consistent

funding at necessary levels to support advanced nuclear technology activities at the NRC is also a fundamental part of support future development and deployment.

The Build Back Better Act (H.R. 5376) includes a Production Tax Credit (PTC) of 1.5 cents per kilowatt hour for nuclear power plants and additional production and investment tax credits for clean energy technologies, including advanced nuclear. The passage of the Build Back Better Act by the Senate and into law would promote the development and deployment of nuclear energy in general, including advanced nuclear technologies.

3. Several provisions in ANIA seek to promote international commercial nuclear power cooperation with our Allies. As you stated in your testimony, U.S. export of nuclear technology can help forge long-term international partnerships while deploying carbon free energy. However, nonproliferation risks must also be central to our strategy for nuclear cooperation. Does ANIA sufficiently address risks with regard to nonproliferation?

    a. Included in these provisions are directives to the NRC to coordinate with international nuclear regulatory agencies. What currently limits the NRC's ability to cooperate internationally?

    The provision of adequate funding for the Nuclear Regulatory Commission (NRC) is essential to ensure that it the NRC able to fulfill all of its obligations, including coordinating with international nuclear regulatory agencies.

    b. What existing limitations to export of U.S. commercial nuclear technology do the provisions in ANIA help address?

    Export of U.S. commercial nuclear technology has been limited by the absence in some countries of the necessary civil nuclear regulatory organizations and legal frameworks to facilitate the development of nuclear power. ANIA helps to overcome this limitation by supporting interagency and international coordination on efforts to build these organizations and frameworks in countries seeking to develop nuclear power.

    c. Is there opportunity through ANIA to address other concerns regarding our international nuclear cooperation?

    ANIA will also require the NRC to coordinate nuclear regulation and oversight training and exchange programs provided to other countries in order to improve nuclear technology licensing. This broad coordination effort on the part of the NRC, which will include the Department of Energy, the National Laboratories, the private sector, and institutions of higher education, represents a new opportunity for the United States to improve our international nuclear cooperation.

    d. What effect would restriction of fuel imports from Russia and China have on domestic fuel supply and costs for reactor refueling?

Russian and Chinese manufactured nuclear fuel has not currently penetrated the US nuclear industry. However, in 2020, Russian uranium provided ~20% of feed material for manufacture into domestic US Nuclear fuel. Restrictions of Uranium imports from Russia could have a negative economic impact on the existing US nuclear energy industry as ~3% of US electricity comes from Russian uranium. While there are numerous other global vendors to source replacement material from, such as Canada or Australia, US-Russian uranium sales and relations have been a positive economic factor in the domestic nuclear industry. Restrictions of uranium imports from Russia may be necessary or prudent given recent global developments but concern should be made to ensure that restrictions are coupled with the necessary support to ensure no undue short-term economic burden to existing nuclear power plants. Additionally, some advanced reactor vendors see Russia as the only near-term viable option for the High-Assay Low Enriched Uranium (HALEU) needed to support aggressive advanced reactor demonstration plans, such as some of those under the Advanced Reactor Demonstration Program. Restrictions on uranium imports from Russia could negatively impact the ability of advanced reactor developers to deploy technology; however, these impacts could be lessened or eliminated if coupled with international cooperation and/or the development of a domestic HALEU supply chain supported by programs such as the Advanced Nuclear Fuel Availability Program.

4. Please describe the risks associated with the current state of spent fuel storage versus the risks associated with spent fuel transport to a centralized permanent or interim storage location. In your answer please comment on the merits of centralized fuel storage.

   The domestic nuclear industry has extensive experience with the safe storage of spent nuclear fuel as well as spent fuel transport. Decades of experience has shown that existing spent nuclear fuel storage has posed and poses no meaningful level of risk to the public. The rigorous design of transportation packaging, selection of routes, and large experience base with the transportation of radioactive materials also ensures no threat, emergent or persistent, from spent fuel transport to the public[1]. A centralized fuel storage location offers the advantage of reducing overall costs of a comprehensive spent fuel management program as well as further addressing the legacy issue of stranded spent fuel.

5. You mentioned in your testimony that the fuel supply chain needs additional attention to ensure accident tolerant fuels are developed and deployed. Please elaborate on this statement, and on whether or not there are any additional policy options that the Committee should consider in order to deploy this technology.

   a. Do the research and development efforts leading the development of accident tolerant fuels also support the fuel needs of advanced reactors?

[1] U.S. Nuclear Regulatory Commission, "Spent Fuel Transportation Risk Assessment," NUREG-2125, January 2014, https://www.nrc.gov/docs/ML1403/ML14031A323.pdf

The US fuel supply chain to support the deployment of accident tolerant fuels is well prepared to scale up as needed. The main challenge in the deployment of accident tolerant fuels is not driven by supply chain difficulties nor material availability but rather by the economic proposition associated with the adoption of accident tolerant fuels. The main challenges in the US fuel supply chain are associated with the deployment of future advanced nuclear reactor fuels, and, unfortunately, efforts associated with accident tolerant fuels have little applicability to advanced nuclear reactor fuels challenges. While some forms of accident tolerant fuels are just beginning to utilize HALEU, the enrichment needs for accident tolerant fuels is very different than those for HALEU for advanced nuclear reactor fuels. Additionally, many advanced reactors are pursuing very different fuel forms than accident tolerant fuels, such as metallic fuels or TRISO, and the needs associated with manufacturing these different fuel forms also offer little overlap with accident tolerant fuels. The two near-term advanced reactor demonstrations under the Advanced Reactor Demonstration Program both include the construction of first of a kind fuel fabrication facilities (isolated in manufacturing overlap from accident tolerant fuels) for new advanced reactor fuels.

Senator Whitehouse:

1. What more could we be doing to make sure that repurposing spent nuclear fuel stays at the heart of advanced nuclear technology innovation?

   Repurposing spent nuclear fuel can play a key role in advanced nuclear technology innovation; however, it can most effectively do that when incorporated into comprehensive and effective spent nuclear fuel management. Repurposing spent nuclear fuel can reduce waste volumes, and potentially reduce long-term costs (in exchange for increased short-term expenditures) and timescales; however, it is not a complete solution for spent nuclear fuel management on its own, as even after repurposing, there will be residual fuel volumes that require disposal. Repurposing of spent nuclear fuel will struggle to remain in the forefront of innovation in the absence of a comprehensive, multi-pronged approach, incorporating the best storage, transportation, and disposal practices. Judging by recent awards, projects and programs related to repurposing of spent nuclear fuel have been funded, but at orders of magnitude less than demonstration and other advanced nuclear supply chain activities. Cost-share support for repurposing spent nuclear fuel, such as that recently awarded to Oklo and Argonne National Laboratory, can play a key role in innovation; however, intermittent support and absence of larger strategy can hamper long term success. The United States needs a strategic fuel repurposing and transformation R and D program as a part of a comprehensive nuclear waste management approach..

Ranking Member Capito:

1. During the hearing, you expressed concern that corporate support limits in the Nuclear Regulatory Commission's (NRC) current and future annual budget requests constrain the "NRC's ability to deal with both existing safety issues as well as licensing and reviewing new reactor designs." The Nuclear Energy Innovation and Modernization Act (NEIMA)

established this limit specifically to ensure that the NRC prioritizes funding for licensing, oversight, and regulatory work rather than overhead costs. Prior to enactment of NEIMA, NRC's overhead costs exceeded 35 percent – more than one out of every three dollars the agency spent paid for activities unrelated to the agency's core mission to safely license and regulate the use of radioactive materials.

a. Will you please clarify how the current NEIMA requirement, which only limits the agency's *budget request* for overhead costs, diverts funding from NRC's ability to deal with safety and licensing issues?

Budgetary planning and requests can have a large impact on actual spending for overhead costs directly as well as indirectly through planned reductions and deferments. Overhead costs for the NRC constitute numerous areas that can affect safety and licensing issues such as human resource management, information technology, administrative services, and training. Having sufficient funding to cover potential fluctuations in these costs is necessary for the NRC's ability to deal with safety and licensing issues but conversely should not negatively impact that ability as well. The NEIMA requirement offered a novel approach to walk this fine line between flexibility, predictability, and functionality; however, many first novel approaches often require later refinement. Predictable and mostly fixed costs, such as those for administrative services, within the NRC's overhead costs offer an opportunity to address this issue through fee reform. Removing these costs from the corporate support cap through new authorizations can reduce burden on the NRC and increase flexibility as well as offering the opportunity to accommodate future NEIMA cap reductions or increased cap reductions.

Senator CARPER. Mr. Cohen, we are delighted you could join us. Thank you for that enlightening testimony.

Now we are going to turn to Maria Korsnick. Maria is still the President and Chief Executive Officer of the Nuclear Energy Institute. She will be followed by Jeremy Harrell.

Ms. Korsnick, please proceed. Thank you for joining us.

STATEMENT OF MARIA KORSNICK, PRESIDENT AND CHIEF EXECUTIVE OFFICER, NUCLEAR ENERGY INSTITUTE

Ms. KORSNICK. Thank you. Good morning, Chairman Carper, and Ranking Member Capito. My thanks to you and the rest of the committee for the opportunity to testify today. It is really my pleasure to be here.

The Nuclear Energy Institute represents more than 300 companies across the Country, including companies that own or operate nuclear power plants, reactor designers, advanced technology companies, and labor unions. Together, we are working to provide the clean, reliable and affordable electric system of the future.

On behalf of those member companies, I thank this committee for its continued support of nuclear carbon-free energy and the thoughtful legislation that we are here to discuss today. Nuclear technology is American technology. From the first commercial plant built in the 1950's to the new reactor designs that, thanks to congressional support, are moving from design to demonstration to deployment. The United States has long been the global leader in nuclear technology.

Our innovation and leadership have never been more important. The world is at an inflection point. The climate crisis requires swift action to mitigate the worst impacts of a changing climate. The urgency to act is finally catching up to the urgency of the climate crisis. We have no shortage of high-level plans. Executing them depends on our choices.

The stakes could not be higher. We need to prepare for a future that demands smarter, more reliable and more efficient energy solutions. Nuclear energy is the key to meeting our clean energy goals while ensuring our electric system remains reliable. We are moving toward alignment in support of nuclear's role in terms of policy, in terms of industry commitments, and in terms of interest from investors and consumers.

Many States, including Illinois, New Jersey, and New York, have taken steps to preserve their existing nuclear generation. Other States, including West Virginia and Wyoming, are taking steps to consider new nuclear for their future energy needs.

Preserving existing reactors offers us many years of additional carbon-free electricity while supporting SMRs and advanced reactors promises to unlock potentially game changing growth in U.S. nuclear new builds both domestically and abroad. This isn't just about reliable carbon-free energy. It is also about creating hundreds of thousands of American jobs.

I appear before you today in support of the American Nuclear Infrastructure Act. The legislation you are considering contains many provisions that will protect current carbon-free generation and maintain U.S. global leadership and a technology necessary for the decarbonization of economies around the world.

ANIA originally conceived of preserving nuclear by enabling EPA to provide payments to economically challenged nuclear plants. This idea continued to evolve and was included in the Infrastructure Investment and Jobs Act that was passed into law last fall. We are grateful for the committee's leadership on this issue. This program can help to prevent millions of tons of CO2 emissions while supporting cost-effective and reliable electricity for millions of Americans.

Further, ANIA accelerates nuclear energy innovation by providing three prizes to advanced reactor designs that complete the NRC licensing process. Navigating the regulatory process is expensive and time-consuming, and creates additional difficulties in securing financing. This unique approach will help accelerate the development and deployment of new nuclear. By creating incentives that reduce and remove these burdens, nuclear innovation can flourish.

Finally, ANIA takes a different, direct approach to bolstering U.S. leadership in nuclear energy by empowering the NRC to focus on nuclear energy export and innovation activities. This is a major step forward in leveling the playing field for U.S. companies competing with state-sponsored enterprises internationally.

The actions outlined in ANIA are not only a critical step in decarbonization and enhancing U.S. leadership, but they are also necessary combat climate change and protect our national security interests. The committee is also considering the STRANDED Act, designed to address one of the hurdles that remains to fully realizing the value of nuclear power.

NEI is supportive of Federal efforts to satisfy its long overdue obligation to remove the used nuclear fuel from nuclear power plant sites. As Congress explores options to address this community impact, we support action that advances a durable solution for used fuel management.

I thank the committee for its work to preserve America's largest source of carbon-free power and to support the development and deployment of new nuclear technologies. Nuclear energy is critical to achieving a just transition to a clean energy future. Many of the provisions in ANIA are positive toward that future.

NEI, on behalf of our members, pledges to work with you to help us get there. Thank you, and I look forward to your questions.

[The prepared statement of Ms. Korsnick follows:]

Testimony for the Record
Nuclear Energy Institute
Maria Korsnick, President and CEO

Committee on Environment and Public Works
United States Senate
February 9, 2022

I am Maria Korsnick, President and Chief Executive Officer of the Nuclear Energy Institute (NEI). I appreciate the opportunity to testify before the committee and would like to thank Chairman Carper, Ranking Member Capito, and the rest of the full Committee for having me today to discuss the critical role of nuclear energy in the United States. During my testimony, I will highlight the importance of nuclear energy and two pieces of legislation that are currently before the Committee, the American Nuclear Infrastructure Act (S.2373) and the STRANDED Act (S.1290)

The most recent United Nations IPCC report is clear that we must act now to prevent the worst consequences of climate change. To protect our environment, our economy, and future generations, we must rapidly reduce greenhouse gas emissions from all aspects of our society. This future will be centered around a clean energy system that utilizes numerous carbon-free technologies, of which nuclear will play a key role.

At the core of decarbonizing the economy is decarbonizing the electricity sector. Given the variety of mature, carbon-free technologies available in this space, we are closer than ever to achieving this goal. However, it's not enough that the grid be carbon-free, it must also be reliable and cost effective. As we've seen recently in places like Texas and California, it is all too easy to take reliable electricity for granted until a disaster strikes. In November 2021, NEI signed onto the U.N. 24/7 Carbon-free Energy Compact to help solve the issue of intermittency in carbon-free energy supplies. Making progress to a net-

zero world will require that we ensure carbon-free energy is not only available, but available 24 hours a day, 7 days a week.

Dozens of utilities are demonstrating leadership on decarbonization through significant emission-reduction pledges, and many of these same utilities are already well positioned for a low-carbon future by virtue of their existing nuclear generation. Supporting existing nuclear generation will be critical for the U.S. to achieve a net-zero future; however, new nuclear will also be needed, particularly as we add increasing shares of intermittent wind and solar generation to the grid. Exciting new nuclear reactor projects are already underway in Wyoming, Idaho, and Washington, while many other states are exploring the option of new nuclear power. Notably, West Virginia recently repealed their decades-long prohibition on nuclear energy in the state. NEI is supporting efforts to expand nuclear energy adoption, but to truly realize the full potential of nuclear energy, continued congressional support is vital.

Achieving Carbon Reduction Goals

At the U.N. Climate Change Conference in 2021, delegates from nearly 200 counties met to reaffirm the global commitment to combat climate change. Following the event, world leaders announced or reiterated their plans to reduce carbon emissions. President Biden released a strategy for achieving a net-zero economy in the U.S. by 2050. These ambitious goals will take carbon-free energy of all types to achieve. It's not enough to continue on the path we've been traveling; to combat climate change we will need bold leadership and dramatic new investments. Carbon-free nuclear energy is available now to help propel the world into a carbon-free future.

Nuclear energy already generates nearly 20 percent of U.S. electricity and half of our carbon-free electricity. The carbon-free and baseload attributes of nuclear energy are easy to take for granted. Since the first nuclear power plants were built in the 1950s, nuclear has quietly provided nearly 30 trillion kilowatt hours of carbon-free electricity, or enough electricity to power every home in the U.S. for 20 years. Nuclear

plants run 24 hours a day, 7 days a week producing power with unmatched reliability and have the added benefit of having all their fuel on site for an entire 18-to-24-month operating cycle. Nuclear plants are hardened facilities that are protected from physical and cyber threats, helping to ensure we have a resilient electricity system. And our nation's nuclear power plants provide tens of thousands of well-paying, long-term jobs.

While nuclear energy has operated for decades in the U.S., that cannot be taken for granted. Unfortunately, the past decade has seen the premature retirement of a dozen nuclear power reactors, with several more slated to close. As nuclear power plants are closed, fossil fuels are stepping up to meet electricity demands. This trend is moving us the wrong direction in our fight against climate change. Maintaining the current operating fleet of nuclear reactors is not only a sensible approach to meeting our climate targets, but failure to prevent early retirements will jeopardize the progress we have already made.

The U.S. Energy Information Administration (EIA) forecasts the retirement of 111 gigawatts of coal capacity by 2050 in the U.S.[1] In addition, the EIA estimates that demand for electricity in the U.S. will expand by around 35 percent during that time. And this estimate is at the low end. Many studies show that to fully decarbonize our economy by the President's 2050 goal, electricity production in the U.S. will need to be significantly higher. We are clearly going to need today's nuclear plants as well as a new generation of reactors to complement rising shares of wind and solar to meet this goal.

As we explore new technologies to decarbonize the economy, nuclear once again offers several promising solutions. Innovative advanced reactor designs, including small modular reactors (SMRs), are capable of solving some of the hardest decarbonization challenges. For example, industrial processes require heat that traditional reactors and other

[1] U.S. Energy Information Administration – 2021 Corporate goal Case: Annual Energy Outlook 2021 Issues in Focus: Table 1.

carbon-free sources cannot provide. Advanced reactors offer modular construction, smaller footprints, and in some cases increased operating temperatures; all of which can help displace fossil fuels currently providing this industrial heat. In addition, advanced reactors, both water and non-water cooled, are ready to be deployed to fill demand left behind by retiring coal plants. As mentioned, we already have examples of these projects underway in Wyoming, Washington, and Idaho, and more are expected to follow.

NEI recognizes that it will take a full suite of carbon-free technologies to reach net-zero. We do not expect nuclear to be the only solution to combating this crisis. However, for too long policymakers left nuclear energy on the backburner as a tool to fight climate change. Policies supporting existing reactors and new reactors are our best option in this fight and there is no better time for action than now.

U.S. National Security

While many discussions about nuclear energy have recently focused on its carbon-free attributes, it's important to remember that U.S. leadership in nuclear has substantial national security benefits. During the 20th century, U.S. leadership allowed us to promote the highest global standards for nuclear safety, security, and nonproliferation; to protect our friends and allies against energy insecurity and adverse foreign influences; and to maintain a healthy domestic supply chain that could also benefit our nuclear Navy and major DOE programs. Unfortunately, in recent years the U.S. has been overtaken on the international stage as Russia and China rush to gain market share in new builds around the world. In fact, there are more than 50 new nuclear power reactors under construction worldwide, only two of which are in the United States.[2] Preserving and expanding our nation's use of clean and reliable nuclear

[2] https://pris.iaea.org/PRIS/home.aspx

energy is essential to advancing not only America's clean energy future, but also our national security interests.

With the development and deployment of advanced reactors well underway, the U.S. is at an inflection point for our future on the international nuclear stage. It is imperative that we act now to successfully complete the demonstrations underway and deploy additional advanced reactors. The lower cost, enhanced safety features, and wider applications of advanced reactor designs make nuclear power a practical option for many countries that already use nuclear energy and many potential new adopters looking to decarbonize their economies or forge strategic partnerships with the U.S. The supplier of these next generation reactors will forge a special relationship with these counties over the century-long life of its nuclear program – from site characterization to regulatory development, training, engineering and construction, operations and maintenance, security services, and finally decommissioning. More broadly, the dominant global supplier will exert considerable influence on nuclear safety, security, and nonproliferation policies and practices.

If the U.S. is to reestablish its leadership in global nuclear safety, security, and nonproliferation; if we are to continue helping our friends and allies against foreign influence through energy supply; if we are to maintain the domestic supply chain that supplies our plants and benefits our nuclear Navy; and if we are to meet our climate goals, then we must lead in the development and commercialization of advanced nuclear reactors.

Preserving the Existing Fleet

From the dawn of the Atomic Age to the beginning of the 21st century, America was the leader in nuclear energy both domestically and abroad. However, this leadership has waned as U.S. nuclear reactors prematurely close while Russia and China rush to advance themselves to the forefront of the industry. The American Nuclear Infrastructure Act

(ANIA) is essential to help reestablish the U.S. as the global leader in nuclear energy.

America's current nuclear fleet is responsible for approximately 20 percent of the electricity demand and avoiding over 470 million metric tons of CO2 emissions every year. This is the equivalent of taking 100 million cars off the road. Not only does nuclear energy avoid more carbon emissions than any other source of energy, but it does so while providing reliable power at over a 90 percent capacity factor. This baseload attribute allows carbon-free energy to continue flowing on the grid when intermittent sources are not available. While these attributes are essential to a functioning electric grid in a net-zero world, current markets do not fully value these attributes. This, combined with cheap natural gas, has forced a number of nuclear power plants to close prematurely and several others to face the same prospect.

The trend of premature nuclear plant closures threatens America's ability to decarbonize and further erodes U.S. nuclear leadership abroad. We are grateful that the authors of ANIA addressed this issue directly, by proposing an EPA program to provide funding to enable continued operation of at-risk nuclear plants. The need for this program was obviated by the inclusion of both authorization and appropriations for a similar program, the DOE Civil Nuclear Credit Program, in the Infrastructure Investment and Jobs Act signed into law late last year. We appreciate the ANIA sponsors' strong leadership on this issue as the ANIA bill spotlighted the crucial need to preserve nuclear energy generation to meet our climate goals and help ensure the U.S. remains on the nuclear main stage globally.

Accelerating Nuclear Energy Innovation

While existing reactors create the bedrock for a net-zero future, new reactors are needed to replace existing fossil fuels and help ensure system reliability. Advanced nuclear designs offer enhanced capabilities enabling nuclear to provide more than just electricity in the future. Advanced reactors will support the decarbonization of industrial and

transportation sectors that fossil fuels currently dominate. The ANIA will help pave the way for this future by requiring the NRC to prepare a report identifying licensing issues specific to non-electric nuclear operations. This type of early action and planning is essential to support the deployment of advanced nuclear for applications other than electricity production.

To make these innovative designs a reality, we must have government support for research, development, licensing, demonstration, and early-stage deployment. The ANIA's program for Advanced Nuclear Reactor Prizes is a unique approach to spur and reward innovation by providing a cash prize to the first advanced reactors licensed by NRC in three different categories. The cash prize is equivalent to the fees paid to the NRC during the licensing process. Navigating the regulatory process is expensive and time consuming for both the developer and licensee. To further spur innovation and accelerate the deployment of advanced nuclear, the financial burden during the licensing process must be reduced. The industry looks forward to working with the committee to further address this issue in the future.

Many communities will suffer challenges as a result of the planned shutdown of coal generating facilities over the coming years. These sites and the associated transmission infrastructure could be reused for an advanced reactor. This could potentially mitigate the financial burden and job losses associated with retiring coal generating facility. NEI suggests the inclusion, in the ANIA, of a grant program for communities with retiring coal assets to study the potential deployment of advanced nuclear would help enable a smoother transition for these communities.

U.S. Leadership in Nuclear Energy

As mentioned earlier, American leadership in nuclear energy has been deteriorating in recent decades. A driver of this trend is the prevalence of state sponsored enterprises competing in the global market. U.S. nuclear energy companies come to the international table at a disadvantage. State-run nuclear companies are able to offer innovative financing and

geopolitical benefits to customers that private U.S. companies cannot match. Leveling this playing field is of the upmost importance if the U.S. is to regain its position as the global leader in nuclear energy.

The ANIA empowers NRC to focus on nuclear energy export and innovation activities. Increasing the NRC's focus on these commercial activities will help to support U.S. national security. By positioning the NRC to accelerate the acceptance and penetration of U.S. nuclear energy technologies internationally, U.S. companies are better able to compete with state enterprises in the global marketplace. In addition, the ANIA takes a significant step in enabling increased investment in U.S. nuclear energy infrastructure by our allies. This change will accelerate demonstration and deployment activities domestically and abroad, further strengthening American leadership.

While there is no silver bullet for solving climate change, the nuclear energy support in the ANIA is a solid step in the right direction. The passage of the ANIA would signal to the world that America is ready to take back the lead in nuclear energy.

Communities Affected by Plant Closures

Communities can be adversely affected when a nuclear plant shuts down. They lose the economic benefits that existed when the plant was producing carbon-free electricity, including hundreds of well-paying jobs and a significant portion of the local tax base. Even after the plant is decommissioned and the site is restored, there can be the loss of economic opportunities that would be available to redevelop the site if it were not for the continued storage of used nuclear fuel. The ANIA and STRANDED Act includes provisions to assist with local economic development activity while the STRANDED Act also provides additional financial assistance to local governments for the used nuclear fuel stored at a decommissioned nuclear site.

The best way to avoid the impacts of premature plant closures is to prevent those closures. Many states have done their part on this front by

enacting programs to recognize the valuable attributes provided by nuclear generation. With the bipartisan enactment of the DOE Civil Nuclear Credit Program, similar to ANIA's credit program, Congress has appropriately followed suit. Although there is considerably more work to be done to avoid premature plant closures—and the impacts they can have on local communities—I again express my gratitude for the Committee's leadership in this area.

When plants do close, however, it is important to remember that the nuclear industry manages its assets better than any other industry. Throughout the operating life of a nuclear plant funds are set aside to provide for its decommissioning. Today, after plants shut down, they are expeditiously dismantled, radioactive components are shipped to established low-level waste disposal sites, and the former reactor sites are restored for future use. The only thing that remains is the spent nuclear fuel, which is safely stored in multi-layered storage canisters designed to withstand disasters such as earthquakes, tornados, and wildfires.

Industry has done its part in restoring the sites and assuring the long-term safety of the dry cask storage systems. It is the federal government's responsibility to remove these transportable storage systems and ultimately dispose of the used fuel. NEI is supportive of federal efforts to satisfy its long overdue obligations to remove used nuclear fuel from nuclear power plant sites. We are encouraged by DOE's recent efforts to develop a consent-based process to identify sites where these dry cask storage systems can be consolidated for more efficient storage until disposal capability is available. There are also two private initiatives underway seeking to provide consolidated interim storage capability. Congress should support efforts to move fuel from shut down reactor sites so that the owners of the restored sites can again create opportunities that benefit the communities. We look forward to continuing to work with lawmakers to reach bipartisan consensus on the best approach for the long-term management of the nation's used fuel.

Conclusion

I want to thank the Committee considering the importance of nuclear in meeting our climate goals and preserving our national security. The Committee's support for nuclear is arguably more important now than it has ever been and we at NEI are encouraged by the thoughtful legislation being proposed. The ANIA tackles many of the challenges advanced nuclear reactor designs have faced in recent years and makes significant strides in setting up the U.S. to regain nuclear energy leadership globally. It also is important to continue advancing long-term solutions for used nuclear fuel management. The Committee's focus on meeting the government's obligations is crucial and we look forward to making progress. Finally, I would like to end on an optimistic note. While the challenges of climate change and regaining our leadership on the nuclear stage may seem to be tall tasks, it has been shown time and time again that a bet against American determination is faulty. With the help of the members of this committee and the broader Congress, I have no doubt that we can become the world leader in nuclear energy once again and enjoy all of the benefits associated with that position. Thank you.

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Senate Committee on Environment and Public Works
Hearing Entitled, *"A Legislative Hearing to Examine S. 2373, the American Nuclear Infrastructure Act of 2021, and S. 1290, the STRANDED Act of 2021."*
February 9, 2022
Questions for the Record for Maria Korsnick

Chairman Carper:

1. During our December hearing with the NRC commissioners, the commission testified that only three percent of the NRC's workforce is under the age of 30 – with the industry not far behind. Have NEI members expressed similar concerns with the need for an influx of skilled workers in the nuclear industry and at the NRC?

As the world explores new technologies to decarbonize the economy, nuclear once again offers several promising solutions. Innovative advanced reactor designs, including small modular reactors (SMRs), are capable of solving some of the hardest decarbonization challenges. Advanced reactors offer modular construction, smaller footprints, and in some cases, increased operating temperatures, all of which can help displace fossil fuels currently providing this industrial heat. In addition, advanced reactors, both water and non-water cooled, are ready to be deployed to fill demand left behind by retiring coal plants. As mentioned, we already have examples of these projects underway in Wyoming, Washington and Idaho, and more are expected to follow.

Ensuring a sustainable nuclear workforce has been a continuing priority for the industry for nearly two decades. Moreover, given the growth that is expected with the influx of innovative technologies under development, as well as the continued long-term operation of existing light water reactors, recruiting and retaining a qualified nuclear workforce are essential to meeting our decarbonization goals. The industry has taken significant strides in this respect and has achieved notable progress in hiring skilled workers under the age of 30 in our workforce. As the nuclear industry continues to modernize and innovate, it is essential that the NRC similarly continues to identify opportunities to recruit and retain its workforce while seeking ways to use its resources in the most efficient manner.

   a. Would you comment on the state of the nuclear workforce needs considering the COVID-19 pandemic, and what the American Nuclear Infrastructure Act of 2021 (ANIA) does or can do to address these concerns?

Much has been done in recent years to bolster the U.S. nuclear workforce, but action is still needed to support a strong nuclear energy future. In 2020, 69 percent of nuclear fuels employers reported having an inadequate number of employees. Despite this, nuclear fuels employers are expecting annual job growth of 7.6 percent. During 2020, 89 percent of nuclear generation firms reported that hiring was somewhat or very difficult. Supporting the nuclear workforce supports Americans of all backgrounds. According to the most recent USEER report, the nuclear workforce includes 34 percent women and 34 percent non-white racial minorities (a higher percentage than the national average). Nuclear energy is a leader in diversity and losses to the nuclear workforce are a step backward in the fight for increasing diversity across sectors. In

addition, many jobs in the nuclear industry are union jobs. The nuclear workforce consists of 21 percent union workers, which is the highest of any energy technology category.

With the deployment of conventional and advanced reactors, the nuclear workforce is expected to grow. According to the DOE, the Natrium project in Wyoming will create thousands of construction jobs and hundreds of continuous operations jobs. And that is just one reactor. As we move to a net-zero economy, many new reactors will be needed to provide clean, reliable power to complement growing numbers of wind turbines and solar panels. Supporting the nuclear workforce isn't just about ensuring we have the capacity to support the existing fleet, but that we have the capacity to support the nuclear energy expansion necessary to combat climate change.

NEI is appreciative of the Nuclear Energy Traineeship Program in the ANIA to support the development of the next generation of nuclear workforce. This program will support the educational and hands-on training requirements for the U.S. to maintain our existing fleet and support a new generation of nuclear energy. In addition, the ANIA creates strong support for future nuclear energy development, which creates additional opportunities for long-lasting, well-paying nuclear energy jobs. This synergistic approach will drive success for many years to come.

b. You mentioned in your testimony efforts by the NRC to allow coal operators to receive credit for operating experience should a coal facility be repurposed for nuclear power. Are there any other opportunities in the workforce provision of ANIA to support job retraining efforts for energy transition communities?

In October 2021, the energy consulting firm ScottMadden released a paper analyzing the job and economic impact of a coal-to-nuclear transition. In its report, it was found that many of the jobs at a small modular reactor (SMR) require a similar skillset to the coal plant the SMR would be replacing. In fact, not only were many of the jobs similar in skillset, but the SMR actually employs over double the workforce of the coal plant. These nuclear jobs pay on average 17 percent more than their coal counterparts.

As identified by the ScottMadden report, the opportunity for transitioning the workforce from a coal plant to a nuclear plant is enormous. There are several actions that could be taken through ANIA to bolster job retraining efforts for these energy transition communities. First, as coal communities increasingly look to nuclear energy for their future, now is an opportune time for the NRC, through its grant programs, and DOE to support these communities to pilot the first workforce transition programs. Establishing a pilot program within the ANIA would help alleviate roadblocks to transition now and pave the way for other communities to follow. Second, the first project to transition coal communities will be the most expensive as processes are developed and education and training infrastructure is built out. Authorizing appropriations in ANIA to support these first projects would help overcome any initial hurdles to program development. Incorporating these two elements into ANIA's workforce provision would set energy transition communities up for success as we move forward into a new age of carbon-free energy in the United States.

2. Following the introduction of the American Nuclear Infrastructure Act of 2021 (ANIA), a Civil Nuclear Credit Program to assist existing reactors that are projected to close due to economic factors was included in the enacted Infrastructure Investment and Jobs Act (IIJA). The IIJA-established program authorizes and appropriates $6 billion through Fiscal Year

2026 for the Department of Energy (DOE) to implement the program. A similar program is included in ANIA; however, unlike the IIJA program, the provision included in ANIA would authorize a credit program to be administered by the Environmental Protection Agency (EPA).

a. In your view, now that the IIJA has been enacted with a civil nuclear credit program administered by DOE, is a similar program administered by EPA needed?

NEI appreciates the committee's leadership in proposing the first Civil Nuclear Credit (CNC) Program through ANIA. Given the CNC program enacted by IIJA at DOE, a similar program is no longer necessary at EPA. However, there is an opportunity to expand the existing program at DOE to cover additional years past the current expiration of the program.

b. What other policies that were not discussed at the hearing should we consider to bolster the safety and economic viability of our existing reactor fleet?

NEI continues to support a nuclear production tax credit (PTC) for existing nuclear reactors. Enacting a PTC would value nuclear energy for its carbon-free attributes and help level the playing field with other renewable sources receiving a PTC.

3. What other policies that were not discussed at the hearing should we consider in order to support the development and deployment of advanced nuclear technologies, in particular accident tolerant fuels?

The United States is leading the world in the development of Accident Tolerant Fuels (ATF). However, Russia and China are quickly gaining ground and the U.S. industry sees three challenges that could impact deployment timelines. First, industry appreciates the strong funding support given to ATF by Congress. However, additional support is needed to maintain the momentum for timely deployment. Industry has experienced challenges with DOE funding shortfalls, unpredictable disbursements to fuel vendors, and DOE's use of appropriations for national laboratory infrastructure that have created schedule challenges. Irradiation, testing and simulation capabilities at national laboratories need enhancements to support industry's development and deployment schedules. However, national laboratory appropriation should supplement rather than subtract from vendor program funding. Second, in a similar approach to the NRC licensing modernization effort for advanced reactors, NRC needs to develop an efficient and modern regulatory framework to license ATF with increased enrichment and higher burnup in an efficient manner. The industry cannot wait for the traditional 20-year NRC fuel licensing timeframes.

4. Several provisions in ANIA seek to promote international commercial nuclear power cooperation with our allies. As you stated in your testimony U.S. export of nuclear technology can help forge long-term international partnerships while deploying carbon-free energy. However, nonproliferation risks also must so be central to our strategy for nuclear cooperation. Does ANIA sufficiently address risks regarding nonproliferation?

Yes. Section 103 of ANIA adds additional nonproliferation provisions for exports under 10 CFR Part 110 including the requirement of a non-inimicality finding if a country does not have an

Additional Protocol in effect or is not a party to the Convention on the Physical Protection of Nuclear Material.

a. Included in these provisions are directives to the NRC to coordinate with international nuclear regulatory agencies. What currently limits the NRC's ability to cooperate internationally?

U.S. nuclear suppliers enter the global marketplace at a disadvantage. They compete not with other private companies, but with state-sponsored enterprises that can offer host countries a range of incentives not available to private entities. To fill this gap, the U.S. government must support U.S. nuclear suppliers engaging in business abroad.

Today, the NRC's international program office supports cooperation with and assistance to foreign regulators. This program is undersized and under-resourced when compared to growing global demand, especially with the advent of new technologies like SMRs and advanced reactors. The ANIA enables the NRC to support U.S. leadership in nuclear internationally through the establishment of a dedicated branch to enable coordination: the International Nuclear Reactor Export and Innovation Branch. Importantly, the ANIA establishes this program off the fee base, which will enable important national objectives to be achieved without creating an undue burden to U.S. industry. The ANIA allows for direct investment by our allies into domestic nuclear plants. The removal of the prohibition on foreign ownership allows U.S. companies to partner with our allies to prove technologies domestically and enable future export opportunities. The combination of these provisions is critical in re-establishing U.S. leadership in nuclear internationally.

b. What existing limitations to export U.S. commercial nuclear technology do the provisions in ANIA help address?

Regulatory approval of technologies is often an expensive and time-consuming process for U.S. exporters and one that must be repeated in each country to which a technology is exported. Section 103 of ANIA provides for increased authority for the NRC to support interagency activities related to use of international standards, as well as regulatory capacity building abroad and training to improve nuclear licensing. If effectively implemented, this may help facilitate licensing of U.S. technologies abroad. A major hurdle to exporting U.S. commercial nuclear technology is the burden of the interagency process. In many cases, an interested party does not know where to start if they are interested in exporting or importing U.S. nuclear technology. And once they determine where to start, the process is slow and expensive. The ANIA addresses this by empowering the NRC to lead on international nuclear export activities. This creates a single point of contact, funded by appropriations, to coordinate these activities, thus greatly reducing the burden on U.S. suppliers.

c. Is there opportunity through ANIA to address other concerns regarding our international nuclear cooperation?

A major impediment to U.S. nuclear energy exports is the cumbersome export control process under 10 CFR Part 810. Despite recent improvements by DOE, the average time to process a Part 810 specific authorization remained at nine months in 2020. By comparison, other leading nuclear supplier countries require between 35 and 90 days to process a nuclear export license.

This immense disparity is a significant competitive disadvantage for U.S. companies trying to compete abroad. It doesn't have to be this way. In a "fast-track general authorization implemented for certain deemed exports," DOE has demonstrated that a streamlined process is possible without compromising national security or nonproliferation objectives. Expanding the fast-track procedures for nonsensitive technologies through ANIA would greatly improve U.S. competitiveness in international nuclear markets.

d. What effect would restriction of fuel imports from Russia and China have on domestic fuel supply and costs for reactor refueling?

The provisions of Section 102 for "Covered Fuel" imports from Russia and China are protective for domestic fuel fabricators. These provisions would not create a supply challenge for U.S. utilities and are expected to have little to no impact on costs for reactor refueling.

5. Please describe the risks associated with the current state of spent fuel storage versus the risks associated with spent fuel transport to a centralized permanent or interim storage location. In your answer, please comment on the merits of centralized fuel storage.

The transition from at-reactor storage through transportation to centralized storage is less a trade-off of risks and more a continuum of progress. This continuum builds on the industry's successful use of robust dry-cask storage technology to store spent fuel safely and securely at sites in 35 states. Industry has maintained 3,600 dry cask storage systems over the past 35 years at reactor sites. These robust casks protect public safety and the environment with multiple layers of concrete and steel containment, and with no moving parts. These systems are designed to be transportable and after shipment can then be stored with the same assurance of safety at centralized sites and potentially permanently disposed of in geologic repositories. Transportation of used nuclear fuel is proven as 1,300 shipments have been conducted in the U.S. and many more internationally.

The risks associated with storage and transportation are low in all cases. This was recently affirmed by the U.S. Nuclear Regulatory Commission in two environmental impact statements addressing the two proposed private centralized interim storage (CIS) facilities in Texas and New Mexico.

The merits of centralized interim storage come in the form of significant improvements in the efficiency with which we continue to safely manage spent fuel. Consolidating security, monitoring, inspection and aging management efforts at CIS facilities would create significant operational efficiencies and reduce overall fuel management costs. In addition, by safely relocating robust dry-cask storage systems currently spread across 35 states, the country would appropriately begin to establish an integrated approach to used fuel management. This would start to ease the $1 million per day financial burden on U.S. taxpayers caused by the federal government's inaction. It also would spur economic development by allowing for the redevelopment of nuclear sites that are fully decommissioned but for the continued storage of used fuel.

The efficiency improvements associated with CIS also were noted in the two environmental impact statements mentioned above. Each one found the cost of centralized storage, including transportation, to be less than the no-action alternative.

6. Do you agree that compensating communities for their hardships brought on by storing spent fuel is a vital component of a comprehensive nuclear waste strategy?

The storage of spent fuel, in and of itself, does not represent a hardship to communities. When all that remains on a former nuclear plant site is a used fuel storage facility, the surrounding communities do lose the economic benefits that existed when the plant was producing carbon-free electricity, including hundreds of well-paying jobs and a significant portion of the local tax base. Even after a nuclear plant is decommissioned and the site is restored, there can be a loss of economic opportunities that would be available to redevelop the site if it were not for the continued storage of used nuclear fuel.

We continue to believe that the best way to address this loss of economic opportunity is for the federal government to fulfill its responsibility to remove transportable spent fuel storage systems and ultimately dispose of the spent fuel. NEI is encouraged by DOE's recent efforts to develop a consent-based process to identify sites where these dry cask storage systems can be consolidated for more efficient storage until a disposal facility is available. There also are two private initiatives underway that may be available for this purpose. Congress should support efforts, such as these, to move fuel from shut-down reactor sites so that the owners of the restored sites can again create opportunities that benefit the communities. We look forward to continuing to work with lawmakers to reach bipartisan consensus on the best approach for the long-term management of the nation's spent fuel.

7. In your testimony you mentioned the value proposition of accident tolerant fuels. Please describe the value of pursuing this technology.

    a. Do your member companies agree that accident tolerant fuels are necessary for the future of the industry?

Accident tolerant fuels (ATF) are an important piece of the industry's future. ATF can enable additional safety, increase operational margins, improve fuel reliability, reduce spent fuel, and enhance plant economics to support continued plant operation and license renewal of nuclear power plants. ATF enables more efficient fuels with increased enrichment and higher burnup that lower fuel costs and extend production cycles for nuclear power plants by reducing the amount of fuel loaded per refueling and enable plants to transition to 24-month refueling cycles. ATF can enhance safety, make the plants more cost-effective and reduce the amount of spent fuel generated by ~20%. Less spent fuel leads to a smaller federal government obligation for spent fuel storage, transportation and disposal costs. The number of dry casks required to store spent fuel is reduced by approximately 1,800 casks assuming an 80-year operating life, which equates to ~$3.5 billion savings for the federal government. ATF also paves the licensing pathway for advanced reactor fuels.

    b. Do the research and development efforts behind accident tolerant fuels also support the fuel needs of advanced reactors?

Current accident tolerant fuel (ATF) concepts are designed for use in existing light water reactors. Specific ATF technologies have the potential for use in SMRs and advanced reactors with some adaptation. Today's ATF research and development also exercise the NRC licensing process and supply chain development for fuel applications with higher enrichment that is required for advanced reactors. ATF advancements are paving the way for a more efficient regulatory framework for advanced reactor fuels.

c. Other than additional investment, are there any other policy needs to deploy this fuel technology?

In addition to investment, the NRC must develop an efficient and modern regulatory framework to license ATF with increased enrichment and higher burnup more efficiently.

Senator Whitehouse:

1. What more could we be doing to make sure that repurposing spent nuclear fuel stays at the heart of advanced nuclear technology innovation?

Doing more of what is already being done would be the most effective approach. DOE has recently entered into a number of public-private partnerships with advanced technology suppliers to develop the infrastructure for repurposing spent nuclear fuel. The ongoing efforts of ARPA-E and the recent agreement between Oklo and Argonne National Laboratory to commercialize advanced fuel recycling are two examples. It is important that these partnerships succeed. To be commercially viable, they must result in solutions that can be economically deployed in competitive electricity markets. To get to that point, DOE support is needed as they work to overcome first-of-a-kind implementation challenges. We look forward to continuing to work with Congress in support of these partnerships.

Ranking Member Capito:

1. The Nuclear Energy Innovation and Modernization Act (NEIMA) established limits on the amount of funding the Nuclear Regulatory Commission (NRC) may request in its Congressional Budget Justification for corporate support, or overhead, costs. Those limits were established to ensure that the NRC prioritizes funding for licensing, oversight and regulatory work in the budget development process. Prior to enactment of NEIMA, NRC's overhead costs exceeded 35 percent – more than one out of every three dollars the agency spent paid for activities unrelated to the agency's core mission to safely license and regulate the use of radioactive materials.

   a. Will you please describe who pays for these overhead costs, such as NRC's rent payments to the Government Services Administration for office space used by a different federal agency, due to NRC's fee-recovery structure?

These overhead costs comprise approximately 30 percent of the NRC budget and are paid through annual fees collected from NRC licensees.

b. Do you support congressional efforts to prioritize ratepayer funding for activities that directly support NRC achieving its mission?

Ratepayers continue to be faced with increased financial burdens because of the continued growth of the NRC budget combined with the loss of operating plants. Included in this increased burden are corporate support costs, which, with limited exception, do not directly support NRC's mission. Ratepayer funding of NRC corporate support costs should be limited to those activities that directly support the NRC's mission.

In addition, under the current fee structure and definition of corporate support, NRC licensees have paid approximately $21 million in rent subsidy to other federal agencies for the Three White Flint North building since FY 2014 and are expected to pay an additional estimated $27 million through FY 2027. This rent subsidy does not support the NRC's mission. NRC licensees should not be required to subsidize the rent of other federal agencies.

2. What other policies could Congress consider to facilitate a predictable, affordable and efficient regulatory review process for advanced nuclear technologies?

We appreciate Congress's focus, through legislation like NEIMA and other actions, to ensure that the NRC establishes a modern and efficient regulatory framework for advanced reactors and is ready to license these technologies through a predictable, affordable and efficient regulatory review process. Industry and stakeholders continue to engage the NRC to modernize and become more efficient by developing perspectives such as the industry regulatory priorities (ML20353A393), application experience (ML21160A246), recommendations for Part 53 rulemaking (ML21309A578), and opportunities to reduce the duration of licensing reviews. Congressional oversight of the NRC has been instrumental in the advances that have been made and continued oversight will help ensure that the NRC can efficiently, effectively and rapidly review new applications so that advanced nuclear can be deployed in a timely manner. We also are evaluating whether additional congressional action would be helpful to achieve these goals, given the rapid growth in market interest in advanced reactors and the potential for new challenges in moving from a focus on the licensing of a few first-of-a-kind plants to a large scale deployment. This change in environment will place additional pressures on the NRC, and its licensing process must be made more efficient. We look forward to continuing to work with Congress to identify additional actions that may be helpful in this regard.

In a similar approach to the NRC advanced reactor licensing modernization effort, the NRC needs to develop an efficient and modern framework to license ATF with increased enrichment and higher burnup. Industry cannot wait for the traditional 20-year NRC fuel licensing timeframes.

Senator CARPER. Ms. Korsnick, thank you for your valuable testimony. It was great to see you. Welcome, and thank you, and our best to everyone at the Institute.

Finally, batting cleanup is Jeremy Harrell. Jeremy is the Chief Strategy Officer at ClearPath Action. Jeremy, welcome today, and you are recognized to give us your testimony. Thank you.

STATEMENT OF JEREMY HARRELL, CHIEF STRATEGY OFFICER, CLEARPATH ACTION

Mr. HARRELL. Thank you. Good morning, Chairman Carper, Ranking Member Capito, and members of the committee. My name is Jeremy Harrell, and I am the Chief Strategy Officer at ClearPath Action. We advance policies to accelerate breakthrough innovations that reduce emissions in the energy and industrial sectors.

Additionally, I represent the U.S. Nuclear Industry Council as the chairman of its board.

Clean energy and climate is regularly top of mind here in Washington as well as many of your constituents. While there is no silver bullet that will solve the urgent climate challenge, accelerating the global deployment of American advanced nuclear reactors will significantly reduce emissions and meet growing energy needs.

The International Energy Agency projects nuclear generation needs to double by 2050 to meet net-zero emission goals. Dozens of American entrepreneurs developing advanced nuclear technologies are racing toward that cause. The bipartisan American Nuclear Infrastructure Act could help unlock their deployment at scale.

I want to underscore three key points in my testimony today. First, advanced nuclear is here now. The Nuclear Regulatory Commission could receive roughly 10 new license applications before 2025, all looking to build advanced reactors over the next decade. Today's NRC is not equipped to effectively conduct those reviews.

Second, the world's clean energy future requires nuclear energy, as illustrated by the IEA's projections. The only real question is, will it be American nuclear or will it be Chinese or Russian?

Finally, the American Nuclear Infrastructure Act is the natural next step in a series of big legislative wins spearheaded by leaders of this very committee. ANIA can ensure that advanced nuclear meets its potential, contributing immensely to global security, economic growth, and emissions reductions.

We are truly at an exciting time for the American nuclear industry. Nuclear power has re-emerged as a smart, reliable power source and an integral part of global emission reduction efforts. A flurry of next generation nuclear reactor companies, including Oklo, X-energy, TerraPower, GE, Kairos, and NuScale are all on the cusp of building reactors in the next decade. These technologies provide clean, reliable power and create jobs in local communities, but also offer additional benefits relative to traditional reactors.

Advanced reactors are smaller, which allow them to be sited in new locations. They can operate flexibly to complement renewable energy, are walk-away safe, and can decarbonize industries beyond the power sector with their high temperature steam and heat.

In other words, these technologies are a new breed of reactor, much different than the fleet the NRC has regulated for nearly 50 years. Many of the NRC's existing requirements are not relevant to these new designs.

Two Congresses ago, this committee wisely enacted the Nuclear Energy Innovation and Modernization Act, otherwise known as NEIMA, directing the NRC to prepare for the licensing of advanced reactors. Advanced reactor companies are ready now, but the NRC is not.

Oklo, for example, the first advanced reactor company to submit a license application the NRC, recently had its application rejected. NuScale, the first small modular reactor, took 5 years and half a billion dollars to get a design certification. There will always be hiccups for first movers, but that cannot become the norm for the review of new technologies.

The NRC must modernize its processes to unlock the potential of these companies rather than add layers of unnecessary and overly burdensome regulations. Licensing is a necessary step between the development of new designs and commercialization. If America is not proactive, the U.S. could fail to meet its own clean energy pledges while also losing ground to China and Russia on technological innovation.

Which leads me to my next point on the global picture: climate change is an urgent global challenge that merits significant action at every level of government and the private sector. While the U.S. and a few others have reversed emissions trajectories, much of the rest of the world is growing their emissions as they grow their populations, their industries, and their quality of life. We need an American innovation-focused approach to solve the global climate challenge.

As I mentioned earlier, nuclear generation will need to at least double globally by 2050 to meet carbon neutrality goals, meaning new nuclear capacity additions, in addition to what we already have operating, need to reach 30 gigawatts per year by the early 2030's. That is the annual equivalent of enough electricity for 20 million households.

That is daunting, but is also a huge opportunity. Nearly 50 countries are projected to have markets for advanced nuclear before 2050, a more than $360 billion market opportunity for the American supply chain. Make no mistake about it: if the U.S. does not seize that opportunity, China and Russia will.

So how does the U.S. seize this moment? Thankfully, Congress has recognized the importance of nuclear energy. Significant bipartisan legislation has been passed, providing both robust support for the existing civilian fleet and for the R&D of nascent nuclear technologies. Now, Congress must provide the direction needed to ensure there is a clear path for the next generation to be licensed, sited and permitted.

The American Nuclear Infrastructure Act contains several provisions in this very vein. These policies include prizes to offset initial licensing costs for first movers, continued regulatory modernization, preemptive environmental reviews of key Federal facilities, and broader international collaboration and investments.

In addition to these important provisions, there are other areas where the bill could be improved. The committee should look to expand the modernization efforts in NEIMA, provide additional financial flexibility to grow the work force of the future, catalyze the next generation of American nuclear fuels, and further streamline permitting of brownfield sites, like former power plants. ClearPath Action looks forward to offering our support to this effort.

Thank you for the opportunity today. I look forward to answering your questions.

[The prepared statement of Mr. Harrell follows:]

Testimony of Jeremy Harrell
Chief Strategy Officer, ClearPath Action
Chairman, U.S. Nuclear Industry Council
U.S. Senate Committee on Environment and Public Works
Legislative Hearing on the American Nuclear Infrastructure Act (S. 2373) and the Sensible, Timely Relief for America's Nuclear Districts' Economic Development Act (S. 1290)

February 9, 2022

Good morning Chairman Carper, Ranking Member Capito, and other members of the Committee. My name is Jeremy Harrell. I am the Chief Strategy Officer of ClearPath Action, a 501(c)(4) organization devoted to accelerating breakthrough innovations to reduce emissions in the energy and industrial sectors. To further that mission, ClearPath develops cutting-edge policy solutions on clean energy and industrial innovation. ClearPath provides education and analysis to policymakers and collaborates with relevant partners to inform our independent research and policy development.

Additionally, I serve as the Chairman of the U.S. Nuclear Industry Council, a leading advocate for American nuclear energy technologies. The Council represents more than 80 companies engaged in nuclear innovation and supply chain development, including technology developers, manufacturers, construction engineers, key utility movers, and service providers.

Thank you for the opportunity to testify today and for holding this important hearing. Climate change is an urgent challenge that merits significant action at every level of government and the private sector. While there is no one thing policymakers can do to solve this challenge, accelerating the global deployment of cutting-edge American nuclear technologies is important to driving down carbon dioxide emissions while meeting the world's growing clean energy needs. Dozens of American entrepreneurs developing advanced nuclear reactors and fuels are racing to contribute to that cause, and the Advanced Nuclear Infrastructure Act (ANIA) could help unlock their deployment at scale.

Since the dawn of the nuclear age in the 1950s, nuclear reactors have been supplying Americans with **clean, reliable, and affordable energy.** To this day, America leads the world in nuclear energy production, and innovators are making great strides to bring the nuclear power of tomorrow to market today.

Accelerating the development of the next generation of nuclear technologies is essential to combating climate change as many of the largest utility companies in the U.S. and governments around the world are making big bets they will reach net-zero carbon dioxide (CO2) emissions by 2050.

Without a larger share of nuclear power — from both existing and advanced reactors — these pledges are less likely to succeed and will certainly be more expensive.

Thankfully Congress has recognized the importance of nuclear energy from both a clean energy and a competitiveness perspective. On a bipartisan basis in the 115th, 116th, and 117th Congresses, legislation has been passed that makes America's nuclear industry stronger. These legislative victories have provided robust support for the existing civilian fleet, which provides about half of total clean energy generation in this country, and have catalyzed a next generation of advanced reactors. As I highlight throughout my testimony, the challenge before Congress now is to recognize that private sector innovation in the nuclear industry is still outpacing the government and continued legislation like ANIA is needed.

Congress should provide the direction and exercise the oversight needed to ensure there is a clear path for new reactor designs to be licensed, sited and permitted. If done effectively, the American nuclear innovation story will move to its next chapter: the deployment of a new generation of advanced reactors that will make immense contributions to global security, economic growth, and emissions reduction efforts.

With this in mind, I will discuss in my testimony:

- **The U.S. today:** All 93 existing reactors and the two under construction in the United States are large light water reactors. The Nuclear Regulatory Commission (NRC) is using the same licensing review process designed for the current fleet of large light water reactors to license a new breed of advanced reactors, which are much different than the current fleet. Many of the NRC's existing regulatory requirements need to be right-sized and these NRC modernization efforts must happen immediately. The overall result must avoid unnecessarily burdensome regulation.

- **Why the clean energy future requires American innovation:** The world needs advanced nuclear technology. America leads the world in innovation - the NRC should also be innovative. Modernizing the NRC's process to enable new designs to be brought to market will help us regain global leadership in nuclear energy, strengthen international security and mitigate climate change.

- **The roadmap to get there:** The American Nuclear Infrastructure Act (ANIA) removes roadblocks that are in the way of deploying the next generation of nuclear reactors by continuing to modernize the regulatory framework for innovative manufacturing and construction techniques. Directing the NRC to continue to modernize aspects of its review process provides additional deployment certainty, and will help enable nuclear energy to deploy at a rapid enough scale to support decarbonization.

I. Building on American Nuclear Energy Success

America has reduced its power sector emissions by 40 percent over the last 15 years, but the easy part is over. Power sector emissions could flatline under current conditions.

A bright spot is that some of America's largest publicly owned utilities and major American companies are addressing climate change by pledging to further reduce carbon dioxide emissions by midcentury. These "net-zero commitments" seek to avoid the flatline, and with the help of improved public policy, developers can accelerate the deployment of clean, reliable, and affordable energy technologies at the scale necessary to fully reach net-zero.

According to our recent report, *Clear Path to a Clean Energy Future*, which tracks the latest power sector trends and models future technology and policy impacts – maintaining existing nuclear reactors is one of the cheapest and most efficient ways to help meet utility commitments and reduce carbon emissions. When optimizing for the cheapest emissions reductions and without raising electricity prices, over 22 gigawatts of nuclear energy were preserved that would have otherwise retired early.

America has led the world in nuclear innovation since the first defense nuclear reactors were utilized during World War II and the early Cold War buildup. Since then, the U.S. has developed a world class supply chain for fuel, production and distribution. America mastered siting and permitting reactors while making safety a top priority. Today, the U.S nuclear industry's roughly 95 thousand megawatts of capacity provides about 20 percent of our grid's electricity. As a bonus, it is the single largest source of carbon-free electricity in the United States – comprising roughly half of our nation's total zero-carbon energy.

Now, a flurry of next-generation nuclear reactor companies including Oklo, X-energy, TerraPower, General Electric, Kairos, NuScale, and many more are all on the cusp of being built this decade.

Over the past five years, strong bipartisan support for this clean energy technology has materialized in Congress, yielding signature public policy wins that will help maintain the United States' position as a global leader in nuclear power.

- **The Nuclear Energy Innovation and Capabilities Act (NEICA)** established the National Reactor Innovation Center and strengthened the Department of Energy's (DOE's) and the NRC's ability to support advanced reactor development.

- **The Nuclear Energy Innovation and Modernization Act (NEIMA)**, signed into law in 2019, provided the NRC the initial direction and financial resources to modernize nuclear safety licensing. It contained a specific requirement to develop a technology-inclusive framework for advanced reactor licensing by 2027. The NRC is currently planning on finalizing this framework in 2025.

- **The Energy Act of 2020** reinvigorated advanced nuclear energy by formally authorizing the moonshot **Advanced Reactor Demonstration Program (ARDP)** and a program to kick start the domestic development of High-Assay Low-Enriched Uranium (HALEU) fuel, which the majority of advanced reactor companies require but today can only be purchased from Russia.

  Two companies have already been selected for major ARDP projects: TerraPower and

X-energy. These two companies, along with their teams that include fuel suppliers, engineering and construction firms, and prominent investor-owned utilities, will partner with DOE and the National Labs to commercially demonstrate these cutting-edge designs in the next seven years. In addition, five other designs received risk reduction awards to advance a second wave of designs towards commercialization in the early 2030s. Importantly, Congress has reinforced the ARDP program by providing significant financial support in both the Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act; P.L. 117-58) and the annual appropriations process.

Many of the strongest proponents of these signature laws sit on this Committee, and I thank you for your work. These past successes provide the momentum necessary to tackle one of the single largest barriers to American nuclear technologies and the immense contribution they can make to global emission reductions - an antiquated licensing and regulatory regime.

II. The Clean Energy Future Require Nuclear Energy

Climate change is regularly top of mind here in Washington as well as for many of your constituents. And it is clear that while the American natural gas renaissance and growing renewable energy sectors have reduced domestic carbon dioxide emissions in the U.S., a flexible, dispatchable, and reliable clean energy source is still required to keep the lights on. This need is just as prevalent globally. Nearly 50 countries are projected to have markets for advanced nuclear power before 2050, a potential ~$360 billion per year market opportunity for the American supply chain. Make no mistake about it: if the U.S. does not seize that opportunity, Russia and China will.

Nuclear power has not only re-emerged as a smart, reliable power source, but also as an integral part of the solution to reducing carbon emissions.

These next-generation advanced nuclear technologies build on the decades of experience that make the U.S. nuclear fleet the safest and most efficient operating in the world. These technologies also offer new opportunities:

- they are generally smaller which allows them to be sited in new locations,
- their high temperature heat and steam provides more opportunities to decarbonize beyond the electricity sector,
- they can operate flexibly and even pair with thermal energy storage to complement the expansion of renewable energy, and
- like their predecessors, they provide clean, reliable power and support stable jobs and taxes in local communities.

Now is the time to seize the opportunity to build upon private industry interest and bipartisan support so that the U.S. can continue this momentum and maintain its global leadership in nuclear energy. However, this outcome will only happen if Congress supports these innovators and removes any unnecessary barriers to commercialization.

III. **The American Nuclear Innovation Act Roadmap**

The Nuclear Energy Innovation and Modernization Act (NEIMA) directed NRC to begin to prepare for licensing advanced reactors, and Congress has provided funding to the NRC to help them prepare since 2017. However, a new licensing structure for advanced reactors will not be available until 2025 and advanced reactor companies are ready now. Oklo for example, the first advanced reactor company to submit a license application to the NRC, recently had its application rejected. It is imperative that rejection was a hiccup and does not become the norm.

The NRC could receive nearly 10 new advanced reactor licenses before 2025, and today's NRC is seemingly not equipped to review them. That is why the NRC needs to modernize and fix its processes to unlock the potential of these companies, rather than add layers of unnecessarily conservative and overly burdensome regulations.

Regulatory modernization is critically important as it is the necessary step between the development of these new designs and commercialization. If America is not proactive with licensing the next generation of designs, the U.S. could fail to meet its clean energy needs and continue to lose ground to China and Russia on technology innovation.

As I mentioned above, all 93 existing reactors and the two under construction in the U.S. are large light water reactors. Oklo is a brand-new design, 1/1000th the size of what is traditionally operated in the U.S. But, the NRC is using the same licensing review process designed around the current fleet of large light water reactors, and many requirements they are imposing are not relevant for the next generation of designs.

This is especially problematic because what is not licensed cannot be built. Without a better system in place, the NRC's process will stifle innovation and risk America's ability to lead in this space.

The NRC is limited by what it can accomplish and currently has no incentive to change without Congressional direction and oversight. Congress can drive the NRC to modernize and thereby remove roadblocks to the commercialization of the next generation of nuclear reactor designs. Let me make it clear, we are not calling for a reduction in safety, only that the NRC's review process is efficient, effective and not unduly burdensome.

Congress should ensure there is oversight and accountability at the NRC, and continue to direct the NRC to modernize its review process. Today, the best plan for this is ANIA.

ANIA contains several provisions to support the next generation of reactors. These include prizes to offset initial licensing fees for some of the first licensed advanced reactor designs, continued regulatory modernization, and broader international development and investments.

Uncertainty in the licensing process creates an unnecessary burden on developers and does not support the NRC's safety and security mission. Being a first mover also requires an advanced reactor company to navigate a complex and outdated regulatory regime that is not designed for – nor could have contemplated – their unique technologies. The NRC needs to proactively

investigate manufacturing and construction techniques that advanced reactors will likely leverage so they will be prepared to address those techniques in the licensing process. Congress can help support these first movers through ANIA and help them pave the way for future companies.

Furthermore, as many of these designs are looking to provide more than just clean electricity, the NRC needs to be proactive in identifying and addressing any potential issues so the Commission can license projects with non-electric applications like heat and steam for industrial facilities. Advanced nuclear reactors are reliable energy sources that can supply large amounts of heat at temperatures up to 800 degrees Celsius. Industrial facilities are large operations that run day and night. Nuclear reactors can easily supply low- and medium-temperature heat and steam; high temperature needs could be addressed by burning hydrogen gas that is produced using high-capacity, carbon-free nuclear electricity. As many industrial companies are not familiar with the nuclear industry, a perception that the regulatory process is an insurmountable challenge will prevent them from even considering nuclear energy as an option. Not even considering nuclear energy can have profound implications on decarbonizing industrial sectors, and make it more challenging and costly.

With the growing global market for nuclear energy, especially in countries that have not traditionally operated nuclear reactors, the U.S. needs to continue leveraging its superior resources abroad. Key strategic allies like Poland, Ukraine, and the United Kingdom are hoping to partner with American vendors rather than their Chinese or Russian competitors. The NRC can and should provide technical and regulatory experience to countries so they can develop the necessary skills to safely regulate nuclear energy. Given the immense global market opportunity, this not only bolsters nuclear security abroad but unlocks economic opportunities for American entrepreneurs.

Regulatory expertise is one such area where the U.S. can lead globally on nuclear energy, and the potential to share this expertise has not received the attention it deserves. Even though the NRC has major work to do to modernize their licensing process domestically, harmonizing regulations is easier to do when building from the ground up; and many of the countries interested in starting nuclear programs have no existing program. There are dozens of countries that will likely establish a nuclear program; a proactive all-of-government approach, including the NRC, should be undertaken to ensure other countries with less-robust safety standards do not fill that need first. There is an added benefit from early engagement – by helping other countries structure their regulatory process, these countries will already be compatible with U.S. nuclear reactors that have navigated the U.S. licensing process. So exporting decades of U.S. regulatory expertise can not only help maintain international safety and security standards, but also enhance the ability of U.S. companies to export their technologies. ANIA looks to address some challenges in deploying nuclear aboard.

In addition to the provisions currently in ANIA, there are additional areas where the NRC can improve.[1] The Committee should look to expand upon the modernization efforts in NEIMA, and make ANIA as robust as possible to modernize the NRC. ClearPath Action looks forward to offering our support in this effort.

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[1] Nuclear Innovation Alliance, Promoting Efficient NRC Advanced Reactor Licensing Reviews to Enable Rapid Decarbonization, December 2021, https //nuclearinnovationalliance.org/licensingdurationsforclimatemitigation

Before I conclude, I would also be remiss if I did not underscore the importance of having a full five-person Commission. The Commission has been down two Commissioners since Commissioner Annie Caputo's term expired at the end of June. The Commission must be at full strength to effectively undertake this important work and prepare for the influx of American entrepreneurs slated to put their technologies forth for review. The Biden Administration should nominate two Commissioners expeditiously.

Conclusion

This Committee has been at the forefront of Congressional efforts on clean energy innovation for many years. Importantly, you have an incredible record of bipartisanship in nuclear energy as marked by the enactment of the NEIMA in 2019. And, you have made sure that America does not fall behind in the race to provide reliable clean energy to the rest of the world. Modernizing the NRC would go a long way in getting new innovations to market and maintaining our global competitiveness.

The close of 2020 saw exciting progress with the passage of the Energy Act. In 2021, your work to craft the Infrastructure Investment and Jobs Act with strong bipartisan support cleared the path for its enactment. And in 2022, there are many exciting opportunities to continue the progress that has been made. ClearPath greatly appreciates what this Committee has accomplished, and we look forward to supporting your efforts in the months ahead.

Thank you again for this opportunity, and I look forward to the discussion.

Senate Committee on Environment and Public Works
Hearing Entitled, *"A Legislative Hearing to Examine S. 2373, the American Nuclear Infrastructure Act of 2021, and S. 1290, the STRANDED Act of 2021."*
February 9, 2022
Questions for the Record for Jeremy Harrell

Chairman Carper:

1. Please elaborate on your assessment of whether the NRC resources are being effectively allocated to advance reactor licensing activities. Given the restrictions imposed by the Nuclear Energy Innovation and Modernization Act (NEIMA) on corporate support and fees, would amending these provisions help to improve the efficiency of the licensing process?

   Since FY17, the NRC has received directly appropriated, off-fee funding to support advanced reactor regulatory infrastructure activities. This funding has been critical for the NRC to prepare to license the next generation of reactors, which are dramatically different from the current operating fleet. The NRC anticipates at least 13 current and potential applications and at least 6 operating licenses by 2027.[1] This, in addition to its other modernization work in accordance with NEIMA, is a significant strain on staff resources. Ensuring that the NRC has adequate funding to modernize its processes in a timely manner to meet this wave of commercial interest is imperative for the NRC to not be an undue burden to the commercialization of advanced reactors and stymie efforts to accelerate U.S. emission reductions.

   Similar to modernizing its processes for licensing advanced reactors, the NRC needs to ensure that it can operate efficiently and effectively. Inefficiencies in the NRC's day to day operations increase costs for both the existing fleet and new applicants as they are subject to either annual and/or hourly fees. Ensuring that the NRC has adequate corporate support that can lead to future improvements in the NRC's processes can have significant benefits. However, if high corporate support costs are applied to the fee base, it could negatively impact plant economics and may be unclear how they are utilized related to license holders. The Committee should consider the recommendations from the NRC staff[2] in addition to other stakeholders to ensure that the NRC has adequate corporate support to operate as efficiently as effectively as possible while not being overly

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[1] https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML22038A001

[2] Letter to the Honorable Thomas R. Carper, et al., submits the NRC's report on NEIMA - Implementation, Impacts, and Recommendations for Improvement on the NRC's Annual Budget Justification; Fees and Charges; Performance Reporting and Milestones; and Accurate Invoicing (https://www.nrc.gov/docs/ML2123/ML21238A132.pdf; https://www.nrc.gov/docs/ML2123/ML21237A033.pdf)

burdensome on license holders due to high fees. We look forward to working with the Committee on this topic.

2. Following the introduction of the American Nuclear Infrastructure Act of 2021 (ANIA), a Civil Nuclear Credit Program to assist existing reactors that are projected to close due to economic factors was included in the enacted Infrastructure Investment and Jobs Act (IIJA). The IIJA-established program authorizes and appropriates $6 billion through Fiscal Year 2026 for the Department of Energy (DOE) to implement the program. A similar program is included in ANIA, however, unlike the IIJA program, the provision included in ANIA would authorize a credit program to be administered by the Environmental Protection Agency (EPA).

    a. In your view, now that the IIJA has been enacted with a civil nuclear credit program administered by DOE, is a similar program administered by EPA needed?

        A similar program administered by EPA is not needed.

    b. What other policies that were not discussed during the hearing should we consider to bolster the safety and economic viability of our existing reactor fleet?

        As previously mentioned, considering the impact of corporate support costs on the existing fleet, while also ensuring that the NRC can operate as efficiently as possible, has the dual benefit of decreasing annual fees and decreasing process inefficiencies (which can lead to delays and increased hourly fees). Improvements to how the NRC operates would benefit the next generation of reactors as they begin the licensing process. Balancing the economics of both existing and advanced reactors, as well as the licensing and oversight activities at the NRC, can have an outsized impact.

        Improvements to how the NRC implements and uses technology can be beneficial as it can lead to a reduction in future corporate support costs, as well as fewer hours (resulting in lower hourly fees) charged to an applicant while still ensuring that the NRC is able to meet its safety and security mission.

        Additional support for research would not only allow the NRC to ensure its regulations are focused on what is important for safety, but also increase the degree of certainty of reviews, as the NRC would be better prepared to review novel technologies. In addition, leveraging advances in research would also help ensure that regulations are not overly conservative and burdensome. We look forward to working with the Committee on these ideas.

3. You mentioned in your testimony the benefits of lowering financial barriers for first movers licensing advanced reactors and that the X-prize provision in ANIA will help to offset fees. What other policies that were not discussed should we consider to lower financial risks associated with initial licensing costs for advanced nuclear technologies and support the deployment of accident tolerant fuels?

   Additional regulatory modernization activities implemented on a timescale that benefits first movers would have a significant benefit. For advanced reactors to succeed in new markets, the NRC must be prepared to license designs that are being used in non-electric applications and license designs that leverage existing site characterization and regulatory analysis that was performed by other state or federal agencies.

   Similarly, directing the NRC to take a more active role internationally would help open these markets for advanced reactor companies to export American technologies. Furthermore, there are benefits to international safety, security, and nonproliferation standards if the NRC actively participates in international regulatory development.

4. Several provisions in ANIA seek to promote international commercial nuclear power cooperation with our Allies. As you stated in your testimony, U.S. export of nuclear technology can help forge long-term international partnerships while deploying carbon free energy. However, nonproliferation risks must also be central to our strategy for nuclear cooperation. Does ANIA sufficiently address risks with regard to nonproliferation?

   a. Included in these provisions are directives to the NRC to coordinate with international nuclear regulatory agencies. What currently limits the NRC's ability to cooperate internationally?

      Ensuring that the NRC has an adequate number of staff that are familiar with next generation technologies will be important for the NRC to take a proactive role in the development and harmonization of regulations in new-to-nuclear countries. To undertake these activities, the NRC will require resources to reach out to countries that may have an interest in nuclear energy. A focus on regulatory modernization and harmonization would allow regulators to collaborate more effectively to reduce duplicative review requirements. This has benefits for industry, but also provides certainty that regulatory standards are met and helps ensure that safety and security standards are met as well. Training programs/exchanges will also be a useful tool to facilitate this.

   b. What existing limitations to export of U.S. commercial nuclear technology do the provisions in ANIA help address?

The creation of a branch within the NRC focused on export and innovation activities is an important step for the NRC to proactively engage with other countries. As the international advanced nuclear energy market is estimated to be in the hundreds of billions of dollars,[3] supporting NRC engagement in these international activities can yield a high return on investment as well as ensure international safety, security, and nonproliferation standards are upheld. The U.S. has an opportunity to be a global leader in nuclear energy, and the NRC has an important role to play in enabling this necessary innovation.

While indirect, any improvements in licensing a reactor domestically will increase marketability for exporting designs internationally. Many countries, especially new-to-nuclear countries, will likely want to see a demonstrated reactor design before ordering their own reactors. Ensuring that reactor vendors have a clear path to commercializing their design domestically can open up international opportunities.

c. Is there opportunity to address other concerns regarding our international nuclear cooperation?

By having the NRC actively engage with international regulators and complementing the DOE's international activities, the NRC will be able to understand concerns early and work to alleviate them. Training and staff exchanges are one way to do this, but actively collaborating on regulatory harmonization can also yield significant benefits. As previously mentioned, ensuring that designs are able to be demonstrated and built in the U.S. in a timely manner can help to alleviate concerns that international partners may have.

It is important to note the immense international demand for nuclear. If the U.S. does not partner with interested countries, competitors like China and Russia will. Upholding safety, security, and nonproliferation standards are of the utmost importance to U.S. policymakers, much more so than for those competitors. Increased U.S. engagement is important to global safety and security, and Congressional support is critical to make this happen.

d. What effect would restriction of fuel imports from Russia and China have on domestic fuel supply and costs for reactor refueling?

Industry organizations like the Nuclear Energy Institute would be better suited to address specific supply and cost impacts for the existing fleet.

5. In your testimony you estimated the cost of economic grants to stranded waste communities to be $2 trillion through 2050.

[3] https://www.thirdway.org/memo/2021-update-map-of-the-global-market-for-advanced-nuclear

a. Please provide the Committee a detail on how you arrived at this estimate.

I misspoke during the oral questioning regarding the estimated cost of the economic grants. Our estimated cost of the program, if projected through 2050, would be about $2 billion annually.

This estimate was calculated using Figure(1-6) in the April 2021 report by the U.S. Nuclear Waste Technical Review Board which estimates the dry storage inventory of commercial spent nuclear fuel (SNF) to be 130,000 metric tons of heavy metal (MTHM) in 2050.[4] MTHM is the common metric of mass for spent nuclear fuel. In S. 1290, Section 2 (4)(B), the rate of $15 per kilogram (kg) of spent nuclear fuel was established for impact assistance payments.

1. 130,000 MTHM = 130,000,000 kg of SNF
2. (130,000,000 kg of SNF) x ($15 / kg of SNF) = $1,950,000,000
3. Rounded for simplification to $2,000,000,000 = $2 billion

b. Do you agree that compensating communities for their hardships brought on by storing spent fuel is a vital component of a comprehensive nuclear waste strategy?

As of September 2020, $8.6 billion has been paid out of the federal Judgment Fund to utilities and there is estimated to be $30.6 billion in additional liability.[5] It is important that taxpayers dollars are maximized, and the federal government moves forward on a spent fuel solution to stop liabilities from increasing indefinitely.

6. Please describe the risks associated with the current state of spent fuel storage versus the risks associated with spent fuel transport to a centralized permanent or interim storage location. In your answer please comment on the merits of centralized fuel storage.

Overall, there are minimal risks related to both the current state of spent fuel storage and transporting spent fuel to a centralized permanent or interim storage location. The Nuclear Regulatory Commission has provided several reports that provide a technical basis and quantify the risks associated with the storage and transport of spent fuel. Some of these include:

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[4] U.S. Nuclear Waste Technical Review Board (2021). "Six Overarching Recommendations for How to Move the Nation's Nuclear Waste Management Program Forward." Retrieved from https://www.nwtrb.gov/our-work/reports/six-overarching-recommendations-for-how-to-move-the-nation-s-nuclear-waste-management-program-forward-(april-2020)

[5] DOE, Agency Financial Report Fiscal Year 2020, DOE/CF-0160, p. 88, https://www.energy.gov/sites/default/files/2020/11/f80/fy-2020-doe-agency-financial-report.pdf.

- "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant" (NUREG-1864),[6] published in 2007, considers the risks associated with first year activities and in subsequent years of storage and finds the risks associated with continued storage due to external events to be extremely low (Table 19 on page 7-6).
- The "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel: Final Report, Volume 1" (NUREG-2157),[7] published in 2014, summarizes in Table 8-1 the environmental impacts of at-reactor storage in the short-, long-, and indefinite timescales.[8, 9]
- The NRC has published four studies to assess the risk of transporting spent fuel, the most recent being NUREG-2125,[10] which was published in 2014.

While the NRC has found that the risks associated with continued storage as well as transportation are low, the merits of centralized spent fuel storage could be considered. For example, centralized storage would:

- Reduce the number of sites eligible to receive payments out of the Judgment Fund, which would reduce federal government liability and cost to taxpayers.
- Allow the land of decommissioned nuclear power plants no longer storing spent fuel on the premises to be reused for other tax-generating activities.
- Decrease required regulatory oversight and associated costs.

[6] https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1864/index.html
[7] https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2157/v1/index.html
[8] Indefinite storage requires dry storage casks to be replaced every 100 years.
[9] https://www.nrc.gov/docs/ML1419/ML14196A105.pdf
[10] https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2125/index.html

Senator CARPER. Mr. Harrell, thank you for joining us. Thank you for your testimony as well.

I am going to lead off the questioning. Next will be Senator Capito. Senator Whitehouse is next in order but he has had to step away for a while. If he doesn't return immediately, then Senator Inhofe, you will follow Senator Capito. Then we will turn to Senator Duckworth, and then depending on who joins us we will take it from there.

In baseball, a pitcher someone in delivering a pitch signals what kind of pitch they are throwing, a fast ball, curve ball, slider. They say the pitcher has telegraphed their pitch. I want to telegraph my pitch to the panel. Probably the last question I will ask you is this. One of the things we are pretty good at, as Senator Capito and Senator Inhofe, who used to be the chairman of this committee, still a valued senior member, but we are pretty good at finding principal compromises. Senator Inhofe and I join together almost every Thursday for half an hour, for a Bible study. You would be amazed at how many Bible studies are prayer breakfasts there are on Capitol Hill, almost all bipartisan.

One of the things we always pray for, Democrats, Republicans, Independents, is wisdom. One of the things I will be asking you right at the end of this hearing is where do you agree, where is there consensus on the key issues before us, where is the consensus on some of the key sticking points. We look forward to hearing from you on that score.

All right, questions. Mr. Cohen, again, thanks for joining us. When the American Nuclear Infrastructure Act was considered by this committee last Congress, I believe you testified that you had concerning regard the NRC budget cuts in the Nuclear Energy Innovation and Modernization Act that placed caps on the NRC's corporate support spending. The NRC has also expressed concerns to our committee about their ability to continue to meet these caps and resulting impacts on the NRC's modernization efforts as these limits are set to become more restrictive over time.

Here is my question. This again would be for you, Mr. Cohen. Do you agree with the NRC's assessment that the administrative budget restrictions in the Nuclear Energy Innovation and Modernization Act ties the hands of the NRC from hiring the best and brightest, and could hurt the NRC's ability to keep up with the industry innovations and new technologies? Second half of the question would be, do you still believe we should amend the Nuclear Energy Innovation and Modernization Act corporate support caps? Mr. Cohen?

Mr. COHEN. Thank you for the question, Mr. Chairman. Yes, we do share the concern that you outlined that the current budget caps are constraining the NRC's ability to deal with both existing safety issues as well as licensing and reviewing new reactor designs.

We have looked at the NRC's submission to this committee, and believe that their analysis is correct. We believe also that this committee should consider legislative modifications to the cap. At a minimum, to provide the NRC with some more flexibility around how the cap is defined with respect to the definition of corporate

support, with adjustment for inflation and, for example, removing 2018 as the base year.

So the answer is generally yes, we believe that those caps have been proven to be overly restrictive and could constrain the NRC's ability to be effective.

Senator CARPER. All right, thanks. Let me also direct my second question, involving advanced reactor deployment. The Nuclear Energy Innovation and Modernization Act requires the NRC to develop a new technology-inclusive regulatory framework, as you know, capable of accommodating the diversity of advanced reactor design, by the end of 2027. The NRC is expected to finalize this framework, not by 2027, but actually I have learned this last week, by 2024, about 3 years ahead of the Nuclear Energy Innovation and Modernization Act's deadlines.

Recently, the NRC denied a license application for Oklo Advanced Microreactor. Although this decision does not prohibit the company from resubmitting an application in the future, the NRC decision has raised doubts among critics about the NRC's capabilities to review license applications before the new framework is put in place.

Would you briefly describe your thoughts on what led to the NRC's denial and comment on the merit of concerns regarding the NRC's capabilities? Do we need further streamlining changes to the regulatory process, or are there other policies the committee should pursue to better support the deployment of advanced nuclear reactors? Mr. Cohen?

Mr. COHEN. Thank you, Mr. Chairman.

I can't claim to be extremely close to the Oklo situation in particular. But my best information suggests the following, that the denial of the application was not linked necessarily to a fatal flaw in the regulatory process or even the way the NRC handled it, but possibly a variety of, I will call them growing pains, in terms of adjusting to these advanced reactor designs and reviews, specifically, communications around the kind of information required.

That said, I think this does suggest the need to get on with the business of implementing NEIMA and in developing a new, separate lane for advanced reactor development. That is the so-called Part 53 discussion that is going on right now. My testimony contains a little hint of our suggestions as to how the future actions by the NRC could more directly and efficiently accommodate new reactor designs.

So I guess my answer is a little bit split. On the one hand, I don't think the current Part 50 arrangement is fatal or even that the NRC is hobbled. I think this one will work out . I think that the Commission did give Oklo a little bit of a road map to come back.

That said, it is clearly much better to proceed on a fit-for-purpose lane of Part 53, which is being developed. That is what we look forward to seeing happen.

Senator CARPER. All right, thanks for your response to that question.

Senator Capito, it is your turn.

Senator CAPITO. Thank you. I am going to yield my slot to Senator Inhofe to begin his questions.

Senator CARPER. All right, Senator Inhofe.

Senator INHOFE. First of all, let me thank both the Chairman and the Vice Chairman for acknowledging the fact that we have a lot of competing committees taking place all the time. This is very important to me, though, and I enjoyed all four of the statements. I thought they were great statements that were made.

Ms. Korsnick, I have long supported nuclear energy and ensuring spent fuel is safely and properly stored in a permanent repository. We have been talking about this issue for so long now, I keep thinking we are getting closer, and I think we are.

While Senator Duckworth's bill is a good faith effort to help her State, I am concerned that basically it kind of pays the communities to tolerate long-term problems. I know localities shouldn't have stranded nuclear waste, but this is a result of the fact that we have been trying, and we have had opposition over the years to permanently dispose of the sites.

There has been resistance, such as there was for such a long period of time, to Yucca Mountain. Taxpayers nationwide, including Oklahomans, already paid the liability costs of storing spent fuel where it is after the government failed to build a permanent repository.

So instead of sending more Oklahomans' taxpayer dollars to localities with spent fuel, we should work together to secure a permanent solution.

Ms. Korsnick, would you agree that Congress should return its focus to securing a permanent repository for the spent fuel? What ideas do you have along that line?

Ms. KORSNICK. Thank you very much, Senator Inhofe. Yes, we very much support a long-term, durable solution for nuclear storage. If I could perhaps step back for a moment, to say we should be very proud of the American nuclear industry for all that it has brought. We are the strongest operating fleet in the world. We bring a lot of American innovation.

That American innovation can be used to help solve this long-term storage issue. We simply need to put our mind to it. When we began the nuclear industry 50 years ago, of course, things were put in place to manage used fuel. We have done that part of it. Money has been collected, over $40 billion today in the Nuclear Waste Fund. We have promised to operate safely and to store this fuel in a safe manner until the government kept up its end of the bargain to pick up this fuel.

The government has not picked up that end of the bargain. I think it is high time that we focus on that. I applaud the DOE for recently putting out an RFI on a consent-based siting process for interim storage. I think that is a good step. We are happy to work together to make inroads.

But as a Nation, we need a long-term storage repository. If you look across the world, it was mentioned earlier, Sweden is doing this, France is doing this, Finland is doing this, Switzerland is doing this.

Senator INHOFE. OK.

Ms. KORSNICK. So we are behind.

Senator INHOFE. All right. We are behind, and I am getting a little behind also. So let me mention, Mr. Harrell, several people in their opening statements talked about NEIMA and the successes

that we have had, and we have had successes. Its core mission is conducting inspections and licensing reviews, yet only 21 percent of its budget is allocated for that purpose, while corporate support is over 30 percent. Mr. Harrell, do you agree that the NRC needs to streamline its corporate support budget so it does not exceed that of its inspection and licensing reviews?

This is kind of an interesting thing, because we are dealing with government here. Some of this comes out quite accidentally. What do you think?

Mr. HARRELL. Yes, that is a great question, Senator Inhofe. Thank you for your strong support for nuclear, and particularly your work at the Armed Services Committee on microreactors and the NEDA. I agree. I think that the resources need to be focused on key areas in modernization. No doubt, we need to inject new talent into the NRC.

As I mentioned in my testimony, 10 new reactor designs could be coming in the next 3 years. We need to be able to focus and bring the NRC to the 21st century and get them focused on these new technologies, and so making sure that resources that are coming in, whether it is corporate support or off-fee resources, whatever it may be, need to be zeroed in on the key licensing areas to accelerate the licensing and ultimate appointment of those advanced reactors.

Senator INHOFE. I appreciate that very much. Let me also compliment you on the statement that needs to be made all the time, and that is, if we don't do it, China and Russia are going to do it.

Mr. HARREL. Yes, sir.

Senator INHOFE. Thank you, Mr. Chairman.

Senator CARPER. Thanks, Senator Inhofe. Thanks for your leadership over all these years on trying to get us to a place where we have safe, clean nuclear energy and do it in ways that are smart.

Senator INHOFE. I appreciate that. I think each member of this committee will say this is probably the least partisan of the committees dealing with such serious subjects. I think we all have been doing well, you folks included.

Senator CARPER. Thanks for saying that. Senator Whitehouse, thanks for rejoining us, and again, for your leadership, too. Thanks.

Senator WHITEHOUSE. Thank you. I would like to ask Mr. Cohen and Ms. Korsnick what we could be doing more of. I know we have a prize in this for nuclear designs that operate off of spent fuel and allow a vehicle for us to go through the spent fuel waste stockpiles that are located mostly at the industrial sites where the power plant was.

What more could we be doing to make sure that this technology that we are encouraging doesn't lose its focus on that aspect of the problem set we are dealing with to make sure that a focus on repurposing spent fuel stays at the heart of innovation? Mr. Cohen first, then Ms. Korsnick.

Mr. COHEN. Thank you, Senator Whitehouse. I don't consider myself to be an expert on this particular topic, but there is clearly a lot of opportunity to, from my understanding and my staff's research, to look at some advanced technologies for reprocessing that are not the traditional technologies for reuse of spent fuel.

I am well beyond my technical depth in describing those, but what I understand is that there are a number of research areas that really could use more funding. The U.S. is behind on this. There are a lot of good ideas, but there is not much funding in that space.

So I am just going to leave it at that high level that there is a lot that probably could be done with Federal RD and demonstration of this advanced fuel reprocessing, and modes other that the traditional MOX reprocessing, for example. I don't have details to offer, but we could, at the committee's request, come back with some more specific ideas.

Senator WHITEHOUSE. Ms. Korsnick? Mr. Cohen, do that that as a QFR and get back to me, if you would. Ms. Korsnick, please proceed.

Ms. KORSNICK. Yes, thank you. I would just offer, in fact, I think there was an announcement this week between Argonne National Lab and Oklo to explore some reprocessing ideas. That tells you that the wheels are moving in terms of people being interested in reprocessing.

I know there are other private companies that are also interested in exploring reprocessing. I would just add that even if we reprocess, it still requires us to have a long-term repository.

I think, ultimately, we need this broader conversation on the used fuel final solution. I think the reprocessing adds a great element, as you mentioned, in terms of being able to use this. We call it used fuel, but, you know, there is 95 percent good energy still in this thing we call used fuel. It is an excellent opportunity for us to tap into it. As Mr. Cohen said, I am happy to bring back more ideas with some additional QFRs.

Senator WHITEHOUSE. I think that danger here is that the economics get misaligned. Companies that are having to follow what for them is the best economic path will go down wrong paths if we haven't got the economics of this aligned properly, in the same way that safely operating nuclear plants closed to open natural gas facilities that polluted a lot more for economic reasons that would have evaporated if the harm and cost of the natural gas emissions has simply been taken into account, as they should been. It was an economic misfire, but it created bad decisions out in the real world, because companies follow real dollars, not ideal dollars.

My worry here is that it is going to cost a little bit more and take a little bit more trouble and effort to deal with repurposed fuel than it is to simply start new. If we allow that to happen, then we will have inadvertently choked off the innovation that could provide a way to put what is now dangerous, toxic, expensive waste with no plan for dealing with it into a productive use. I hope we can continue to focus on that and make sure we don't set up an economic system in which we inadvertently steer people away from solving that problem instead of toward solving that problem.

Mr. Cohen, you mentioned hydrogen. Is nuclear power a potential source for what we would call green hydrogen?

Mr. COHEN. Senator, if by that, you mean zero carbon hydrogen, for sure.

Senator WHITEHOUSE. That is what I mean.

Mr. COHEN. Absolutely. There are a number of good studies out on that. Most recently, there was an analysis of the potential even for the Diablo Canyon Nuclear Power Plant in California to co-produce electricity and hydrogen. That report went into great detail on how that could be done.

This is not rocket science. The technology is well understood. Electrolysis has been around for many, many decades, but the particular advantage of nuclear in producing hydrogen is the potential to couple electricity production with high-temperature heat, which, as I understand it, makes the hydrogen production process much more efficient.

I believe there are now four pilots, maybe even six now underway under previous legislation authorized by Congress to demonstrate this, very small-scale. The next step for the U.S. is to scale those up to a much larger level. In fact, the most recent infrastructure act includes a provision for a hydrogen hub that would be nuclear based.

Yes, absolutely, the technical capability is there. Hydrogen is going to be needed at large-scale to displace gas and oil, and nuclear could definitely be part of that zero-carbon mix.

Senator WHITEHOUSE. Thank you, Chairman. Thank you to all the witnesses.

Senator CARPER. Those are great questions. Senator Capito, and then after Senator Capito's questions, we return to Senator Duckworth next, and we have been joined by Senator Kelly. Thanks for joining us, Mark. Ranking Member Capito, it has been a great hearing so far. We are only about halfway through. Go ahead, please.

Senator CAPITO. Thank you. My first question is going to focus on using the sites of former coal-fired power plants. Obviously, this is an important question for me. One of the reasons that West Virginia changed their law, I think, was to try to remove the barriers of nuclear energy, but also to couple those two initiatives together. I believe that in Wyoming, this is already moving forward.

Ms. Korsnick, what can we do, either Congress or at the NRC to facilitate the creation of nuclear jobs in these former coal communities?

Ms. KORSNICK. Thank you, Senator Capito, for that question.

You are right on the mark. Repurposing coal plants or other fossil plants is extremely attractive for future nuclear plant siting. For one thing, they have the transmission already there. That is a challenging part of the infrastructure, if you will. It is costly to build, so it is a great opportunity to reuse that.

I can say, just a point of note, recently the NRC did revise some guidance, that would actually help coal plant operators to receive some credit for their experience operating fossil plants as part of their review process to become a certified nuclear operator. It is things like that that we can do.

I operated nuclear power plants for many, many years, and when we did refueling outages, we brought the folks down from the coal plants to help us in our refueling outages. Nuclear and coal, nuclear and fossil have a long history of partnership. Nuclear plants, we boil water differently, perhaps, than a coal plant, but after that, once you have turned it into steam, there are a lot of similarities

in the jobs and a high degree of opportunity for us to bring jobs to these former coal plants.

Senator CAPITO. Thank you.

I want to talk a bit about the expense. Mr. Harrell, I believe you mentioned an application that had cost a half a billion dollars, and I can't remember how long it took. Obviously, this has to be a sticking point of the initial application, but also the innovation that is going to be required. What kinds of ideas would you have in terms of being able to afford to actually move in this direction?

Mr. HARRELL. It is a great question, Senator Capito, and thank you for your strong leadership on this bill and other clean energy issues, both at this committee and at the Appropriations Committee.

I think one of the key ideas here, and included in your legislation, is the XPRIZE to offset some of the fees related. I was mentioning NuScale in my testimony, $500 million over 5 years to get to design certification, $70 million of that in fees. That is a huge barrier to entry.

There are a variety of exciting, advanced reactor companies that have technology that can contribute to both our economy and to emissions reductions that are startups. They are venture capital raised. So that type of financial barrier is providing a barrier for these companies to move forward, and essentially saying you need big backers to move forward.

I think that is squandering an opportunity for American entrepreneurs as a whole. Right-sizing regulations to make sure that they are consistent with the true risk of these reactors, so we are not doing a dilatory review type of thing. Then providing support to some of these advanced reactors, particularly first movers who are doing the heavy lifting here at the onset, I think are really important.

Senator CAPITO. I appreciate that. I appreciated Mr. Cohen's response on hydrogen to Senator Whitehouse's question. I would like to ask both of you if you have anything to add on the innovators that are developing designs to generate high-temperature heat to be used for manufacturing and industrial purposes. We are requiring the NRC to identify and address potential regulatory barriers to deploying this for other technologies.

Where is the nexus here between creating a hydrogen economy and having nuclear power at the same time? I will go to you, Mr. Harrell, first, and then Ms. Korsnick.

Mr. HARRELL. Yes. That is one of the most exciting components of these new designs, a bunch of different applications. Nuclear can play a huge role in hydrogen production as a 24–7 resource and it contributes to the no-cost [phonetically] paradigm, the ability to use processed heat in manufacturing of hard to abate sectors, like steel and concrete.

Even outside of the climate space, nuclear thermal propulsions is a really exciting opportunity in a way that these new technologies can help expand our space frontiers. We are excited about it, but it is a new frontier for the NRC, and they are used to only electrical applications.

Senator CAPITO. Ms. Korsnick, did you have anything to add there?

Ms. KORSNICK. Yes, thank you.

I would just add that we talk about how long it took to license some of these technologies, but after you license it, there is also a licensing process for the site, in other words, a site selection process. When you asked earlier about what other things we can do, what are the next barriers, I think we need to really look at the NRC process for siting so we can take some of these coal sites and sort of quickly understand that they are suitable for nuclear.

I think it goes to your last question as well. If you are going to use nuclear for other things, you are going to want to site those nuclear plants, in fact, near some of these manufacturing facilities. So there is a nexus around siting and making the siting process more effective and more efficient.

Senator CAPITO. Thank you. Thank you, Mr. Chair.

Senator CARPER. Thank you so much. Senator Markey has joined us. Senator Markey, I understand under the rules of the committee, you could move ahead of Senator Duckworth and Senator Kelly and ask your questions. If it is not urgent for you to leave, if you could let them go first, I would appreciate it.

Senator MARKEY. When you phrase it that way, it sounds like an offer I can't refuse. Senator Duckworth, you are recognized.

[Laughter.]

Senator CARPER. You are a good man. Thank you.

Senator DUCKWORTH. I thank Senator Markey.

Mr. Knabel, when the city of Zion accepted the economic benefits and the risk of hosting a nuclear facility to generate zero emissions power for itself and surrounding communities, what did Zion expect to happen to the lakeside property once the plant's operating license had expired?

Mr. KNABEL. We expected that the property would revert back to unrestricted use, that the site would be cleaned up, and we would have the opportunity to have the community either redevelop for, again, replacement tax base or to be able to use the property for recreation or other purposes to grow our community. We did not expect to have a 90-acre nuclear footprint buried onsite or be a nuclear storage site indefinitely, for sure.

Senator DUCKWORTH. Thank you. I think this is an important point, because the Senator from Oklahoma mentioned that part of the problem we have here is that we have not come up with a location for disposal or long-term storage of a nuclear site, whether it is Yucca Mountain or where else.

My point is even if we agree today on a site, wherever that is, it will still take 20 years to develop that site. In the meantime, cities like Zion remain a de facto nuclear storage facility, and that is simply not fair to the community. As our Nation debates the permanent solution to safely dispose of and store radioactive nuclear waste, it is my hope that we can find common ground around a simple principle: that until a permanent solution is implemented, the Federal Government should help communities deal with economic and social harms of stranded nuclear waste.

Mr. Knabel, can you explain why the city of Zion needs Congress to pass the STRANDED Act and finally fulfill the Nuclear Waste Policy Act of 1986 original vision of distributing economic impact assistance payments to help stranded communities offset the eco-

nomic and social harms of temporarily storing nuclear waste, even if that temporary ends up being 40 years?

Mr. KNABEL. Sure. It was agreed to in 1982 that there was a social and economic impact to municipalities that stored waste on an interim basis. This is just reiterating that need.

But during the time that we have been a storage site, that the plant has been decommissioned and closed, we have been operating at an annual deficit, basically have been treading water ever year. Every year, we go a little further beneath the surface.

We don't have the opportunity for redevelopment. Our property tax base has declined significantly. We have been irreparably damaged financially community wide as a result of this. This is crucial to us being able to survive to even get to a point where we can talk about moving the waste or even get to a point where we can talk about reuse.

We are less staffed for police, fire, and public works than we were in 1998, and we are handling three times the calls and service demands from the community. Over 60 percent of infrastructure is 70 years or older, and we don't even have the funds to address those issues. We are just trying to survive and still be in existence.

This will help us to address those deficits, to try and put a plan in place to get a return on that investment so that we can be self-sustaining, we can dig out of that hole, to get to the point where we can even start to address those issues.

Senator DUCKWORTH. Thank you.

I think this is critical to say, passing the STRANDED Act will actually help us make good decisions on where to move the nuclear fuel. I think it will act almost as a pressure valve to take the pressure off making a decision immediately to, say, choose Yucca Mountain or someplace like that, so that we can make good decisions on where this waste will go. Because in the meantime, the waste can remain where it is in a way that the community that is holding the waste can sustain it.

The Economic Development Administration administers the Assistance for Nuclear Closure Communities Program, often referred to as the NCC Initiative. As I noted in my statement, while promising, the NCC initiative suffers from key limitations, which my STRANDED Act seeks to address.

Mr. Knabel, can you explain why the EDA's NCC Initiative falls short in meeting the urgent needs of stranded communities like Zion and address why it is so important to expand the EDA's support, as my STRANDED Act will seek to do?

Mr. KNABEL. Absolutely. The program as it is currently written is a nice idea for maybe a step three in our process. As I mentioned, we would be lucky to have the luxury of only having to figure out how to pay for our infrastructure like other municipalities do.

However, we are not at that point. The way I have kind of equated it to others is, when you are worried about trying to put food on the table for your family, you can't even consider how you are going to fix the leaky roof.

Development projects, first of all, on a site or in a community that cannot attract redevelopment because of tax base or because of blighted property, it is just not feasible, but second, it also has

matching requirements on there that we simply can't add to our budget that is already hemorrhaging as a result of 20 years of spiraling property values due to the decommissioning.

So there is a limitation on that. It a good step three, but the STRANDED Act addresses the step one needs.

Senator DUCKWORTH. Thank you. I have additional questions, but I will submit those for the record. I yield back.

Senator CARPER. Thank you, Senator Duckworth. Senator Kelly, and then Senator Markey.

Senator KELLY. Thank you, Mr. Chairman. I appreciate your having this hearing today on these important pieces of legislation.

I want to start by discussing the American Nuclear Infrastructure Act of 2021, Ranking Member Capito and Senator Whitehouse's bipartisan bill, which I support. Nuclear energy is critical to our shared goal of reducing carbon emissions and fighting the effects of climate change, and this bill would provide financial support and more regulatory certainty to next generation advanced nuclear reactors, help more Americans get trained for good-paying, high-skilled jobs in the nuclear industry, improve coordination with international nuclear regulators, and support nuclear investments made by our allies, and provide financial support for our aging nuclear fleet.

Important to me, this bill builds upon the work I have done to support the cleanup of abandoned uranium mines in Tribal communities. As a member of the bipartisan group of Senators who negotiated the infrastructure law, I fought to secure $5 billion for investments for superfund sites and brownfield cleanups, including for more than 500 abandoned uranium mines on the Navajo Nation. I appreciate steps taken in this legislation to further strengthen U.S. global leadership in next-generation nuclear energy technologies to compete with China and Russia.

This brings me to my first question. Ms. Korsnick, can you expand upon your testimony on the ways that China and Russia are threatening to rival U.S. leadership on the international stage, and how the American Nuclear Infrastructure Act's provisions relating to international nuclear reactor export activities and international regulatory competition would help to combat the challenges that are posed by Russia and China?

Ms. KORSNICK. Yes, thank you, Senator. If you would, imagine the partnership that grows when two countries work together on commercial nuclear. It essentially forges a 100-year relationship, from design to build to operate decommissioning. The idea of working together with nuclear forms very strong geopolitical bonds. This is something that we should strategically look at as supportive of United States geopolitical interests.

In that same way, China and Russia are very interested in controlling other countries' energy supply for reasons that you actually have seen play out, even over in Europe over gas lines, for example. There is a lot of power in controlling somebody's electricity supply.

China is going all-in. I think they are building 20 reactors right now, and they have a strategic plan to build a whole lot more. China, right now, looks like the United States in the 1950's. They

are building all kinds of different types of reactors. They want to get good at all of them.

Both China and Russia, when they show up in other countries saying, let me help you out, I will operate it, I will build it for you, I will operate it for you, and I will take your used fuel. They make a deal with these other countries that is so attractive, it is very difficult for any of the U.S. companies to compete. We can either do something about that, or we can reap these benefits in 10 to 20 years.

Senator KELLY. When you talk about how the partnership between two countries is lasting and enduring and sounds like it helps both of them, have you seen, are China and Russia partnering with each other on nuclear technology?

Ms. KORSNICK. I don't see as much. I can't say that it is not happening. I can say both of those countries have expressed common interest in certain other countries. For example, they are both interested in places in Africa. They have both expressed interest in Brazil. They are very interested in a longer-term strategic play, where it is their technology that is operating in as many countries as they can make that happen.

Senator KELLY. Thank you, Ms. Korsnick.

Mr. Cohen, I wanted to ask you about the role nuclear energy can play as a clean, firm source of electricity. As you can imagine, as the sunniest State in the Nation, Arizona is a leader in solar energy deployment and development, and there is a lot more growth to come. But reliability is a challenge, especially in Arizona's long hot summer months when air conditioning is non-negotiable.

Mr. Cohen, for States like Arizona, which are prime markets for solar energy deployment, what role does a firm source of energy, like nuclear energy, play in ensuring grid reliability and keeping costs low for customers?

Mr. COHEN. Thank you for the question, Senator Kelly. Yes, all of the studies that I have seen for the Southwest, and this is true for all the studies actually that we have done for all the geographies I have seen in the U.S., suggest that renewables and nuclear don't really compete. What they do is complement each other. Even in a very sunny State like Arizona, you do have a great solar energy resource, but it is quite variable by season, by a factor of as much as two to one.

What nuclear does is provide an always-on base, if you will. Even if it has to be curtailed at certain times or ramped down on certain days because of very, very high solar production, there are typically still a lot of cost savings in having that always-available source.

It is also true that Palisades in Arizona is a mainstay right now of the western grid and reliability. So renewables are great for reducing costs at the margin, but what nuclear provides is a firm base when the sun isn't shining, when the wind isn't blowing. That is often true for weeks, even months where it isn't blowing at the levels aren't at maximum, nuclear can provide and fill those spaces and ensure a much lower cost grid.

It is often nuclear versus renewable; I think that is a false distinction. They work very well together.

Senator KELLY. I think folks are often unaware that when the demand is the highest is not actually when the sun is shining the brightest and is directly overhead. Demand is usually in the hottest part of the day, also happens to be the time that people are coming home from work and shortly thereafter, the sun is at a much lower angle and is not generating as much electricity. So this is a good option to fill that demand gap.

Thank you, Mr. Chairman.

Senator CARPER. Senator Kelly, thanks so much for joining us.

Senator Markey, you are next. I think Senator Padilla may be trying to join us after you question the witnesses. Thank you for allowing the other two Senators to go ahead of you. Thank you.

Senator MARKEY. No, of course. Thank you, Mr. Chairman.

We have a moment here where we can just kind of do a review of the nuclear industry as it sits today, including the two nuclear power plants in Georgia, the Vogtle Plants, which were proposed as $14 billion for the two units to be generating electricity. They have had their problems over the years, let's be honest, and it is up to $30 billion now for the two units. Still, they are not without their difficulties.

Let's just talk about that as a state-of-the-art for the industry, and there still is no known meltdown for a solar or a wind project in the United States, so the safety issues, obviously, around nuclear, are not small.

In the infrastructure bill, which has already passed, there were $6 billion for the nuclear industry that was built into the infrastructure bill, which we all voted for. In the Build Back Better Bill, Mr. Chairman, there is, as passed by the House, and hopefully, we could get to it in the Senate, there is actually $23 billion in production tax credits for the nuclear industry just through the year 2027. I know Senator Manchin is arguing to cover it up to 10 years. That would obviously increase it, but $23 billion in that bill.

From my perspective, I think that we should just realize that this is an industry that has had difficulty in actually bringing any new plants online. It gets more and more costly as each year goes by.

Yet, we should also be focusing on the wind and solar and other industries. If we are going to do something, we just have to do it together. That is actually what the Build Back Better Bill is. The Build Back Better Bill deals not just with nuclear, $23 billion in tax credits, but also tax breaks for wind and solar and battery technologies and all electric vehicles, so that we are looking at this from a comprehensive perspective.

Mr. Cohen, do you agree that we should be investing in mass deployment of renewable energy and not just focusing exclusively on nuclear in order to achieve our climate and clean grid potential?

Mr. COHEN. Yes. Thank you, Senator, for that question. I absolutely agree with that. We have been big supporters of the renewable tax credits and all other kinds of RD&D and deployment. It absolutely has to be a balanced portfolio. That is what all the modeling suggests.

In fact, most of the modeling suggests that the zero-carbon grid of the future is likely to be dominated, actually, by sources like wind and solar. Again, nuclear can play a supporting role, but

without that inexpensive wind and solar, at scale, the cost of decarbonization will be much more expensive. Absolutely, both of these policies have to work in tandem.

Senator MARKEY. So, in addition to nuclear plant bailout, which is in this bill, there is also a doubling down on the infrastructure bill, and it is a $2.5 billion Advanced Reactor Demonstration Program by making taxpayers foot that bill for additional advanced reactor activities. Supporting that continued nuclear generation also then raises questions about nuclear waste and how our Country is going to handle those issues.

Mr. Cohen, do you agree that a long-term solution for nuclear waste needs to be a principal component of any discussion of additional nuclear generation in our Country?

Mr. COHEN. I think that it is a problem that needs to be solved. I believe it is a problem we can solve. I think we are going to have to get way out of the box in terms of how we solve it in a way that other industrialized countries like Sweden and Finland have managed to do.

I do not view a permanent solution as an absolute precondition, however, for any additional deployment of nuclear. I believe that these two issues can be pursued in parallel.

Senator MARKEY. OK. Well, from my perspective, this is a perfect subject for discussion in the Build Back Better Bill. We clearly are going to be looking at technologies that should be invested in in order to deal with our clean energy programs, and this is a very good hearing to have in order to explore this one part of it.

I will say, again, a part that is unlikely to add, over the next 10 years, a significant amount of electricity, given the Vogtle Plant experience. But if it is coupled with tax breaks for wind and solar, all-electric vehicles, and battery storage technologies, well, that is a good discussion. Then we can just allow the market to work in order to demonstrate, ultimately, which of these technologies is going to be producing electricity between now and 2030.

Again, I hate to say this, but it is unlikely that there will be another new nuclear power plant that will be authorized in that period of time. But I am very open in the Build Back Better Bill to adding on to what we already voted for in the infrastructure bill for the nuclear industry. But I think it should all be tied together as an all-of-the-above strategy in this clean energy field.

I thank you, Mr. Chairman, very much, and I thank the Ranking Member.

Senator CARPER. The Senator from Massachusetts raised an interesting and timely point. In the Clean Energy Tax Credit provisions within Build Back Better, which I have started to call Build Back Slimmer, but there are provisions that actually do, tax provisions provide production tax credits that are, my staff and I and others on this committee were involved in. We have tax provisions for clean hydrogen, green hydrogen that are in that legislation.

My hope is that, as we come back and try to find the portions, significant portions, I hope, of Build Back Better, Build Back Slimmer, that we will be able to include some of the things that we are talking about right here, makes a lot of sense.

Senator MARKEY. Can I just say?

Senator CARPER. Please.

Senator MARKEY. The beauty of Build Back Better is that the tax that all these incentives are technology neutral. So yes, it is hydrogen and it is nuclear, but it is wind and solar and battery storage technologies. So it is technology-neutral, and it will all be there. It is just a race to the finish line at that point, so I just think that is important for us to understand.

Senator CARPER. Great, thank you so much.

Senator MARKEY. Thank you.

Senator CARPER. Senator Padilla was trying to join us by WebEx. Do we know if he is on or off? If he comes on, let us know.

Senator Capito, would you like to go next?

Senator CAPITO. I have just a couple quick questions.

I wanted to ask, first of all, before I do that, because I forgot to do this before, I would like to ask unanimous consent to insert two articles into the record. One is an article from Reuters titled California Urged to Keep Nuclear Plant Open to Meet Climate Goals. The other is from Forbes titled NRC's Rejection of Oklo Application, which we have heard about in this hearing, Shows the U.S. is Miles Behind China in Advanced Nuclear Reactors.

[The referenced information follows:]

February 9, 2022

U.S. Senator Cynthia Lummis
Russell Senate Office Building
Suite SR-124
Washington, D.C. 20510

Dear Senator Lummis:

We are writing to bring an opportunity to your attention. New approaches to remediation of contamination at uranium waste piles and abandoned uranium mines (AUMs) across the West can separate radioactive materials from the mine waste leaving behind clean waste rock for safe site reclamation. Our technology, High-Pressure Slurry Ablation (HPSA), is one such approach. However, the inconsistent and, as we believe, incorrect application of laws enacted in the 1970's addressing uranium milling and mill tailing wastes to current proposals for clean-up and recycling of materials at AUMs has created uncertainty that is stifling technology development and contributing to the failure to remediate AUMs. Updating these laws to provide clarity and appropriately accommodate mine site remediation and recycling efforts will go a long way to addressing legacy environmental issues of concern at AUMs.

Background: In the 1940s, the uranium mining industry operated under the leadership and direction of the U.S. Atomic Energy Commission (now the Department of Energy) to support production of weapons and later fuel for emerging nuclear reactor technologies. Currently, the Department of Energy (DOE) estimates there are 15,000 AUMs throughout the western US, with most of these sites located in Colorado, Utah, New Mexico, Arizona, and Wyoming. Approximately 75% of these AUMs are on federal and tribal lands. We estimate over 683 million tons of low-grade uranium waste rock is located solely across the Navajo Nation and Defense Related Uranium Mines (DRUMs). Grades of this uranium waste rock vary between 100 and 1000 mg/kg, amounting to up to 683,100 tons of uranium.

Statutory and related regulatory ambiguity is frustrating the efficient remediation and reclamation of these AUMs. The clean-up of AUM waste rock and transportation of the recovered ore for recycling at a uranium mill facility is distinct from uranium milling. However, regulators have struggled, without more guidance, to distinguish non-chemical, kinetic separation processes involved in mass reduction and separation from the chemically intensive processes and high uranium concentrations involved in actual milling. This uncertainty has frustrated the development of technologies to sustainably recycle various critical minerals.

Furthermore, waste minimization is a key strategy of the U.S. Environmental Protection Agency under the Resource Conservation and Recovery Act and the U.S. Department of Interior under 43 CFR 3809 – Surface Management enacted to prevent unnecessary and undue degradation of public lands. Waste minimization at uranium mine sites comes in the form of reducing the volume of ore-containing rock transported offsite for processing. Reducing the amount of transported ore-containing rock, consequently, reduces the amount of waste a conventional uranium mill must manage after processing the ore/rock.

Legislative Proposal: To resolve relevant statutory and regulatory ambiguity to ensure that novel waste minimization technologies are not placed under uranium milling regulations and thereby unnecessarily inhibited, we urge you to introduce legislation that:

- Provides for the use of waste minimizing technologies for treating waste rock and processing ore at abandoned, inactive, and active uranium mining sites or other sites with uranium ore or waste material.
- Updates the current regulatory framework to recognize the environmental benefits that novel technologies and approaches can bring to mine site primary creation, secondary creation, or remediation resulting in minimization of uranium mining-related residuals volume and, subsequently, mill tailings.
- Facilitates the use of technologies that reduce environmental hazards and radiological risks associated with uranium production and remediation activities.
- Clarifies that residual material created by waste minimization technologies is exempt from regulation (as byproduct material) under the Atomic Energy Act, and that it may be returned (reused) to its place in nature (e.g., where it was mined or another comparable mine).
- Provides for efficient licensing of uranium waste minimization activities that recycle material (that would otherwise be a waste) to create jobs, and ultimately, facilitate clean electricity.
- Clarifies that methods for waste minimization do not create byproduct material as defined in Section 11e. (2) of the Atomic Energy Act.

Benefits of Amendment to AEA:

- Remediate uranium waste piles throughout the U.S. in an economical manner.
- Reduce the amount of imported uranium by recycling uranium already present on thousands of surface uranium waste piles or engaging in primary or secondary creation for future processing of uranium-rich ore throughout the U.S.
- Support best practices to equitably address waste minimization efforts that impact disadvantaged communities consistent with just transition and environmental justice principles.
- Allow for primary and secondary creation of high-grade uranium ore which is easier to mill at a licensed site.
- Provide significant employment opportunities for those residing in impacted communities.
- Promote waste minimization which is a key pillar of environmental protection.

Technologies like our High-Pressure Slurry Ablation (HPSA) Technology would benefit from a certain and timely regulatory process that encourages remediation and recycling of uranium waste piles. The difficulty in making an old law fit new circumstances out of an abundance of regulatory caution is contributing to the significant waste clean-up problem and serving as an impediment to the commercialization of important technologies that can improve the quality of our environment. We have attached a description of our HPSA process for your information.

Thank you for your attention to and consideration of this important effort to improve the way we address the environmental legacy of our country's uranium mining.

Sincerely,

Greyson Buckingham
Disa Technologies, Inc.
CEO & President
307-690-2508
Greyson@DisaUSA.com

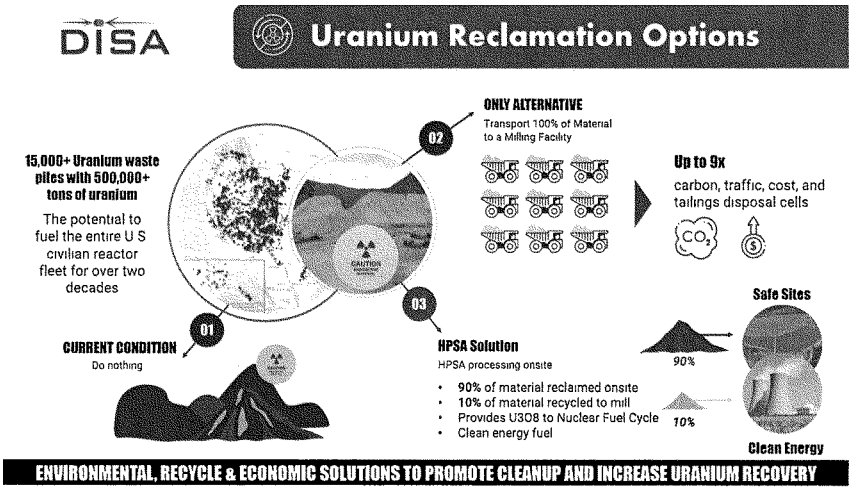
Attachment: Disa's High-Pressure Slurry Ablation (HPSA) Technology (or Kinetic Separation)

Disa's High-Pressure Slurry Ablation (HPSA) Technology (or Kinetic Separation)

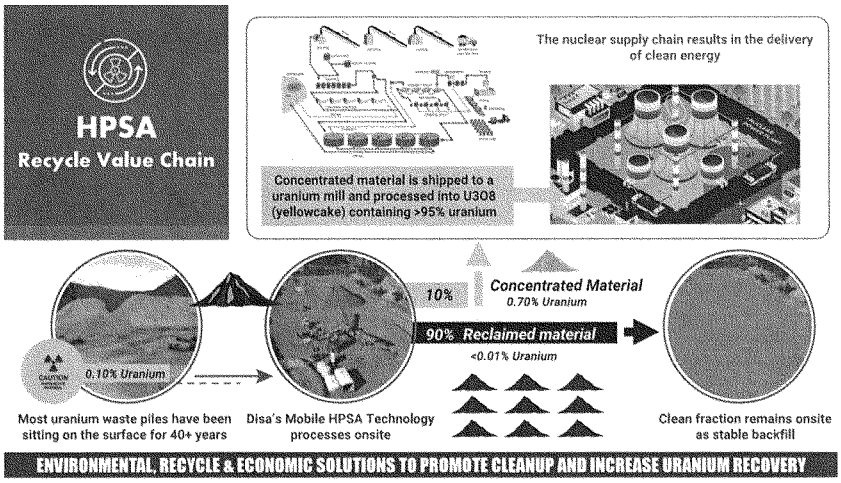
The HPSA technology uses a mechanical process—no chemicals—to separate radioactive material from waste rock and produce higher concentration uranium ore to later be used for uranium milling, consequently, minimizing resulting mill tailings waste. HPSA enables uranium to be separated from mining waste materials, significantly reducing the radioactivity in the material volume left onsite. HPSA further reduces the tailings waste volume that is generated by recycling this material at a uranium milling facility. HPSA technology can be highly valuable for remediating abandoned and inactive mine sites, reducing waste volume generated from operating mines, and substantially increasing the efficiency of uranium processing at operating mills. HPSA technology has demonstrated its exceptional ability to fulfill the specific need for selective liberation of uranium and other valuable minerals in an energy efficient manner, particularly when mineral-rich layers can easily be separated from the host rock. Evidence of HPSA's efficiency is best represented by HPSA's processing of uranium mine waste rock from uranium hosted sandstone formations, where the soft mineral patina coatings of uranium can be easily separated (disassociated) from the harder sand grain. This disassociation concentrates uranium into the finer particle fraction of the material mass, making it more economically viable for physical and chemical separation (milling) downstream.

HPSA Benefits:

- HPSA is revolutionary to the uranium reclamation market as its application allows for 85% of the original material to remain onsite as a remediated and stable coarse fraction while the concentrated uranium mineral-rich fines (representing 15% of the original material and 90% of the overall uranium) can be recycled to a conventional uranium mill and converted to yellowcake (U_3O_8).
    - Any remaining uranium in the remediated and stable coarse fraction of the original feed is below source material limits and interlocked in the quartz gains inhibiting its mobility. Thus, this portion of the mass does not pose any hazard to the surrounding communities or watersheds.
    - The liberated, concentrated, and separated uranium-bearing fine fraction of the post-processed material possesses sufficiently high uranium concentrations that it can be subsequently recycled at a traditional uranium mill where it can continue in its journey to ultimately be used as nuclear fuel, providing clean electricity.
    - This mechanical technique, where HPSA uses water instead of chemicals, reduces radioactive waste at mine sites, which renders HPSA technology an environmentally friendly remediation option.
    - Finally, this technology provides economic value. By increasing uranium concentrations in a smaller volume of material, uranium recovery facilities can more easily recover and further concentrate the uranium while generating less waste to be stored onsite.



- **Domestic Nuclear Fuel Supply Chain Benefits:** The domestic nuclear fuel supply chain can be dramatically reinvigorated by using HPSA to convert uranium waste piles from a liability into an asset, while, at the same time, protecting the environment.
    - Given the quantity of low-grade uranium waste rock in the U.S., even if a fraction of these waste rocks were processed by HPSA technology and recycled at a conventional uranium mill, domestic uranium production could easily meet the imported 21,300 tons of U_3O_8 in 2019.
    - This technology also reduces the overall radioactivity levels in the waste at mine sites, simplifying site remediation efforts and decreasing remediation costs. In addition, Congress appropriated funds for a domestic uranium fund which could be partially supplied by these environmentally responsible activities.
    - While HPSA presents environmental benefits, it also creates opportunities for supply chain efficiencies.



Potential Customers: Department of Energy; Environmental Protection Agency, Navajo Nation, state and local governments, conventional uranium mills, conventional uranium mining companies, currently closed but not fully decommissioned sites, and any other mine or waste site.

February 4, 202211:42 AM EST
United States

California urged to keep nuclear plant open to meet climate goals

By Timothy Gardner
3 minute read

Feb 3 (Reuters) - Nearly 80 scientists and academics, including a former U.S. energy secretary, on Thursday urged Governor Gavin Newsom to delay closure of California's remaining nuclear plant to comply with state laws on fighting global warming.

"The threat of climate change is too real and too pressing to leap before we look," said a letter to Newsom from Steven Chu, a former U.S. energy secretary, and the others. "Considering our climate crisis, closing the plant is not only irresponsible, the consequences could be catastrophic."

The letter was organized by Isabelle Boemeke, a model and founder and executive director of Save Clean Energy, a nonprofit group that promotes the emissions benefits of nuclear power.

Faced with rising costs for operating the plant's two reactors, the utility PG&E (PCG.N) decided in 2016 to allow their licenses to expire in 2024 and 2025, which would close the last nuclear plant in the nation's most populous state.

Environmental groups concerned about earthquakes, nuclear waste, and use of seawater to cool reactors, had also pushed for the closure.

As concern about climate change has mounted, however, so has the call to keep open Diablo Canyon, which backers say is the state's top source of emissions free power.

U.S. Energy Secretary Jennifer Granholm said in a Reuters interview in November that she would be willing to talk with California officials about the possibility of keeping it open once the federal government makes progress on dealing with nuclear waste, an issue for which there is no permanent fix.

Granholm said then that there is a "change underfoot about the opinion people may have about nuclear." The Department of Energy did not immediately respond to a request for comment.

Erin Mellon, a spokesperson for Newsom, said retail energy providers are in the process of procuring projects to replace power generated by Diablo Canyon and that California has the technology and plans to meet its clean energy goals.

PG&E said its focus is on safely operating the plant until the end of its licenses.

Diablo Canyon can withstand earthquakes larger than nearby faults are capable of triggering, the letter said. It cited an assessment that PG&E sent in 2018 to the U.S. Nuclear Regulatory Commission finding no significant seismic or tsunami hazards to the plant.

The Union of Concerned Scientists, a nonprofit group that has studied seismic risks to nuclear plants, says Diablo Canyon is one of the top 10 U.S. plants most vulnerable to earthquakes and was built to a more stringent, though insufficient, standard than reactors in the U.S. East.

Reporting by Timothy Gardner; Editing by Bill Berkrot

Jan 31, 2022, 12:36pm EST|1,709 views

NRC's Rejection Of Oklo Application Shows US Is Miles Behind China In Advanced Nuclear Reactors

Robert Bryce
Contributor
Energy
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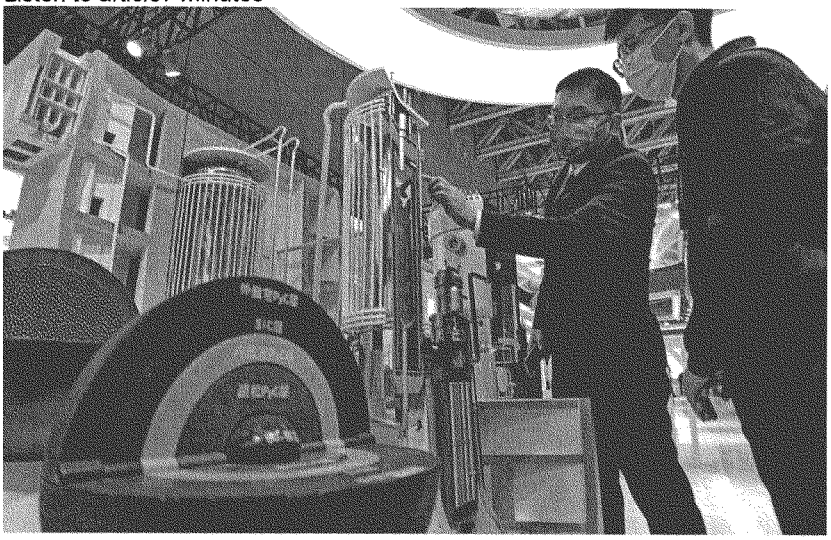

A visitor learns about Huaneng's high-temperature gas-cooled reactor model at the China ... [+]

BARCROFT MEDIA VIA GETTY IMAGES

China is beating the pants off the United States in the race to deploy next-generation nuclear reactors. Wait. That's not quite true. To have a race, the competitors have to be assembled at a starting line. The hard truth for the U.S.

nuclear sector is that bureaucratic inertia is preventing it from even approaching the starting line.

Proof of that came earlier this month when the Nuclear Regulatory Commission rejected Oklo Power LLC's application to build and operate a 1.5-megawatt fast reactor in Idaho. Oklo is among a group of American startups that are hoping to get permits for new small modular reactors (SMRs) that could replace the large light-water reactors that dominate the existing domestic nuclear fleet. Many of those reactors are being prematurely shuttered (including the Indian Point Energy Center in Buchanan, N.Y., which was closed last year) and others are reaching the end of their expected lives.

The NRC said, "Oklo's application continues to contain significant information gaps in its description of Aurora's potential accidents as well as its classification of safety systems and components." It added that the rejection was made "without prejudice" and that Oklo "is free to submit a complete application in the future."

To be sure, Oklo's application to the NRC which was accepted for review by the commission in mid-2020 to much fanfare, was not a typical one. According to Rod Adams, the publisher of Atomic Insightsand managing partner at Nucleation Capital, a firm that is investing in advanced nuclear ventures, Oklo's application was about 600 pages long. Oklo submitted the shorter application because, in its view, the design of its reactor obviated the need for a more extensive document. By contrast, another nuclear startup, NuScale, submitted an application to the NRC that included some 12,000 pages. Adams said that the NRC's guidance document for applications covers some 4,500 pages. (NuScale received design approval for its reactor from the NRC in 2020. NuScale's reactor is a scaled-down version of existing light-

water reactors, which the company says "build on the vast global experience with this technology learned from over 60 years of operation.")

Thus, it's clear that Oklo's application to the NRC — and the design of its reactor – are far different from what federal regulators are used to seeing. But according to news reports, the agency didn't even warn Oklo before it issued a press release that the company's application had been rejected. Caroline Cochran, the co-founder, and chief operating officer at Oklo, (who was on the Power Hungry Podcast in August 2020) told CNBC that the rejection was "as much of a surprise to us as anyone else. We weren't given any heads up at all before it basically went public yesterday. We really didn't have any indication that this was coming." Meanwhile, the NRC claims the company had not provided all the information it had requested.

It's also clear that the NRC's application and permitting process continue to be what veteran technology investor Ray Rothrock calls "an uncontrollable risk," for companies and individuals wanting to bring new reactors into the commercial market. According to a report published last year by the Nuclear Innovation Alliance, getting approval for a new reactor design from the NRC can cost "tens of millions of dollars" and that high cost is "discouraging development of pioneering advanced reactors." It also said that NuScale's successful application and permit "took more than 10 years" and that "Due to regulatory fees, development costs, and associated engineering, NuScale noted that it cost the company more than a half a billion dollars in total to get their design certification."

All of that background on the NRC, Oklo, and NuScale brings me to my point: timing and appearances matter, particularly when it comes to nuclear energy.

The NRC's rejection of Oklo's application came less than three weeks after a consortium of Chinese companies announced that their high-temperature gas-cooled reactor (HTGR) in Shandong Province had been connected to the electric grid and was producing commercial quantities of juice. According to *World Nuclear News*, "The plant features two small reactors that drive a single 210 MWe turbine. It is owned by a consortium led by China Huaneng (47.5%), with China National Nuclear Corporation subsidiary China Nuclear Engineering Corporation (32.5%) and Tsinghua University's Institute of Nuclear and New Energy Technology (20%), which is the research and development leader."

HTGRs are among the next-generation of high-efficiency reactors that could provide an alternative to coal-fired power plants in China and many other countries. Chinese companies have been working on HTGRs for more than two decades. According to *World Nuclear News*, one of the two reactors at the site in Shandong reached first criticality in September and the second hit that milestone in November. Electricity production from the plant began flowing onto the electric grid on December 20.

Put short, while the U.S. dithers on regulatory matters, China is racing ahead with cutting-edge reactor designs that are safer and more flexible than the reactors now in use. According to Bloomberg, China now has 46 reactors planned or under construction. Meanwhile, here in the U.S., exactly two reactors are under construction.

I have said many times that if the U.S. is serious about reducing greenhouse gas emissions, it must get serious about nuclear energy. Alas, that isn't happening. Furthermore, it's readily apparent that despite never-ending claims from top officials in the Biden Administration about the urgency of the

need to address climate change, nuclear energy is not a priority. Need proof of that? Today, more than a year after President Biden was sworn into office, two of the five commission seats at the NRC, spots that are supposed to be filled by presidential appointees, are still vacant.

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Robert Bryce

Senator CAPITO. I would say to my friend who is leaving from Massachusetts that I am for an all-of-the-above energy plan, myself. You are just leaving several, very significant energy-producing materials out of what you were talking about. You know what I am talking about: natural gas, coal, carbon capture utilization. I will just put that on the record.

You can head out now, that was my comment to you, thank you.

Senator MARKEY. I just forgot about carbon capture, we are actually marking at $200 billion for carbon capture, and $200 billion for carbon capture and sequestration. So again, we are totally open to any negotiation on carbon, hydrogen, all those issues.

Senator CAPITO. Thank you.

Ms. Korsnick, during COVID, there were lessons learned all around the horn on everything, but certainly some lessons learned in the NRC and the way they did some inspections by greater remote access to plant data. I am wondering if you have any examples of how these plants have improved their operations because of some of the lessons learned during the COVID pandemic.

Ms. KORSNICK. Yes, thank you, Senator. We actually had great success during COVID. We were able to run all of the refueling outages and significant work at all of our nuclear plants during this COVID experience.

As you mentioned, one of those things was to kind of think about more creative ways that the NRC could conduct their oversight of our operations. At the end of the day, it proved, in some cases, more efficient and helpful for them.

We very much look to identify some of those best practices and integrate those lessons learned into permanent processes and procedures of the NRC. For example, they were able to conduct several of their inspections remotely. Not everything avails itself to that kind of inspection, and so we are not saying we don't need NRC inspectors onsite by any means, but there were ways we think that they can run their business more efficiently. We allowed them more access remotely to our sites to facilitate it. I think it was a win-win.

Senator CAPITO. Good, good. Mr. Harrell, final question from me on the STRANDED Act. I didn't know if, obviously, there is a cost to everything, and there is an authorization level, I believe, in the act that Senator Duckworth has brought forward. I didn't know if you at ClearPath had done any kind of estimate as to what the actual cost of something such as the STRANDED Act could cost.

Mr. HARRELL. Yes. It is a great question to ask, Senator Capito. If these economic impact grants continued indefinitely toward 2050, we are looking at $2 trillion. No doubt, the status quo serves no one well, and I think that includes Zion, Illinois. We need a variety of solutions to the spent fuel problem.

I think innovation can play a major role in that. I think you have included some important provisions in ANIA to get at the support for communities who formerly hosted sites. One of the biggest things we do, and kudos to you and many members on this committee, including the chairman, on the infrastructure bill, one of the biggest things we can do is avoid closing these plants altogether so we don't have this economic story.

Then, advanced reactors can play a role in using spent fuel. There is innovation in storage of fuel. There are exciting companies like Deep Isolation that are looking at storing spent fuel in bore holes, and so I think that is an area where we can wisely spend dollars and get to a solution. Because I do worry if a $2 trillion program over the next 30 years is established, we are just perpetuating the same problem that exists.

Senator CAPITO. Right. Well, thank you. Thank you, Mr. Chairman.

Senator CARPER. Thank you, Senator Capito. Again, thanks for your leadership on not just this issue, but especially on one of the two bills that we are holding this hearing on today. This has been a great conversation.

I think we have been joined remotely by Senator Padilla by WebEx. Senator Padilla, if you are there, I would be happy to recognize you at this time. Are you there?

Senator PADILLA. Great, thank you, Mr. Chairman. I appreciate the flexibility. I was there in person earlier. As you know, multiple committees are meeting, so I am joining virtually.

I want to begin by recognizing that my home State of California has actually three nuclear facilities in various stages of decommissioning: San Onofre, Rancho Seco, and Humboldt Bay, with the most recent action being the NRC's November 18th announcement that it has terminated the license for Humboldt Bay Unit Three, and released a unit site for unrestricted use.

Operating nuclear power plants provides economic opportunities for local communities during the operation. As plants are decommissioned, communities often experience a significant loss of tax revenue and a loss of good-paying jobs.

I know Senator Duckworth already spoke earlier about the STRANDED Act and what it could mean for communities undergoing these sorts of transitions. I wanted to point out another unique element of the decommissioning process and future use of sites. Some of California's decommissioned facilities are connected to or located very near existing electrical transmission infrastructure. Given the stigma around reusing former nuclear facilities because of cleanup concerns and otherwise, it does beg the question of how we can best put this land to use after facilities are decommissioned, how we best use the area.

Question for Mr. Knabel. Beyond just financial support, are there additional support or services that the government could provide to smooth transitions and maintain local economies following the closure of a nuclear power plant?

Mr. KNABEL. Thank you, Senator Padilla. I believe Senator Duckworth's act addresses that, in part with the task force and the creative grant program, or the XPRIZE program. As you mentioned, there is a stigma associated with a decommissioned plant that you can look at 90 acres of lakefront property and say, that would be fantastic, but who is going to want to build on a prior nuclear footprint?

On a local level, we try and look at ways to reuse that, and we try and attract business, we try and look at, is there potential for a natural gas plant. Again, you have the switchyard there for the electric grid infrastructure.

So anything that can be identified through Federal resources to help get us back on track would obviously be appreciated. I think it is necessary to dig out of the hole for our community, for yours, for everyone that is affected by this, ultimately.

As I mentioned earlier, we have to make sure that we are around to be able to benefit from that. Something like that is going to take quite a while to develop and see the benefit of. Step one of the STRANDED Act deals with noncompetitive grants. But there is a hope that, ultimately, there will be some sort of highest and best use for that property, but we know that it will never be what we originally had, what was there, and what was promised, especially while the spent fuel is still onsite.

Senator PADILLA. All right, to be continued.

The second question, let me frame it here. Currently, there is roughly 86,000 metric tons of commercial spent fuel sitting in communities, not just across California, but across the Country. That figure is increasing at the rate of about 22 metric tons per year. The waste is currently stored at 121 sites in 35 States, mostly at the very same facilities that produced it.

In the next 3 years, all of California's nuclear power plants will be shut down or are in the decommissioning process, which will leave the spent nuclear fuel at each power plant site. Again, referencing California specifically, here. As I am sure you all know, despite safety assurances, localized storage garners intense public interest, particularly in California, in light of seismic activity and earthquake risk. know there is increasing dialog about the consent-based siting strategy for storage.

I am asking Mr. Cohen this question, if an interim or permanent storage site ever did become operational, spent fuel and waste would have to be transported through countless communities from the current site to that interim or permanent storage site.

How do you balance that transportation need with the alternative of leaving waste where it currently is, from a risk and benefit standpoint?

Mr. COHEN. It is a great question. I will venture a personal opinion, maybe not even an organizational opinion on this, that it has been demonstrated that we can transport nuclear waste safely. It has been done for many decades.

However, and the alternative is to leave everything where it is, so you do have a tradeoff. There is always some risk in transport, but there is also risk, certainly, to future economic development in communities, as you have noted, in leaving things onsite. I think the best thinking is that we really need to move this waste. Again, I don't think it is an impossible task to do that safely.

I can provide a more thoughtful and extended answer in writing, if you prefer. The evidence does support that you can safely transport nuclear spent fuel.

Senator PADILLA. A written response would be helpful and appreciated. Thank you both. Thank you, Mr. Chair.

Senator CARPER. Senator Padilla, thanks so much for joining us, and for your patience today. We have a vote underway in the floor. I think we have about another 10, 12 minutes that I can stay here with you. It may seem longer, but it won't be long, about 10 or 12 minutes, then I have to go on and vote.

A question, I want to ask one question for Mr. Cohen, and I think probably Ms. Korsnick as well. We will let our other witnesses off the hook on this one. Just keep in mind, I telegraphed my picture earlier. The last question I will ask is, where do we have some consensus here, maybe a couple of major points from each of you to share with us.

Before we get to that, Mr. Cohen, Ms. Korsnick, recent advances in nuclear and material science has provided an opportunity to build safer, more efficient alternatives for existing nuclear fuel rod technology. These technology advancements are leading to a safer, more efficient nuclear fuel rod technology called accident tolerant fuels. These new accident tolerant fuels can serve as an important bridge to advanced reactors, while at the same time, allowing current nuclear reactors to be safer and more cost competitive.

Here is my question, again, for Mr. Cohen and Ms. Korsnick. Would each of you take a minute and discuss what you know to be the status of accident tolerant fuels today, just briefly, and would each of you provide maybe one policy option we should consider to support the next generation of nuclear fuels? Mr. Cohen, then Ms. Korsnick.

Mr. COHEN. I might suggest that Ms. Korsnick, who is more expert on this topic, go first.

Senator CARPER. All right, there you go. Ms. Korsnick, would you go first, please?

Ms. KORSNICK. Great, thank you. Yes, so your question is on accident tolerant fuels.

Senator CARPER. Yes.

Ms. KORSNICK. I think this is a wonderful opportunity for the industry. Again, American innovation at play. I think it is going to bring forward a variety of options, whether those options are used in current reactors that we use today or the reactors of tomorrow. I think it is a great opportunity.

It is likely to be more expensive, so I think, as with anything, I think you have to sort of balance the need for that additional expense with the value that it brings. I think there is a good value proposition there.

In terms of a policy option, I would suggest, we have some investment today in accident tolerant fuel. I think we should look at that investment and see if we can bring accident tolerant fuel to the markets even sooner.

Senator CARPER. All right, thank you.

Mr. Cohen, anything, very briefly you want to say, and then we will go to the next question?

Mr. COHEN. I would just add, the next step is obviously to think about fuel fabrication and the full supply chain, and that needs further attention.

Senator CARPER. Thank you.

I will go back to my original, what I said to you at the beginning of the hearing. The pitch, well-telegraphed, is right here, in the ideas. We always look on this committee, more than probably any committee in the Senate, as much as any committee in the Senate, we look on ways to find consensus, even where there is a lot of adversity.

What I would ask each of you to do is just to take a minute and tell us where you think there is, based on what you have heard today, and said today, where are some good areas for consensus that we ought to definitely, definitely pursue? Thank you. Let me go first with Mr. Knabel. Would you go first?

Mr. KNABEL. Thank you, Chairman. As far as common ground, I don't think these two bills are mutually exclusive to each other. ANIA and STRANDED realize that nuclear is part of our future for green energy.

The piece that needs to be included is the end process. The current process, we are an example of the benefit of nuclear while the plant was operating, regionally benefiting other communities, nationally benefiting. But the current process ended at decommissioning, where everyone kind of washed their hands of it and said we are done. However, we were still left with the mess.

ANIA recognizes that there is a need to figure out what to do with that waste, that that should be part of the process. That should be part of the overall proposal to make sure that we have the entire beginning to end in the process and how to best have everyone benefit from that and nobody left holding the bag.

Senator CARPER. Thank you. Thank you, sir.

Mr. Cohen.

Mr. COHEN. Thank you, Mr. Chairman. I would say, just as a preliminary comment, that I feel like there is a great deal of consensus, certainly, among this panel about what the priorities are, dealing with the legacy problems, but also making sure that there is a viable pathway for advanced nuclear through the NRC licensing process, and also dealing with the long-term waste issue.

Just a sort of an observation, which is that more than the consensus within this committee or among this panel is the fact that there is emerging consensus in the society about nuclear. I think that has changed quite a bit. It should make the job of this committee and this Congress easier.

I inserted some polling data, which is quite interesting, which shows a vast majority of Americans support continued use and expanded use of nuclear energy. In particular, the Democrats, which are often thought to have a less favorable view, are also substantially in favor of this technology.

I don't think it is rocket science to figure out what the remaining areas of concern are: waste, safe regulation of advanced nuclear. We still need the kind of legislation you have put forward in recent years to speed these sorts of less expensive, safer, easier to deploy reactors.

So I am heartened that there is an enormous amount of consensus, not just bipartisan consensus in Congress, but in the society at large.

Senator CARPER. Thank you, sir.

Ms. Korsnick.

Ms. KORSNICK. Yes, thank you.

I agree very much with Armond Cohen. I would say, areas of consensus are the nuclear is a needed partner with wind and solar to create the best solution. I think very much an opportunity as you demonstrate these technologies can pair very well, you also actually lower consumer cost by doing that.

I think another area is that American innovation is bringing forth really fantastic new nuclear options, making it more flexible and more useful, more diverse, whether it is hydrogen, whether it is high temperature steam, or whether it is electricity. So we must encourage that. We can encourage it through the licensing process. Make that more efficient. Make the site permitting process also more efficient.

I will end with, the United States does, in fact, need a durable waste strategy.

Senator CARPER. Thank you.

Mr. Harrell, please.

Mr. HARRELL. Thank you, Mr. Chairman.

I think what I heard clearly was, new American nuclear is an economic opportunity, important to global security, and a climate imperative. It needs to be enabled now. Even Senator Markey, who was talking about a little bit of skepticism, is rooted in, nuclear needs to play a significant role on a relevant climate timeframe.

Legislation like ANIA is going to be necessary to bolster licensing both in the short-term, before the NRC completes the part 53 process, which isn't going to be completed for another three to 5 years at least, direct flexibility on applications because nuclear can play a huge role outside of electrical applications, like in heavy industry, and common sense permitting. Because in the end, if we are going to contribute to reducing emissions, we need to be able to build these things quickly so they can contribute to a 21st century electrical grid.

Senator CARPER. Yes. Thank you, thank you all.

I will do a couple quick comments, if I could. First, thank you. I want to thank your witnesses. I want to thank all our colleagues who have come today. I especially want to thank Senator Capito and Senator Duckworth for their leadership, Senator Whitehouse, and others.

I want to thank your staffs. We have staffs who work very well together. On most Thursdays, when we are in session, Senator Capito and I meet in person, usually with at least one member of our team, Adam and Mary Frances.

I think on this Thursday, I just suggested to Senator Capito when she ran off to vote, that we think of enlarging that conversation, and people who come to that conversation, but really to focus on followup to this hearing today, what we have learned, where there is consensus, and some areas that we might look forward to working together, really along the line that Senator Markey has suggested.

We have one witness, at least one witness today from Illinois. I am reminded of another son of Illinois, Abraham Lincoln, was once asked a question, what is the role of government. He said, the role of government is to do for the people what they cannot do for themselves. There is a great role here for us to play on this committee. I think we are well-primed to build on some of a lot of our earlier work, to build on what was in the infrastructure bill, and to build on what could be in a slimmed-down version of the Build Back Better Bill.

I used to be a Governor, and I was very much involved in the National Governor's Association. I headed it for a while and headed

up something the NGA called the Center for Best Practices. We would look, I would always look, as Governor, at other States and see what they are doing well, learn from what they are doing, and to learn what they are doing badly, so we would know what not to do.

When I look around the world with respect to nuclear, people, my father's family is on the German side, his roots are in Germany, I think the German people are smart and capable people. But the idea that they are shutting down their nuclear power plants so that they can buy natural gas from Russia, not a good idea. Maybe we can keep that lesson in mind as we figure out how to avoid shutting down more nuclear power plants and creating even greater threats on the climate side.

Also, my colleagues have heard me say many times, no silver bullets. No silver bullet as we face adversity here, problems to solve. No silver bullet here, but a lot of silver BBs. How about that? A lot of silver BBs. You have helped us identify a bunch of them. We want to act on it, sooner rather than later.

Last, we had a great hearing a week or so ago on recycling. Senator Boozman and I cochair the Recycling Caucus in the Senate. Others on the committee here are very much involved. Senator Capito and I held a hearing on recycling and recycling strategies working hand-in-glove with the private sector, with EPA, and others.

One of the comments that was made, I think was something like, one person's trash is another person's treasure. In this case, spent fuel rods, some people would call that as trash and something to demean, look at with abhorrence. There is a way, and the people in France are kind of leading the effort here and have been for a while, to figure out how to repurpose spent fuel rods.

I think Ms. Korsnick, I think your statement said about 90, 95 percent of the energy is unused within the spent fuel rods. People think of that as waste. Turns out there is actually, within that trash, if you will, there is a lot of treasure. We have to figure out how to harvest that treasure.

Last, I have focused many, many times in this committee as Chairman and before, I am always, I think what I am about, what I my colleagues think about is, how do we save this planet and the threats that we face with climate change, dire threats we face across the planet and climate. How can we do that in a way that creates economic opportunity, a lot of job creation, and improves the quality of life for our people? We can do it all. We can, and we have to be smart enough.

When Jim Inhofe and I get together with our colleagues for our Bible study tomorrow, say a word of prayer at the end, we will pray for wisdom. We will pray for wisdom for all of our colleagues and folks like you all and others around the Country, that we are smart enough to figure out how to do it all and get this right. I am encouraged with hearings like this, we will do that; we will do that. In adversity, lies opportunity. Thank you, Dr. Einstein.

Before we adjourn, some housekeeping. Senators will be allowed to submit written questions for the record through the close of business on Wednesday, February 23d. We will compile those questions

and send them to our witnesses, who we will ask to respond by March the 9th, if you could do that.

Do we have any unanimous consent requests to close with? No? OK. I love to ask unanimous consent requests to include stuff in the record when nobody else is here, so I would be the only one who could object, but I don't get to do that today.

With that in mind, this hearing is adjourned. This has been a great day, and again, our thanks to all of you and to our staffs who worked so hard to make this day possible. Thank you.

[Whereupon, at 12:08 p.m., the hearing was adjourned.]