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BUILDING A 100 PERCENT CLEAN ECONOMY: ADVANCED NUCLEAR TECHNOLOGY'S ROLE IN A DECARBONIZED FUTURE

TUESDAY, MARCH 3, 2020

House of Representatives

Subcommittee on Energy

Committee on Energy and Commerce

Washington, D.C.

The subcommittee met, pursuant to call, at 10:31 a.m., in Room 2322 Rayburn House Office Building, Hon. Bobby L. Rush [chairman of the subcommittee] presiding.

Members present: Representatives Rush, Peters, Doyle, Sarbanes, McNerney, Tonko, Loebsack, Butterfield, Welch, Schrader, Kennedy, Kuster, Kelly, McEachin, O'Halleran, Blunt Rochester, Pallone (ex officio), Upton, Latta, Rodgers, Olson,

McKinley, Kinzinger, Griffith, Johnson, Flores, Hudson, Walberg, Duncan, and Walden (ex officio).

Staff present: Jeff Carroll, Staff Director; Catherine Giljohann, FERC Detailee; Omar Guzman-Toro, Policy Analyst; Rick Kessler, Senior Advisor and Staff Director, Energy and Environment; Elysa Montfort, Press Secretary; Lino Pena-Martinez, Staff Assistant; Alivia Roberts, Press Assistant; Tim Robinson, Chief Counsel; Andrew Souvall, Director of Communications, Outreach and Member Services; Tuley Wright, Energy and Environment Policy Advisor; Peter Kielty, Minority General Counsel; Bijan Koohmaraie, Minority Deputy Chief Counsel, CPAC; Mary Martin, Minority Chief Counsel, Energy & Environment & Climate Change; Brandon Mooney, Minority Deputy Chief Counsel, Energy; Brannon Rains, Minority Policy Analyst; and Peter Spencer, Minority Senior Professional Staff Member, Environment & Climate Change.

Mr. Rush. The Subcommittee on Energy will come to order. The chair now recognizes himself for 5 minutes for the purpose of an opening statement.

On December the 2nd, 1942, the world's first controlled, self-sustaining nuclear chain reaction occurred right beneath the surface in my district, the 1st District of Illinois, at the University of Chicago. This occurrence, in conjunction with the discovery of nuclear fission, propelled our nation into the dawn of a new era.

Since the creation of the Chicago Pile 1 reactor, the world's first nuclear reactor, peaceful applications of nuclear technology have provided solutions to various modern challenges. This includes the detention and management of threats to human health, food security, and demands for electricity. However, one of the greatest challenges facing our world remains with us and that is the challenge of climate change.

Catastrophic climate change is an existential threat that will spare no community from its widespread impact. The large-scale deployment of low-carbon energy is necessary to decarbonize economic sectors and reduce greenhouse gas emissions. It is likely that the world's energy usage will see a fifty percent increase by 2050.

We are faced with this reality and it is critical that we

deploy every method at our disposal to effectively mitigate the consequences of this increased usage. This includes the use of next-generation nuclear reactor design. At present, existing light water reactors account for up to 20 percent of our annual electricity generation in our nation, making them the second leading source of low-carbon emitting power, and are necessary to meet climate goals and growing energy needs.

To remedy challenges posed by climate change, nuclear plants must evolve, must evolve to become increasingly cost-competitive, readily deployable and, most importantly, they must be safe and secure through the advancement of next-generation nuclear technologies like small modular and other advanced reactor concepts.

We, our nation, can accomplish these objectives. Emerging reactor designs are to produce nuclear power with greater efficiency and flexibility. For instance, these expandable sources of energy may be assembled in factories and shipped to underserved areas. Apart from this advanced reactor design may also result in the recycling of nuclear fuel and much-needed waste volume reduction.

Today's discussion is deeply important to our nation's path to a clean energy future, and I want to thank each and every one of our witnesses for their participation. And with that I want

to yield to my friend, the gentleman from Michigan, from Ohio, rather, my friend Mr. Latta, who is going to speak in the time of the ranking member, Mr. Upton. Mr. Latta is recognized for 5 minutes.

Mr. Latta. Well, thank you, Mr. Chairman. And I know my good friend who sits to the north of me in Michigan, I saw he got a big smile on his face when you said from Michigan, and some times of the year, those are fighting words in Ohio, so. But, Mr. Chairman, thank you very much for holding today's hearing, and I also want to thank our witnesses for appearing before us today on this very important subject.

As we continue our discussions in this subcommittee about reducing emissions, there can be little doubt that nuclear technology will play a central role. Our expert panel of witnesses today will update us on the state of advanced technologies, the prospects for these technologies in energy and industrial applications, what we should be doing to make progress towards actually licensing and building new nuclear power generators, and how we support widespread deployment both in the United States and in foreign markets.

Advanced nuclear will help the U.S. maintain its role as a global leader in energy innovation. The U.S. was the first to commercialize nuclear power for generation on the electric

grid, and for decades we led the way in the production of nuclear fuel. Unfortunately, we are now falling behind other nations, including our adversaries.

If we are going to maintain our energy security into the future, we need to invest in our existing nuclear fleet and streamline the deployment in advanced nuclear power. That is why in the last Congress, I introduced the Advanced Nuclear Technology Development Act which require the Department of Energy and the Nuclear Regulatory Commission to collaborate on a regulatory framework and licensing requirements to provide certainty for the deployment of advanced nuclear technology. This legislation passed the House, and many of its provisions were included in a larger energy package that President Trump signed into law in 2018.

I am also interested in how we can maintain a durable, domestic civilian nuclear industry. I commend the Trump administration for their attention to this issue, including how important it is for the United States to increase nuclear fuel production. In his budget, the President calls for the establishment of a national strategic uranium reserve to provide additional assurances of the availability of uranium in the United States in the event of market disruption. I believe it is important that Congress authorize this action and I plan on

introducing legislation to do so.

Aside from the energy security implications, having a strong domestic nuclear industry is essential to any conversation about reducing emissions. The fact is, the nation's existing light water fleet is the dominant form of emissions-free power in many regions of the United States, far surpassing what is provided by wind and solar. According to industry data, nuclear provides more than half of the emissions-free electricity in the United States. If we are serious about reducing emissions and paving the way for new advanced technologies, then we must maintain a robust, existing fleet as well as the intellectual, technological, and regulatory infrastructure that supports it.

Again, I want to thank our witnesses for appearing with us today and I look forward to this important discussion. And, Mr. Chairman, I yield back the balance of my time.

Mr. Rush. The gentleman yields back. The chair now recognizes the chairman of the full committee, my friend Mr. Pallone, for 5 minutes for the purposes of an opening statement.

The Chairman. Thank you, Chairman Rush.

Today's hearing continues the committee's series on building a hundred percent clean economy. At the beginning of the year, I joined Chairman Tonko and Rush and other committee Democrats in releasing the CLEAN Future Act, a bold plan to achieve net-zero

greenhouse gas pollution in order to combat climate change. We have held 15 climate hearings over the last year, seven of them specifically designed to examine how to achieve deep decarbonization of various sectors of our economy, and today we will focus nuclear energy's role in a clean energy future.

Over the last decade, the power sector has made great strides in reducing its emissions, nevertheless, it remains responsible for twenty-eight percent of our nation's total carbon dioxide pollution. Fossil fuels also still represent nearly two-thirds of electricity generation, so it is essential that we consider any and all technologies that can reduce our dependence on fossil fuel and boost our decarbonization efforts.

Achieving a fully decarbonized economy will require electrifying more things Americans use every day, like vehicles, furnaces, and hot water heaters. We will also need to electrify most industrial and manufacturing processes. But electrification will only help us achieve our carbon reduction goals if the electricity comes from clean sources.

Nuclear power is a stable and reliable generating technology that emits no greenhouse gas pollution. It should be an important tool for decarbonizing our economy. Yet an increasing number of nuclear power plants in recent years have ceased operations for a range of factors, primarily because of the challenge to

compete financially in power markets. As these plants go offline, the generating sources replacing them should also be emissions-free.

But in many regions of the country, this retiring electricity generation is largely replaced by natural gas. Advanced nuclear technologies have the potential to provide more of the clean energy we need to decarbonize our economy. Advanced reactors can be designed to provide enhanced safety features and produce less waste. They also offer more flexibility than the designs in operation today because they can come in different sizes and they can be constructed faster with lower construction costs and sited in more remote areas.

While we have yet to see any advanced reactors fully commercialized, one project from NuScale is expected to receive final approval from the NRC this year, and there are also many other promising proposals in the research and development phase with an eye towards deployment in the next decade. Supporting advancements in nuclear energy and bringing these new technologies to scale is one piece of the puzzle necessary to meet our climate goals. We have to invest in renewable energy and energy storage technologies, which will play a big role in decarbonizing the power sector. But studies show that in order to get to a hundred percent decarbonization affordably,

we need reliable carbon-free resources like advanced nuclear power that can sustain output for long periods of time. Advanced nuclear also can work with other clean energy sources, like solar and wind, to fully decarbonize the power sector without big increases in utility bills.

At the beginning of the century, there were rumblings of a nuclear energy renaissance with multiple large nuclear projects planned and the NRC staffing up to handle new license applications. But that didn't come to fruition, and we must contemplate how the next generation of reactors can be brought to market and deployed affordably. And this is something I believe most Democrats and Republicans agree on. I hope we can continue to work together to find ways to facilitate the development and deployment of advanced safer, cleaner, and more flexible nuclear technologies.

So we have a knowledgeable panel of witnesses today, including the CEOs of two companies actively working to commercialize advanced reactor designs. I hope we can shed more light on current challenges, the policies Congress can pursue to facilitate the transition, and how advanced nuclear technologies can play a role in achieving a full decarbonization of the power sector.

I know I have a minute left, but I don't think anybody wants

it, Mr. Chair, so I yield back.

Mr. Rush. The gentleman yields back. The chair now recognizes Mr. Walden, the ranking member of the full committee, for 5 minutes for the purpose of his opening statement.

Mr. Walden. Good morning, Mr. Chairman.

Mr. Rush. Good morning.

Mr. Walden. I want to welcome you and our witnesses, certainly, to this really important hearing. I want to thank you for having this. The focus of today's hearing obviously is fundamental to addressing climate change risks and one that Republicans have logically and proudly championed, advanced nuclear technology.

The most cost-effective way, indeed, the only reasonable way to reduce greenhouse gas emissions and foster our national economic and security interests is through innovation, especially nuclear innovation. Encouraging the deployment of nuclear technology and, I must add, strengthening our current nuclear fleet and industrial base, implementing policies that helps reassert U.S. nuclear leadership globally, these all provide a really promising path forward to meet both our environmental needs and our energy security priorities. In fact, it is the only way forward to meet these priorities, I would say.

So today can help us focus on what is possible and what is

necessary to build on recent policies we have enacted to ensure we have the right regulatory landscape, the right policies to strengthen our domestic civil industry and the innovative technologies on the horizon. U.S. global leadership here is sorely needed. Exporting clean power and clean power technologies will do more to drive down global CO2 emissions than some arbitrary cap that countries fail to meet.

In May of last year, the International Energy Agency released an information report on the role of nuclear power and clean energy systems. It did not find current trends very encouraging. The report noted that nuclear and hydropower "form the backbone of low-carbon electricity generation," responsible for three-quarters of the global low-carbon generation and the reduction of over sixty gigatons of carbon dioxide emissions over the past 50 years. Yet IEA found in advanced economies, nuclear power is in decline, with closing plants and little new investment "just when the world requires more low-carbon electricity."

There are various reasons for this, some relating to cost overruns and delays, others to policies that fail to value the low-carbon and energy security attributes of nuclear. In any case, the report found this failure to encourage nuclear will undermine global efforts to develop cleaner electricity systems.

Germany demonstrates this very problem. As it chose to shut

down its nuclear energy, it has doubled down on expanding renewables like solar and wind. Ironically, to make this work, it also doubled down on coal. This nuclear phase-out has cost Germany $12 billion dollars, seventy percent of which is from increased mortality risks from stronger air pollutants. That is according to the National Bureau of Economic Research, by the way.

If other less technologically advanced nations even could match the rate of renewables growth reached by Germany, they would only hit about a fifth of what is necessary to reach climate goals and with more expensive energy. So, would they then be forced to bring on line even more coal-fired sources than Germany?

On the other hand, as outlined by the authors of the pro-nuclear book, A Bright Future, France and Sweden have both demonstrated in the 1970s and '80s how to do it. They showed that the buildout of nuclear can be done at five times the rate of Germany's experience with renewables with increased electricity production and relatively lower prices. So I think the answer is obvious about the importance of nuclear energy. The question will be, can the United States take the lead going forward? We can help do that in this Congress if we fully acknowledge what U.S. leadership on nuclear will mean both for cleaner power and industrial systems here and abroad, and

for the ever-important national security attributes of a strong U.S. industry.

Witnesses have noted in recent hearings that recognizing how the United States energy and climate policy affects energy and energy technology relationships worldwide is critical to addressing emissions where they are growing the fastest and for strengthening our national security relationships. Resurrecting technological leadership in nuclear technology around the world will meet our broader national and energy security reasons, much as unleashing U.S. LNG from our shale revolution restored our ability to counter Russia in energy markets while also driving cleaner technology.

Our nuclear energy exports boost our national security priorities. We on the Energy and Commerce Committee have been working in a bipartisan manner over the past few Congresses to enhance U.S. nuclear policies. There is most certainly more to do and I think today's hearing will help us explore some of that, and that is both administratively and legislatively, to pave the way for advanced nuclear.

Let me welcome the panel today, which I am pleased to see represent several important perspectives including industry, regulatory, safety, and international expertise. Two innovative companies, TerraPower, and from my home state of Oregon, as the

Chairman referenced, NuScale. All of these witnesses can speak of what we need to do to build, operate, and lead with these new technologies. So let's work together on an even better nuclear power policy for America. Today represents a good first step, and I yield back.

Mr. Rush. The gentleman yields back. The chair would like to remind members that pursuant to committee rules, all members' written opening statements shall be made part of the record.

I would like to now welcome our witnesses for today's hearing. Ms. Maria Korsnick is the President and Chief Executive Officer of the Nuclear Energy Institute. Mr. Armond Cohen serves as the Executive Director of the Clean Air Task Force. Mr. Joseph Hezir is the Principal for the Energy Futures Initiative.

The Honorable Jeffrey Merrifield is the Chairman of the Advanced Reactor Task Force, the U.S. Nuclear Industry Council. Mr. John Hopkins is Chairman and Chief Executive Officer of the NuScale Power, LLC. And last, but certainly not least, Mr. Chris Levesque. He serves as the President and Chief Executive Officer of the TerraPower, LLC. Thank each and every one of you, name by name, for joining us today and we look forward to your testimony.

Before we begin, a little instruction on the lighting system that is in front of you. In front of you is a series of lights.

The light will initially be green at the start of your opening statement. The light will turn yellow when you have 1 minute remaining, and at the yellow light, please begin to wrap up your statement at that point. The light will turn red when your 5 minutes are up. And with that said, Ms. Korsnick, you are now recognized for 5 minutes for your opening statement. Welcome.

STATEMENTS OF MARIA KORSNICK, PRESIDENT AND CHIEF EXECUTIVE OFFICER, NUCLEAR ENERGY INSTITUTE; ARMOND COHEN, EXECUTIVE DIRECTOR, CLEAN AIR TASK FORCE; JOSEPH HEZIR, PRINCIPAL, ENERGY FUTURES INITIATIVE; HONORABLE JEFFREY S. MERRIFIELD, CHAIRMAN, ADVANCED REACTOR TASK FORCE, U.S. NUCLEAR INDUSTRY COUNCIL; JOHN L. HOPKINS, CHAIRMAN AND CHIEF EXECUTIVE OFFICER, NUSCALE POWER, LLC; AND, CHRIS LEVESQUE, PRESIDENT AND CHIEF EXECUTIVE OFFICER, TERRAPOWER, LLC.

STATEMENT OF MARIA KORSNICK

Ms. Korsnick. Good morning. I am Maria Korsnick, president and CEO of the Nuclear Energy Institute, and I want to thank you, Chairman Rush. I appreciate the opportunity to testify this morning and I thank the entire subcommittee for continuing to focus on nuclear energy and, specifically, the role of advanced nuclear technology in reaching our decarbonization goals.

I sincerely appreciate the overwhelming bipartisan support that we saw for NEICA as well as NEIMA. Both bills will help ensure that the United States remains a global leader of nuclear energy innovation. Nuclear energy generates most of our nation's clean energy. Nuclear generation helps to combat our climate crisis by producing over 800 billion kilowatt-hours of

emission-free energy every year. In 2018 alone, the current fleet avoided emissions of over 500 million metric tons of carbon dioxide. That is equivalent to avoiding all the emissions from all the cars in the United States.

Looking at today's energy mix and at our goals for further decarbonization, it is clear that we need nuclear alongside other clean energy sources such as wind, solar, and hydropower. We need these technologies to complement each other not work against each other, so we appreciate that the majority's CLEAN Future Act discussion draft takes a technology-neutral approach that values nuclear energy's carbon-free generation.

States and utilities have also recognized the need to decarbonize the energy sector. California, New Mexico, Colorado, New York, and Washington are among the states that have set goals to require one hundred percent clean and reliable energy by 2050, if not sooner, with more states likely to act. And likewise, dozens of utilities have also made significant emission reduction pledges, with others already well-positioned for a low-carbon future by virtue of their existing nuclear generation.

Electric utilities are looking for firm, dispatchable, carbon-free solutions to complement wind and solar to meet their decarbonization pledges and they recognize that the second license renewal for the current nuclear fleet and advanced

technologies are integral to meeting those goals. The U.S. leads the world in innovative companies and the nuclear sector well reflects America's entrepreneurial spirit.

NEI's members include approximately twenty advanced reactor developers with design set range in size from a few megawatts to a few hundred megawatts to the large gigawatt-class reactors. And advanced nuclear technologies could also contribute to decarbonization in other sectors such as transportation. Electric cars should be powered by a carbon-free energy source. And new nuclear technologies that can compete with other forms of firm, carbon-free generation in the U.S. will be highly sought after in the global market.

I am extremely hopeful because real progress is being made. The Tennessee Valley Authority recently received the nation's first Early Site Permit for a small modular reactor at its Clinch River site, and NuScale is expected to receive its design certification for its SMR later this year. Oklo is expected to apply for a license from the NRC for their Advanced Fission Plant.

GE-Hitachi and Kairos Power are actively engaging with the NRC on their innovative SMR designs, and Southern Company is teaming with TerraPower on a molten salt reactor technology. In addition, the nation's first AP-1000 light water reactor, Vogtle 3, is scheduled to come online next year, and Vogtle 4

will operate in 2022. These two reactors will generate enough carbon-free electricity to power a million homes and businesses.

And we are also very pleased that Congress funded the Advanced Reactor Demonstration Program. This program sets a goal for two demonstrations to be operational in the next 5 to 7 years, and facilitates two to five other projects in the future. The show of government confidence in nuclear technology is a catalyst for the capital investment needed for commercialization. Further, once passed, the bipartisan NELA will help ensure that our nation's advanced reactor program thrives in the coming decade, spurring innovation through demonstration projects, establishing a pilot program for long-term federal power purchase agreements, and providing a pragmatic approach to ensuring that the fuel to power these advanced reactors will be available when needed. In closing, today's fleet is America's emission-free workhorse. Nuclear carbon-free energy powers our homes, our businesses, and our Navy. It enables deep space exploration, solves medical challenges, it helps fund schools and essential services in communities across the country, and nuclear generation provides a critical, carbon-free energy solution now and for the future.

Thank you and I look forward to working with you to ensure that our nation can take full advantage of the nuclear generation

that we have to offer and I am happy to answer any questions.

[The prepared statement of Ms. Korsnick follows:]

**********INSERT 1**********

Mr. Rush. Thank you.

Mr. Cohen, you are now recognized for 5 minutes.

STATEMENT OF ARMOND COHEN

Mr. Cohen. Thank you, Chairman Rush and Ranking Member Walden, and members of the committee. I am not going to talk from a written statement, but I want to really fundamentally address the issue, why bother with nuclear at all? We have remarkable progress on renewables. Thankfully, renewable costs have come down dramatically, seventy-five, eighty percent, over the last 20 years. Battery costs are dropping. Why would we want to move forward with this technology?

And we have a couple visuals, and I don't know if we can put up the first slide if that is ready to go and, if not, I will try and talk from it verbally.

[Slide.]

Mr. Cohen. The first slide that is in your deck, and I know this is kind of hard to see, but on the left we see the amount of carbon-free energy we have to deploy over the next 30 years to get to a one hundred percent carbon-free grid by mid-century. You can see it is a pretty steep climb and, in fact. it amounts on an average basis to about 35 average gigawatts per year. Now

to put that in context, that is one New York State's worth of electric infrastructure every year. So we have to build a New York power system every single year for the next 30 years and it all has to be carbon-free, so you get some sense of the scale of this task.

The bars on the right represent our best historic track record of building capacity. On the far left you have wind and solar averaged over 2010 to 2018, about 3 gigawatts per year. The best year was 5 gigawatts, and on the right was nuclear during its best decade from 1980 to 1990. And you can see that even that -- we will talk about scaling advantages of nuclear -- we still would need to build it about five times the rate that we did historically.

The takeaway message from this graph is that if you think you are going to get there with just one thing, one source, whether it is wind or solar, or it is natural gas with carbon capture, if it is nuclear, I would suggest that is a very, very risky bet. And so this game is all about scale and timing and that is where nuclear has extraordinary advantages. Again, very, very lucky to have the kind of renewable resource we have, but in terms of filling up that hole and hitting that one New York a year target, we are going to need everything we have got.

[Slide.]

Mr. Cohen. The next slide, if you can put it up, addresses -- I realize it is a bit of an eye chart, but it is in the printed copy of the testimony. So the other challenge here is to make sure as Ms. Korsnick said that we have 24/7, 365 reliable power. Now what we have illustrated or modeled on the left is the western states at a hundred percent wind, solar, and hydro. There is a little bit of mistake in my testimony. This is wind, solar, and a very large amount of hydroelectric power which is to some extent dispatchable. But what you see is those shaded lines, we have the full year represented on the x-axis, but we have 68 days and then another 35 days when that wind, solar, and hydro output can't supply the energy on those days by a significant fraction in some cases. Now that is with nominally a hundred percent renewable ability, and this is cost-optimized and we can go into the details, but those gaps have to be filled. And on the right, you see what the storage requirement would be to fill those gaps.

That storage requirement would be about 3.3 terawatts of storage. Just think of that number, 3.3. The entire U.S. electric grid is one terawatt. So we would have to triple the size of the U.S. electric grid just in storage and just for the fourteen western states; that the capital cost of that investment would be about 1.6 trillion dollars, which again to put that in

perspective, the entire electric bill of the western states is 80 billion a year.

So about a 20x capital spend over what the western states spend, and so obviously the cost of doing this is very, very large. And by the way, we dropped the cost of storage to seventy-five percent from where it is today to derive those numbers, so I am assuming a lot of innovation.

[Slide.]

Mr. Cohen. The final slide makes the point about scale. And this, what we see here is France and it was referred to earlier, so this is the French grid from 1960 to 2015. The blue line is fossil generation on the French grid and the red line is nuclear generation. And you can see that in a space of about 15 years, France went from entirely fossil to about twenty, fifteen percent fossil. That was due to the nuclear power program.

Now that wasn't done for climate reasons. It was done to get off, you know, Middle Eastern oil. But nonetheless, it shows you that when you want to scale this technology, you can do it very fast, and there are all kinds of reasons for that. It is a very power-dense technology if you can scale and get to the rate. We talked a little bit about how compact it is. But this is the kind of scale we need to be at, and I am not suggesting

that the entire U.S. electric grid be powered by nuclear, but you could do that. Or you could do a very significant fraction, and history proves that is the case.

Finally, let me just make a comment from a quote I like from James Baldwin in a very different context. "Not everything that is faced can be changed, but nothing can be changed that is not faced." And what we have to face here is the size and scale of this problem and the fact that there is no perfect solution. Nuclear is not perfect, but it is good enough and it is there and we can use it to decarbonize the economy. Thank you.

[The prepared statement of Mr. Cohen follows:]

**********INSERT 2**********

Mr. Rush. Thank you.

The chair now recognizes Mr. Hezir for 5 minutes.

STATEMENT OF JOSEPH HEZIR

Mr. Hezir. Thank you, Mr. Chairman, and thank you, members of the subcommittee, for having this hearing today. I am Joseph Hezir. I am a principal at the Energy Futures Initiative, or EFI as I will refer to it.

EFI is an energy policy think tank that was formed by former Secretary of Energy Ernest Moniz. I have had the good opportunity of working with him now for over 10 years, first at the MIT Energy Initiative, then serving as the chief financial officer at the Department of Energy, and then co-founding EFI with him a little over 2 years ago. Our mission simply stated is to identify opportunities for innovation in energy technology, business models and policy to accelerate the transition to a future clean energy economy.

So in the nearly 3 years since our founding, EFI has produced over thirteen separate reports on energy innovation and clean energy policy. Many of these reports touch on nuclear energy issues and I have tried to summarize some of those in my prepared statement. Drawing from this statement, I would just like now

to sort of emphasize five main points. The first point I want to emphasize is in thinking about the title of today's hearing and, really, the theme that this committee has set, building a hundred-percent clean energy economy. It is important that we recognize that in doing so that we need to think about it in terms of net-zero carbon. Even with significant energy innovation including nuclear, not all sectors of the economy will necessarily become a hundred percent clean. There are subsectors within transportation industry and the built environment where there may be no clean technological solution or where the solution will be cost-prohibitive. Consequently, within EFI we also emphasize the need for large-scale carbon management, both carbon capture as well as carbon removal from the environment. Advanced nuclear technologies provide the potential for large-scale clean electricity, but a hundred percent clean energy economy will also require companion efforts on large-scale carbon management.

The second point I want to emphasize is that advanced nuclear energies are part of the key element of what we have called at EFI, "the Green Real Deal." As you all know, the House has resolution on the Green New Deal and that resolution has called attention to two very aspirational goals, one being the urgency of addressing the climate change issue and, secondly, the need to do so in a manner that ensures social equity.

Our report on the Green Real Deal translates these aspirational goals into a framework for action that would create a clean energy economy in ways that minimize costs, maximize economic opportunities and accelerate solutions and promote social equity. We have identified five foundational principles for the Green Real Deal including innovation to provide optionality and flexibility, building coalitions, ensuring social equity, and addressing all emitting sectors, and last but not least, providing an all of the above solution set.

The reason I mention these five foundational principles is that advanced nuclear energy technology reflects all of these principles, particularly in providing optionality and flexibility as part of the an all-of-the-above solution. And looking forward from now through mid-century, we see optionality and flexibility becoming increasingly important as we look into the next decade and head toward ambitious goals for mid-century.

The third point I want to make is that advanced nuclear energy technologies are essential to an energy portfolio with significant breakthrough potential. We have done a major study of the energy innovation landscape, and as part of that we identified five particular technologies that we thought have breakthrough potential, one of which is advanced nuclear energy technologies. And so, we see that as becoming a very important

point for many of the reasons that others on this panel will talk about.

The fourth point I want to make is simply that advanced nuclear energy and a strong federal role is important not only for energy and climate reasons, but also for national security reasons. Many people have touched upon it, but I want to just emphasize two points, one being the point about the fact that the U.S. has been a leader in nuclear nonproliferation policy around the world and having a strong and robust civilian industry is very important to advancing that goal. The other important goal is the fact that there is a very important interplay between the commercial nuclear industry and our nuclear Navy, and those two are very mutually reinforcing.

So, in conclusion, I just want to say that at EFI we do not endorse particular legislation. We do not take formal positions. But we do very much support the concept of improved public-private partnerships, and we see in the legislation that you have before you many opportunities to do just that. So, thank you very much.

[The prepared statement of Mr. Hezir follows:]

**********INSERT 3*********

Mr. Rush. Thank you.

The chair now recognizes Mr. Merrifield for 5 minutes.

STATEMENT OF JEFFREY MERRIFIELD

Mr. Merrifield. Mr. Chairman and members of the subcommittee, it is an honor to testify before you today. I am here in my role as chairman of the Advanced Nuclear Task Force of the U.S. Nuclear Industry Council.

It has become very apparent that we must deploy a wide range of technologies to reserve the global production of greenhouse gases. I am pleased to be here to discuss how advanced nuclear energy can help address this challenge. Over twenty NIC companies are developing advanced reactors using light water, high-temperature gas, molten salt, and liquid metal ranging from micro to large reactors. These designs have made tremendous progress over the last 5 years, with modularity and safety features that allow them to replace coal- or gas-fired units or be used for desalinization or process heat.

NIC appreciates what this committee and its counterparts have done in passing a variety of nuclear bills as well as increasing funding for DOE's Office of Nuclear Energy. Last May, NIC attended the Clean Energy Ministerial in Vancouver. The head

of the International Energy Agency, Fatih Birol, talked about the role that nuclear plays in fighting climate change.

Over the last 50 years, nuclear has reduced CO2 emissions by over 60 gigatons, equal to 2 years of global energy related emissions. Yet without policy changes, advanced economies could lose twenty-five percent of their nuclear capacity by 2025 and two-thirds by 2040. Absent life extension, these closures could add four billion tons of annual CO2 emissions, putting us further into the hole. As IEA states, it is considerably cheaper to extend the life of a reactor than build a new plant, and the cost of life extensions are competitive with wind and solar.

As you know, Germany, which is seeking significant renewables, is shutting down seventeen of its nuclear units. A December 2019 study funded by the National Bureau of Economic Research states the German nuclear power was mostly replaced with power from coal plants which led to a release of an additional 36 million tons of CO2 per year. By their estimate, this increase in particulate and SO2 emissions likely killed over 1,100 people per year in Germany from lung or heart disease.

Several states, including Illinois, Ohio, and New Jersey have adopted zero emissions credits to protect existing nuclear generation from economic shutdown. Unfortunately, a recent decision by FERC in December of 2019, which expanded the Minimum

Offer Price Rule, or MOPR, will have the effect of eroding these efforts and will further reduce the carbon-free generation of these important plants.

While wind and solar resources are needed to reduce carbon emissions, they are not the only solution. According to a recent MIT report, firm, low-carbon resources including nuclear power, bioenergy, and natural gas plants that capture CO2 consistently lower the cost of decarbonizing electricity. Without these resources, costs rise rapidly as CO2 limits approach zero. According to the report, zero-emission cases without firm resources will require installed generation and storage that could be five to eight times the peak system demand.

NIC believes that the demonstration program and federal power purchase agreement provisions included in the Nuclear Energy Leadership Act that has been reported to this committee would significantly enable advanced reactors and we support the prompt passage of this bill. I previously testified on the need for high-assay, low-enriched uranium, otherwise known as HALEU, for many advanced reactors. While many positive steps have been taken by DOE to address the supply of this material, given the important civilian, military, and space applications of HALEU, we believe this committee will need to closely monitor DOE's efforts.

Over the last 30 years, the U.S. has gone from being the preeminent nuclear exporter to trailing Russia, France, Korea, and China in international nuclear deployments. Last October, I attended a NIC delegation to Kenya. We met with leaders over a dozen Sub-Saharan countries who were investigating advanced reactors. They said the following: "We need nuclear generation to provide clean carbon-free economic growth for our countries, or else we will be forced to buy coal or other fossil plants because renewable energy will not be enough. We want American nuclear technologies and we want American nuclear assistance, but we keep asking ourselves, where are the Americans?"

Advanced reactors provide a clear opportunity for the U.S. to retake the lead in the deployment of nuclear technologies and will spur exports, create jobs, strengthen our international relations, and provide clean, carbon-free energy around the world. Unfortunately, the ability to finance these technologies and export them is hindered by the existing impediments in international finance institutions that discriminate against nuclear energy. We believe the development of advanced reactors would justify the International Development Finance Corporation to reverse the prior OPIC policy prohibiting nuclear financing.

Finally, similar anti-nuclear policies at other institutions including the World Bank, the Asian Development

Bank, and others are based on a lack of understanding regarding the clean energy benefits of nuclear. We urge Congress to seek the reversal of these anti-nuclear policies and enable U.S. advanced nuclear exports to bloom.

With that I thank you and I request that the four reports that I referenced in my testimony be included in the record. Thank you, Mr. Chairman.

[The prepared statement of Mr. Merrifield follows:]

**********INSERT 4**********

Mr. Rush. Hearing no objection, so ordered.

[The information follows:]

**********COMMITTEE INSERT**********

Mr. Rush. The chair now recognizes Mr. Hopkins for 5 minutes.

STATEMENT OF JOHN HOPKINS

Mr. Hopkins. Thank you, Chairman Rush, members of the subcommittee, it is an honor to be before you today. My name is John Hopkins. I am the chief executive officer of NuScale Power.

The NuScale SMR is a disruptive technology that could change the way the world views nuclear energy and will play an important role in the next generation of zero-carbon baseload electricity. We are based in Corvallis, Oregon. We have 300 employees and our major private investor is Fluor Corporation. Advanced small modular reactors offer an opportunity for true decarbonization with safe, flexible, efficient, and affordable technology. NuScale's SMRs have revolutionized nuclear safety with a very simplified design and walk-away safe technology.

Each NuScale module can generate up to 60 megawatts of electric power. Up to twelve modules are housed at each site providing a total of up to 720 megawatts. All twelve modules can shut down and self-cool for an unlimited period of time with no operator interaction, no need for additional water, and no

electricity requirements. SMRs can integrate with renewable energy and can load-follow, provide reliable power to mission critical facilities and to industrial processes like desalinization, and serve as emission-free baseload power. Recent studies by MIT, the International Energy Agency, and the E3 study commissioned by Energy Northwest in the state of Washington, show that without nuclear energy costs of achieving deep decarbonization goals will be two to three times higher.

The NuScale design has been under review by the NRC since 2017. The 12,000-page Design Certification Application took over 2 million engineering hours, involved over eight hundred people and cost $500 million to prepare. In December 2019, the NRC completed Phase 4 of the review. Completion of Phase 4 signifies near completion of the technical review for the Design Certification Application. The NRC is on track for completing NuScale's DCA by the end of this year 2020. To reduce risks for the first-of-a-kind technology, DOE has supported public-private partnerships and the program is working. In 2013, NuScale won a very competitive DOE 50/50 cost-share funding opportunity which accelerated NuScale's advancement through a very complex NRC Design Certification process. This is what DOE's SMR program is created to do and our success is due to your strong bipartisan support. NuScale is the only near-term

commercially deployable advanced technology today. We are preparing for our first deployment project, the Utah Associated Municipal Power Systems Carbon Free Power Project, which will be sited at the DOE's Idaho National Laboratory. NuScale's innovative manufacturing process and investments in SMR technology are helping to grow the clean energy economy. Our supply chain is already extensive with over fifty suppliers located in 25 of our states. We anticipate over one thousand construction jobs per plant, and once operating each NuScale plant is expected to employ over three hundred full-time employees with an average salary of $85,000. This is about twice the workforce of a similarly-sized coal plant and six times that of a combined cycle natural gas plant.

There are several policy measures Congress can take to speed in our advanced nuclear community. Continued resources for Department of Energy's public-private partnership should be a priority. If appropriations for DOE's SMR program continue, funds will be used for acceleration of design finalization activities, development of the manufacturing supply chain in this country, and site licensing and deployment activities. NRC should have sufficient resources to process advanced nuclear applications in a timely manner. The Nuclear Energy Leadership Act, introduced by Representatives Luria and

co-sponsored by twenty-five bipartisan members, will accelerate growth in the advanced nuclear community. The CLEAN Future Act includes important changes to federal long-term power purchase agreements. The provision would help reduce the risk of advanced reactor projects by extending the maximum length of federal power purchase agreements to 40 years.

We are grateful for the support of the Department of Energy and the Congress. We take the responsibilities associated with the use of our taxpayer dollars very seriously and are singularly focused on our role in the reestablishment, as many have said at this table today, of U.S. leadership in our nuclear technologies. I want to thank the committee for the opportunity to testify before you today and I am looking forward to your questions.

[The prepared statement of Mr. Hopkins follows:]

**********INSERT 5**********

Mr. Rush. I want to thank the gentleman.

The chair now recognizes Mr. Levesque for 5 minutes for an opening statement.

STATEMENT OF CHRIS LEVESQUE

Mr. Levesque. Thank you, Chairman Rush and members of the subcommittee. My name is Chris Levesque and I am the chief executive officer of TerraPower, an advanced nuclear technology company based in Bellevue, Washington.

Including the past 5 years at TerraPower, I have spent my entire career working in nuclear energy beginning my service in the Navy on submarines. I have also had the opportunity to work on civilian nuclear projects in the U.S. and internationally. These experiences greatly inform my comments today as well as my belief that the U.S. must retain its leadership in nuclear energy technology. In 2006, our company's founders, Bill Gates and Nathan Myhrvold, began looking for a technological solution to the dual challenges of the growing global demand for energy and the rising threat of climate change. The answer they discovered is advanced nuclear technology.

The United Nations Intergovernmental Panel on Climate Change, the IPCC, provides a number of pathways to keep global

emissions below 1.5 degrees Celsius. None of those pathways will be achieved if we allow for a reduction in the share of global power provided by nuclear. In fact, the high economic growth scenario calls for global nuclear power demand to increase by five times current levels. Because nuclear provides always-available power, it can play a key role in a one hundred percent emissions-free future. TerraPower's designs are walk-away safe and use natural forces like gravity and air cooling, not human intervention, to keep the reactors safe when faced with unplanned events. Our plants can run on natural or depleted uranium and can reduce waste over conventional designs by nearly eighty percent. Because they do not require enrichment and because they burn up more of the fuel in the reactor core, they significantly reduce the risk of proliferation.

These improvements make our reactors safer, cheaper, and able to operate with lower volumes of waste. Our technology is also specifically designed to integrate into a grid with large amounts of wind and solar generation. We are developing an integrated energy system that uses heat from our reactors to store energy in a molten salt loop like a giant thermal battery. This stored energy can be used during periods of low solar and wind activity, and can also be used to supply industrial processes the currently require the burning of fossil fuels.

Our reactors will be essential for reducing hydrocarbon use in the industrial and transportation sectors as we move toward a carbon-free economy. A measure of the urgency and interest of our work, I would like to mention the remarkable nature of our workforce. We have attracted mission-driven, talented, sought-after young minds who want to solve the climate crisis. We compete with our neighbors in Seattle at Microsoft, Amazon, and others across the nation, for the best and brightest minds in engineering and science. They push us every day to solve the remaining challenges in our path to demonstration and deployment.

It is important that Congress supports the demonstration of advanced nuclear technology. Because our designs are novel and cutting-edge, it will be virtually impossible to find sufficient capital to build a commercial reactor without first demonstrating these new reactors at scale. We are excited that the fiscal year 2020 appropriations bill provides 230 million dollars for demonstration of advanced nuclear reactors. It also provides for continued investment in the versatile test reactor, the VTR, a key platform for nuclear innovation.

We also support the Nuclear Energy Leadership Act, NELA, and appreciate the number of members of this committee who have joined as co-sponsors of NELA. NELA builds on the work of this committee to encourage innovation and private investment. And,

finally, we are grateful for interest and leadership demonstrated by this committee on climate change. Our company was founded on the premise that we must end global energy poverty while at the same time protecting the planet. We wholeheartedly believe that America is up to solving the challenge of climate change and TerraPower is ready to play a key role in making a one hundred percent emissions-free future a reality.

In conclusion, we know America can lead in nuclear innovation. In the coming decades, many new countries will employ nuclear energy to meet their growth needs. China and Russia stand poised to supply these countries with their technology; the U.S. needs to be ready with our own. On behalf of TerraPower's 150 innovative employees working to make that goal a reality, thank you for the opportunity to appear before the committee.

[The prepared statement of Mr. Levesque follows:]

**********INSERT 6**********

Mr. Rush. The chair thanks all the witnesses. We have concluded our opening statement phase of this hearing and now we will move to member questioning. Each member will have 5 minutes to ask questions of our witnesses, and I will start by recognizing myself for 5 minutes.

As mentioned, global demands for electricity are likely to double by 2050. With this in mind, Mr. Cohen, would you detail the importance of pairing firm and dispatchable energy sources, specifically nuclear power, with renewables.

Mr. Cohen. Right. Well, Mr. Chairman, first of all, just to recognize the size of that, while the U.S. electric demand may double, it may triple or quadruple in developing countries, which you look at a country like now like Bangladesh where virtually there is no electricity per capita, so we are looking at much bigger multiples of growth in some of those countries.

And the question really becomes, and some people would say, well, let's just build all solar and wind and we will do batteries. And again, the analysis I showed you is you can do a lot of that, and I think the modeling would say you could probably do it pretty cheaply until you get to the fifty percent of energy mark, but to get to those very high levels you do need this firm capacity.

And as was mentioned, several of the technologies being developed not only provide firm capacity, but can also go up and

down with the wind and sun, so those holes I showed you would be complemented rather easily by nuclear. So for the developing world as well as for the U.S., it is clear that we are going to need a lot of kilowatt-hours and we are going to need a lot over the next 30 years and that nuclear is clearly a potential player in providing those kilowatt-hours.

Mr. Rush. Ms. Korsnick, what challenges does nuclear power face with current electricity markets and how will they impact the next generation of technology?

Ms. Korsnick. In the current marketplace today, the attribute that nuclear brings to the table is its carbon-free nature and that is not recognized by the market. In one case we imagine that it is a fair market, but there are a lot of things that are actually at play in this market, so you have some things that get a subsidy. We also have the very low cost of natural gas due to the success of fracking, and nuclear is really getting squeezed, if you will, from both sides.

And so the real case here is we need to value the carbon-free attribute that nuclear brings to the table in order to make that business case for those plants of the future in some of the markets.

Mr. Rush. Mr. Hezir, recent plant closures have sparked concerns over the future of emerging reactor design. According

to a March 2019 EFI report, approximately 72,000 people are employed by the U.S. commercial nuclear power sector. What impact, if any, will nuclear power plant closures have on the next generation technology and the nuclear workforce in general?

Mr. Hezir. Thank you for that question. We conduct an annual energy employment survey that supplements the work that is done by the Bureau of Labor Statistics that captures a lot more of the data on the energy workforce, and as you indicated, our last survey showed that there was a total of over 72,000 workers in the nuclear sector including nuclear fuels. And that number by the way is about one-third higher than what you would see in the Bureau of Labor Statistics data because we capture a lot of the contractor data that don't show up in some of the BLS classifications.

As others have indicated here at the table, nuclear plant employment tends to be much higher than at other generating facilities whether it is natural gas combined cycle or even coal, and so a closure of a nuclear power plant can have a very significant impact not only on direct employment, but also on the kind of the ripple effect as well because many of these plants are located in areas where they are by far the largest employer or in many cases the sole employer. So that is a very significant issue that has to be taken into account.

The flip side of it is, it is a great opportunity for advanced nuclear to provide jobs particularly in cases where plants have been shut down like coal plants or other plants for other reasons.

Mr. Rush. I want to thank you. The chair's time is up. Now the chair recognizes my friend from South Carolina, Mr. Duncan, for -- Mr. Latta, for 5 minutes.

Mr. Latta. Well, thanks, Mr. Chairman. And again, thanks to our witnesses for appearing today. I really appreciate your testimony.

Commissioner Merrifield, if I may start my questions with you. In your testimony you point out that the United States has fallen out of a leadership position when it comes to nuclear exports. Would you expand on the economic and national security implications of having a strong, U.S.-based nuclear energy industry out there?

Mr. Merrifield. We know that if you sell a nuclear power plant to a country outside of the United States that creates the foundation of a relationship that can date 50, 60, even 100 years down the road, if you look at the beginning of training the workforce there, building the reactor, supplying the fuel, and having the engagement of U.S. nuclear technology providers actively engaged with that country.

As we lose those opportunities to other countries around

the world, and Russia and China are the two countries right now who are being most aggressive in their building platforms and are providing significant financial support for deploying their reactors, that really puts us behind the eight ball. So these are critically important that we establish those relationships and provide those exports. It is a matter of jobs, it is a matter of national security, and to the extent that we have Americans involved with programs outside of the United States, it gives us an insight on those programs that has a commensurate benefit with nonproliferation goals.

Mr. Latta. Let me follow up. What can Congress and the Department of Energy do to encourage American investment in uranium mining, conversion, and enrichment to make sure that we regain our leadership role in nuclear energy?

Mr. Merrifield. Well, we have extraordinary capabilities in the United States to provide for uranium mining, and certainly the activities of their being undertaken to consider having a supply of that available is worthy of consideration of this committee. It is critically important that we have the other steps in the nuclear fuel cycle. Right now we have one conversion facility. The Honeywell Metropolis site is currently shut down in a temporary shutdown because of a lack of need for those services.

We as a country do not have any U.S.-owned enrichment facilities. We do have Urenco, which has a facility in New Mexico that is supplying a portion of the U.S. fleet, but for uses of the U.S. military, for uses of higher enrichment of fuel for some of our needs in space and needs for the military that can't be supplied by the Urenco facilities, we as a country need to have the ability to do higher enrichments of fuel that we don't have.

So that is a critical, an area of critical importance and one I think the Department of Energy should be credited for actions that they are taking in terms of trying to address that need.

Mr. Latta. Thank you.

Mr. Hopkins and Mr. Levesque, as the leaders of two American companies operating in the nuclear sector, I would like to get your perceptions on a couple of issues. What type of assistance are your foreign competitors receiving from their governments to develop and deploy advanced nuclear technologies?

Mr. Hopkins. I would like to start. John Hopkins.

What we are seeing and was just mentioned in China and in Russia, they are actually in the process of developing their own what they call small modular advanced reactors. I believe what they offer, typically, when they go into areas of Sub-Sahara Africa or the Arabian Peninsula, they do a wraparound financing package. So not only do they bring the deployment of a

technology, they also are willing because they are state-owned enterprises so it is a more of a government to government sale with financing as part of the process.

Mr. Latta. Mr. Levesque?

Mr. Levesque. And I would agree with my colleague, Mr. Hopkins, and I would add, as long as we allow that to go on without encouraging U.S. nuclear energy companies to move forward internationally, you know, the Chinese and Russian counterparts are just increasing their experience as they build more of these plants. Because as what we have seen with some of our own challenges in building new plants part of that is due to inexperience, so as the Chinese and Russians move forward with these plants, domestically and internationally.

Mr. Latta. Could you elaborate on the inexperience, could you elaborate a little bit on that?

Mr. Levesque. Well, you know, I will compare it to my U.S. Navy experience where, you know, at Newport News Shipbuilding you were able to see the benefits of serial production in different submarine classes that the first one, understandably, would cost more. But soon the shipyard workers and engineers would, you know, learn plant to plant and you would see a sharp learning curve and, you know, a strong reduction in cost as you move from the first to the second to third plant. And what we have seen

in the U.S. in the last 20 or 30 years is that we haven't really committed to a new build program that has allowed us to have that kind of learning curve and into, you know, realize that reduction in cost that you get. So we really need to get our experience level up and we need to do that by starting to build plants again.

Mr. Latta. Thank you.

Mr. Chairman, my time has expired and I yield back.

Mr. Rush. The gentleman yields back. The chair now recognizes the gentleman from California, Mr. Peters, for 5 minutes.

Mr. Peters. Thank you, Mr. Chairman. I appreciate you holding this hearing today and have been looking forward to it. Nuclear energy represents currently fifty-five percent of our emissions-free energy in America, and I think I understand the strong case you have all made that emission-free advanced nuclear technology has to be part of our plan to solve the climate crisis.

I want to note that in my district we have a number of smart physicists and engineers performing groundbreaking work in advanced nuclear. They are creating new materials like silicon carbide ceramics that can be used in new or existing reactor fleets and they work at a constituent company called General Atomics where hundreds of people are working on advanced nuclear reactors that produce less nuclear waste and provide energy that is cheaper

and safer. The company is also participating in the nuclear fusion program known as ITER, which partners with over thirty other nations to develop fusion energy technology and that is the kind of science that I think Congress and the DOE would like to support.

I don't want to skip a step though because there is obviously a political challenge associated with this and I think I haven't really heard you address the waste issue. One of the major candidates for President who claims he is for addressing the climate crisis has ruled out nuclear and I think there is a sense that -- and I certainly have this in our district where we have seen the closure of the plant at San Onofre, north of my district -- people are concerned, why would we go down this road if it is going to generate more waste. I know that that is not the case here. I would like to see maybe, Mr. Hopkins, you talked a little bit about small reactors. What should I tell my constituents about why they shouldn't be worried about waste?

Mr. Hopkins. Having come into this industry, sir, 7 years ago, I was quite amazed at the rigor that we put under dry cask storage in of what we call our spent fuel, what I call, actually, unused energy, in that our particular reactor, the core is 120th the size of a gigawatt sized reactor and our plan is to from a --

Mr. Peters. That is new and old.

Mr. Hopkins. I am sorry?

Mr. Peters. The new technology --

Mr. Hopkins. Yes, sir. Yes.

Mr. Peters. Okay.

Mr. Hopkins. From the legacy of tech, 120th the size.

Our intent right now in our facility is to have 60 years of storage at site for the amount of spent fuel that we will use during that cycle.

Mr. Peters. Is there less residue at the end of the process under the new technology?

Mr. Hopkins. Less residue?

Mr. Peters. Less waste, effectively.

Mr. Hopkins. Well, with a core of less than one, our megawatt reactor at 60 megawatts would have less amount of the total volume.

Mr. Peters. Let me say too that I was listening to Mr. Cohen and the quantity of this task. It strikes me that the government is by nature bureaucratic, slow to respond to the need for innovation. Do you see any things, maybe I would offer this question to other people, any things we should be doing in terms of permitting to make these goals more achievable?

Mr. Cohen. I was actually a cofounder of something called

the Nuclear Innovation Alliance that put forward particularly to the NRC a series of suggested approaches to make the NRC licensing process more innovation-friendly, which, thankfully, the NRC has taken up.

Mr. Peters. Okay.

Mr. Cohen. You know, rather than trying to license by exception from a traditional playbook of a traditional light water reactor, I think the NRC has got the message that they need to prepare kind of a separate lane for innovation, so that is in terms of safety licensing. In terms of permitting on the ground, you know, I think that the issue is going to be public sentiment.

And, frankly, I talk to a lot of my colleagues in the environmental community who might have a concern about waste or they might have a concern about safety, but they also recognize the size of the lift. And my guess is you are going to see significantly more support for this technology over time and particularly as the climate issue becomes more urgent.

Mr. Merrifield. Congressman, having served as NRC commissioner, you know, 5 years ago I would have had a much bigger list of concerns about the direction the NRC is going. I think they should be commended. I think based on the recommendations that many of us have made, they have made a lot of progress in creating a more risk-informed framework for advanced reactors.

They have a lot of work in play. Clearly, more work needs to be done to avoid, you know, half billion-dollar investments to get licensing, but I think progress has been made.

One thing I didn't want to leave on the table, you asked, I think, an important question that people ask about waste. Having been a regulator of that and having been on spent fuel transports, I think the thing that folks need to remember, used nuclear fuel is the most heavily regulated and safest protected metal in the world.

If you took all of the used nuclear fuel in the United States, all of it, it could fit in the San Diego Stadium where the Chargers used to play, up to about a depth of twenty feet. No one anywhere in the world has ever been injured by nuclear used fuel, no one anywhere, ever. We have tankers full of chemicals that are on our highways that could cause prompt deaths very quickly. That is -- me -- that is of much greater concern than the transport of nuclear waste.

Mr. Peters. My time has expired. And I would just let the record reflect that no one suggested that that would be a use for our old stadium. Thank you.

Mr. Rush. The gentleman yields back. The chair now recognizes Mr. Duncan for 5 minutes.

Mr. Duncan. Thank you, Mr. Chairman. Thank you all for

being here. I am from South Carolina and we lead the country in nuclear. Seven reactors generate nearly fifty-three percent of the state's electricity and over ninety-five percent of the state's carbon-free emissions.

While we produce nuclear energy, we also produce nuclear waste. Commercial reactor sites store in my state around 4,800 metric tons of used fuel as of 2017. In addition, Savannah River Site stores approximately 8,000 tons of vitrified nuclear waste from EM, and thirty-five million gallons of high-level liquid waste from their environmental management cleanup.

So South Carolinians have contributed due to the Waste Policy Act, $3.1 billion including interest, to the DOE's Nuclear Waste Fund to permanently dispose of the used nuclear fuel at Yucca Mountain. This is the third most of any state in the country. As small as South Carolina is, we have paid almost more than any other state. We are at number three in the country. We want something for our money and that is to store the nuclear waste. Nuclear waste currently sits, 122 sites, 38 states around the country. In addition, we have 12 tons of plutonium at Savannah River Site and the Mixed Oxide plant is now in mothballs.

So the lack of durable use fuel programs is giving the U.S. nuclear industry a black eye. Seventy percent of all reactors currently under construction are from Russia and China. These

two countries who are also our adversaries in certain ways are positioning themselves to take a leading role in establishing global nuclear norms. I think several of the panelists have talked about Russia's positioning this morning. If we want to maintain our competitiveness in the global nuclear arena and continue to incentivize investment in the industry, it is imperative that we as a nation establish an integrated waste system and permanent repository.

I had the opportunity to talk with the President on Friday evening about this particular issue and he pointed out that Russia has stored a lot of their nuclear waste -- I say "stored" -- dumped into the ocean. That is alarming. So I think everyone is supportive of pursuing advanced reactor technologies, but we also need to prioritize maintaining our existing fleet. I am fascinated with SMRs. I am fascinated with thorium reactors, the whole molten salt aspect that Mr. Levesque talked about.

Mr. Merrifield, given the lack of an integrated fuel system, new commercial reactors will be de facto waste sites as they currently are. How does the lack of an integrated waste system with interim storage linked to a permanent repository inhibit the progress of the U.S. nuclear industry?

Mr. Merrifield. Well, it is certainly from the questions that we receive from the public, it is an issue on their concern.

I think, you know, I have a tendency to try to look at the bright side of things. I think we are making progress. We have the used fuel at the sites which is stored very, very safely in storage facilities both wet and dry. We have the opportunity before us to have two interim storage facilities, one in New Mexico and one in Texas that can provide an interim opportunity to store that fuel until Congress makes a decision with the President on moving forward with a final repository.

One of the things that is going to happen in the context of the next year is that the world's first used fuel long-term repository will be opening in Finland. If you were to travel to that site, and I suggest folks do that, you would see it is a very straightforward way of storing that fuel. We have the technological capabilities as a country to store used fuel safely. I personally looked at the Yucca Mountain issues. I think, I personally think it is a perfectly fine place to put it. We need to make a political decision in terms of moving forward and that obviously rests with all of you.

Mr. Duncan. Well, the decision was made in the 1980s, the geological site was found, Yucca Mountain -- I have been out there as well -- as a nuclear national solution to a national problem.

You know, I am from South Carolina. We had a nuclear reactor being constructed. Southern Company and SCANA both are the only

new reactors built in over 30 years, I think, since the one in Tennessee. So I can't really talk about positive benefits of building new nuclear reactors because of what happened in South Carolina.

I will go back to Mr. Levesque, if I am saying that right, and his point that we should have a cookie-cutter design, and why are we having all these extra costs in building new nuclear reactors when we are redesigning the will every time we get to that point. I don't think Russia and China have that. I think they have settled on one design and they are replicating that over and over and I believe that price curve bends down at that point.

Mr. Levesque, I wanted to ask you, switching gears a little bit, I am fascinated with those reactors. One particular interest to me is liquid fluoride thorium reactors, a type of molten salt reactor. Do you think that is a viable future?

Mr. Levesque. So the two technologies that TerraPower has chosen to pursue are the Traveling Wave Reactor, which is a sodium-cooled reactor, and our Molten Chloride Fast Reactor which is liquid fuel and liquid coolant. So earlier in, you know, TerraPower's development --

Mr. Duncan. I am out of time. I want to ask you, is anybody using these type of reactors?

Mr. Rush. I am sorry. The gentleman --

Mr. Levesque. You mean the thorium-based?

Mr. Duncan. Yes.

Mr. Levesque. Not yet. There are some companies who have chose that as their development path. We chose molten chloride fast reactors.

Mr. Duncan. 5 minutes goes in a hurry. I yield back.

Mr. Rush. The gentleman's time is up. The chair now recognizes Mr. Doyle for 5 minutes.

Mr. Doyle. Thank you, Chairman and Ranking Member, for holding this hearing.

Nuclear power is going to be critical in making sure we meet our hundred percent clean economy goal. Pennsylvania is the home of the first civilian nuclear power plant in the country. Pennsylvania knows the importance of being a leader in developing new nuclear technologies and ensuring that our existing fleet continues to provide carbon-free power into the future.

Nuclear power already provides Pennsylvania with around forty percent of its electricity and provides close to ninety percent of our carbon-free power. It is a vital source of clean energy. It provides hundreds of good paying jobs. It boosts local economies. And while our current fleet continues to provide us power, we are at the beginning of a new era in nuclear

power.

Advanced nuclear reactors have the potential to pair with renewable energy sources, create energy storage solutions, and help decarbonize industrial manufacturing processes all while being cheaper and safer. I am a strong supporter of nuclear power and I believe we should continue to build on the investments we have made in recent years to advance research, development, and deployment of advanced nuclear reactors to ensure that we remain a global leader in nuclear energy technology and reach our clean economy goals.

Mr. Hezir, I would like to start with you. Your testimony mentioned how advanced nuclear needs to be part of a broader strategy for decarbonization and the value it will provide in a system with more and more renewable power. Can you elaborate on the role of advanced nuclear in such a power system and how deployment of these technologies should happen in concert with other technologies like renewables?

Mr. Hezir. Thank you for the question. Yes, I think Mr. Cohen had addressed some of this, but I will kind of elaborate on what he said. Basically, first of all, we are, as the chairman had indicated we are seeing an increase in demand for electricity. And with decarbonization of other sectors of the economy, they are moving to decarbonization through various strategies that

use more electricity such as electric vehicles or electrification of industry, so we are seeing an increase of demand.

We are also seeing the potential for changes in the demand in the shape of the demand where the typical cyclical demand structure is based on primarily residential/commercial use, and with these other uses now, the demand curve is going to change. And so, there is -- which is going to increase the need for having more generation such as nuclear that has baseload capability that could generate 24/7. And so, we would see that as being very, an important element in working with intermittent resources that would generate only parts of the day.

I think the other key thing that we saw in our review of breakthrough technologies is the importance of long-term duration electricity storage. Right now we don't have that. Basically, what is being deployed today is typically 4 to 6 hours of storage. What we really need is to get to daily storage and maybe even seasonal storage. And so, as those technologies move along, we also need to continue to expand the baseload capability so we see all of those kind of fitting together and kind of moving forward in concert.

Mr. Doyle. Thank you.

Mr. Merrifield, you noted in your testimony current nuclear plants face challenging market conditions and advanced reactors

aim to get around this problem by using new technology and designs to be cheaper to build and operate. Can you explain these conditions? And, in your opinion, can advanced nuclear technologies become cost-competitive with natural gas and if so, when?

Mr. Merrifield. Yes. I think there is variety of really good things in that question, one of which is the cost issue. The advanced reactor developers that are out there right now recognize that they need to meet cost structures that are going to be similar to combined cycle gas units, so that really is their target. You get there through modularization, having more of that work done on a factory floor, taking that work out of the field with stick built. That is what, you know, obviously, John Hopkins team at NuScale is doing as well.

One of the areas of focus, and I have encouraged the Department of Energy to take a look at this in work I am doing with the University of North Carolina Charlotte, how do we fix the issue of construction itself? Fully half of the cost of building a nuclear power plant and the issues that they faced at Summer and Vogtle was because of engineering construction. That is an area that needs a lot of attention and focus. We are doing very well in the development technologies. We have a lot of progress we have made on advanced manufacturing, but

advanced construction engineering is what is going to be required in order to enable these technologies.

The last part of your question is the market structures. I mentioned in my testimony some of the difficulties at FERC right now. There are efforts by your state and others to allow existing nuclear assets to be, to stay on with the appropriate financial support because of the reliance, reliability, and resilience they give to the grid. Without changes, if those MOPR policies stay advanced reactors will be put at a disadvantage versus renewables. That needs to change and I think you all in your oversight of FERC really need to ask them that hard question. Thank you.

Mr. Doyle. That is a great point.

Mr. Chairman, I yield back.

Mr. Rush. The gentleman yields back.. Ms. McMorris Rodgers is recognized for 5 minutes.

Mrs. McMorris Rodgers. Thank you, Mr. Chairman. I am pleased that you are holding this hearing today and recognizing the important role that nuclear must play in our clean energy future. Without utilizing and growing our current nuclear energy capacity, it is impossible for us to achieve significant emission reductions. We see it playing out in countries like Germany who are moving away from nuclear power due to some advocacy from some

of the environmental groups, and subsequently we have seen emissions increase as the steady baseload of power needed is being replaced by coal-fired plants.

The U.S. has led the world in nuclear energy innovation, but in recent decades we have started to cede that global leadership. We have also become too dependent on imports of uranium to power our nuclear reactors, reducing our energy security and increasing our dependence on supplies from untrustworthy state actors like Russia. To that end, I am pleased that the Trump administration has proposed the creation of a domestic uranium reserve in the most recent budget proposal. We must be doing more to encourage the development and deployment of advanced nuclear technologies.

Mr. Levesque, it is great to have you testifying in front of the committee this morning on behalf of TerraPower. We are proud to have you based in Washington State. In your testimony, you discuss how countries like Russia and China are actively supporting the development of advanced nuclear technologies by directly subsidizing state-supported companies. Through this government support, these countries are better able to export their technology to other countries creating decades of dependence on Russia and China to meet their nuclear energy needs.

At the same time, you state "no other country has the capacity

for innovation and the freedom to think innovatively like the United States," and I couldn't agree more. However, I am concerned that government red tape and intransigence is setting back our ability to fully realize the potential of our private sector innovation, especially when it comes to exporting our technology to combat the spread of Chinese and Russian influence globally.

Would you expand on the current state of global competition in advanced nuclear reactor development and, specifically, how can we as policymakers ensure a regulatory framework that enables companies like TerraPower to compete with state-subsidized companies?

Mr. Levesque. Thank you, Congresswoman Rodgers, and thanks for your support in Washington, as always.

So, I agree with all the points you made on the state of affairs with Russia and China, and earlier Mr. Hopkins was describing the kind of economic benefits that those state-owned companies have as they pursue export projects. But I do want to offer innovation and new technology as an opportunity for the United States, because what you see around the world is other countries are doing quite well at copying our old technology, okay.

In Pennsylvania in the late 1950s, Congressman Doyle

mentioned, Shippingport was the demonstration reactor for light water reactors. That once we proved that light water reactors could operate at commercial scale that led to a hundred reactors being built in the U.S. and more than 400 built around the world based on U.S.-born technology. And that resulted in these 100-year relationships that American companies had with those countries and those companies. So now as we look at new technology, you can see other countries have copied our old stuff and are making incremental improvements to it. Innovation is really the American role. We are good at it. We are good at managing projects with diverse groups of experts. I have worked on international projects and I know oftentimes they call on the American project manager to put the teams together. It happens to be something we are good at.

So we need to recognize that again because we are getting outnumbered greatly on Gen 3 plants, something like 40:1 on new builds around the world, and we are facing great challenges that Ms. Korsnick mentioned, keeping our Gen 2 plants running because of the, you know, incorrect market forces. But we need to recognize that advanced reactors and new technology are, you know, America's opportunity to regain nuclear leadership because we are losing it.

Mrs. McMorris Rodgers. Do you have anything specific on

the regulatory front?

Mr. Levesque. On the regulatory front, I think we need to continue what we have started. You know, the NRC's mission is to protect people and the environment and we respect that. And, you know, Congress passed NEIMA, the Nuclear Energy Innovation and Modernization Act. I think that was really important in empowering the NRC to change because without that congressional empowerment and direction to change, you know, they might not be, you know, free to act with all their stakeholders. So I think it was very important that Congress pass NEIMA. And I have seen, we have had Chairman Svinicki and Commissioner Caputo at TerraPower and meet with their senior management regularly, I can tell the NRC is responding to that and so I think NEIMA was a very good start.

Mrs. McMorris Rodgers. That is great. It is always inspiring to hear about American ingenuity. Thank you.

Mr. Rush. The gentlelady yields back. The chair now recognizes Mr. Sarbanes for 5 minutes.

Mr. Sarbanes. Thank you, Mr. Chair. Thank you to the panel. This is a very interesting topic. I am learning a lot.

In December of last year, the Federal Energy Regulatory Commission issued its Minimum Offer Price Rule, MOPR, for the PJM capacity market. And the FERC order as you know targets

generation resources that receive a state subsidy. Mostly clean energy projects including renewables like wind and solar, but also nuclear, and I am concerned. I know a lot of people are concerned that this type of market rule could have a negative effect on advanced nuclear projects obtaining financing as well as these other sources of renewable energy. Ms. Korsnick and possibly Mr. Merrifield, if you would like to speak to it, could you talk to the importance of market rules in clean energy development specifically in this instance, advanced nuclear project development, and can you discuss the negative impact FERC's MOPR rule might have on the viability of the future advanced nuclear projects? And I know maybe your membership comes with some competing views on this topic, but if you could at least speak to some of the concerns, legitimate concerns out there with this rule, and then, Mr. Merrifield, if you want to offer some comments as well. Thank you.

Ms. Korsnick. Great, thank you. I appreciate the question. Yes, I would just say, fundamentally, the fact that nuclear is highly reliable as well as carbon-free, fuel-secure, these are attributes that are not recognized in the marketplace today. And in some cases, the states have decided it is very important to them because they are very interested in the climate. They are very interested in being able to contribute in their

own way at a state level and so they have put programs in place to protect their nuclear fleet.

The real challenge that this recent decision by FERC and the Minimum Offer Pricing Rule, MOPR, has put in place is that it really undoes, if you will, and steps on those states' rights, where the state has said this is important to us and how we want to have clean energy in our state and, essentially, it takes that away by taking whatever that credit was and asking the companies then to add that into their bid, likely pushing them out, if you will, of the market. So it is a fundamental challenge in the marketplace. And what is the so-what of it? This has to do with the capacity market. With not going into a lot of details, it could really unwind the capacity market as we know it today. So it is very, very important, because fundamentally it is talking about the value of those electrons that are produced by these power plants, and you have these advanced reactors, well, they are going to be playing in some of the same markets and so it is very important that fundamentally all of the positive things that you have heard about nuclear today that the marketplace reflects it.

Mr. Sarbanes. Thank you. As it relates to the -- and I completely concur with Maria's remarks. I think, you know, as you look at the existing fleet, we have extraordinary capability

to produce large amounts of carbon-free power. And to the extent states have made the initiative to say we think this is important for the people of our state to have the Federal Energy Regulatory Commission put in place a system that essentially is going to knock those systems out and put us further behind the eight ball on controlling carbon emissions is a bad public policy outcome.

As it relates to advanced nuclear, we have work to do. I mean part of the problem is us. I had one of my associates take a look at a number of interactions that advanced nuclear companies have had with FERC on their websites, less than a handful, right. So the level of attention that the renewable community has given, both wind and solar and others, to FERC has been extraordinary. Our voices haven't been heard. We have been, you know, talking to a lot of other folks, but that is an area where there does need to be focus. I think this committee needs to focus on that. We don't want to be in a position where we have the development of these great technologies but we can't put them into those states because of a market structure that is inappropriately sourced by FERC.

Mr. Sarbanes. Thanks very much. I yield back.

Mr. Rush. The gentleman yields back. The chair now recognizes the gentleman from Texas, Mr. Olson, for 5 minutes.

Mr. Olson. I thank my friend from Chicago. Welcome to our

six expert witnesses. I got to tell you I am stunned that it has been decades since America has made a commitment to real, new nuclear power. We should be ashamed of that. Why, because nuclear power is CO2 emissions-free. In fact, in 100 minutes I have been sitting here, I have exhaled a lot of CO2, much more than one plant does in 100 years. It is baseload power. It is ready. It is reliable and it is safe. Hurricane Harvey proved its safety.

We have two nuclear power plants in Texas. One up there at Comanche Peak and one there at Bay City, close to my home, the South Texas plant. That plant had the worst part of the Hurricane Harvey hit it. The northeast quadrant is where the storm surge is, the winds are, the rain. Not one blip in the containment room, anything, from that power plant. So again, it is safe.

And as you know, Mr. Levesque, we have lost two nuclear-powered submarines in our history. We lost the Thresher in 1963 and the Scorpion in 1968. These boats were designed to scram the reactor if they had a catastrophic destruction like those subs endured. We have checked out those boats, we know where they sank. It has been almost 70 years now, there has not been one blip of nuclear power from those two reactors. They worked as designed in the ultimate crisis for a naval vessel.

So my point is, this is very safe technology as well and also new nuclear means lots of good high-paying jobs, and I want to talk to you about that, Mr. Hopkins. As you probably know that Fluor is the first Fortune 500 back in my hometown of Sugarland, Texas. We love Fluor. We are happy that they are a big partner with these SMR reactors.

In your testimony, you talked about around 1,200 new jobs in construction per plant. That means heavy equipment operators, welders, electricians, pipefitters, plumbers, all across the spectrum to build a new power generator SMR. And Fluor as you know has made an MOU with the North America's Building Trades Unions for construction of your nuclear power, your NuScale plants here in America. Another example, Wharton County Junior College back home has built a campus in Bay City, Texas, right by the South Texas plant, to retrain the reactor technicians who are fleeing because they hit their limit, their ages.

Can you elaborate on these jobs to be created with the NuScale, the SMR power, the nuclear power grids, the little -- how much jobs created and how this can affect disaster recovery, because these things can be set up quickly and be running full-time in a very short space on the ground as well. You, Mr. Hopkins?

Mr. Hopkins. Sorry, sir. I thought you were referring to Mr. -- the advanced reactors we are talking about here today are,

as you mentioned, three critical components: extraordinarily safe, they have to be economic, and they are carbon-free. And from a jobs perspective, we are seeing the dynamics in this company change, currently, in that the Utah Associated Municipal Power, who represents power facilities in eight western states, have elected to go with the small modular reactor at their first site.

And for the job component, as you mentioned we have a very good relationship with labor and we need pipefitters, we need carpenters, and for our first plant we are nominally looking at about a thousand of these jobs. And as you build them what we are seeing also, seven states now are going forward with clean energy initiatives and what we are seeing is in a UAM situation what we are doing, they have -- they are looking at 700 megawatts of coal replacement. Now the coal is not going away for economics, it is their particular facilities, the economics don't currently support it or they have exhausted the resource.

So they have elected to go with small modular reactors, which is us, and if you look at the potential for jobs in this country, if I -- we have just completed analysis from a three to six hundred coal facility as an example, or an aged fossil plant, we can go in and utilize advanced reactors in that existing community to create and cross-train those people working in the advanced reactor community.

And it is not that we need 4-year degreed engineers, what we need is associates degrees, vocational degrees, and military experience. So we have just, we have been working with our customer base to get the data to help appreciate how many of those jobs can we, in fact, in those communities cross-train, and it is quite amazing.

The other thing we are seeing here in terms of manufacturing capacity, we have seven forgings required for the NuScale module. When we started this there was nobody in this country that could do those forgings for us. Now there are two companies that can do it in this country, and the reason being they saw market certainty going forward and a sustained capacity for suppliers to get involved in this process and so it is going to continue to build. So it is high-paying jobs, as we mentioned, you know, $85,000 for average, and our ability to go into these communities in small rural communities that need these jobs, we are going to be there.

Mr. Olson. Thank you. I am out of time.

One question for you to close, Mr. Levesque. You were a sub driver and a sub builder. I am a sub hunter.

Mr. Rush. The gentleman's time has expired.

Mr. Olson. What does 31 to 7 mean to you, my friend?

Mr. Rush. The chair now recognizes the gentleman from

California, Mr. McNerney, for 5 minutes.

Mr. McNerney. Well, I thank the chairman, and I look forward to working with Mr. Duncan on nuclear waste issues in the next term. I thank the witnesses too for your testimony this morning.

Mr. Cohen, you noted the important role that the market demand plays in the nuclear energy competition, I am just following up on Mr. Sarbanes' question. Can the government play an important role in creating market demand for nuclear power?

Mr. Cohen. Absolutely. And I neglected to mention in my initial oral statement what is in our written statement, which is our very, very strong support for the Power Purchase Agreement provisions of the NEILA bill. There is no way we are going to get off the dime without some sort of market pull, so that is an important example of that kind of policy that we need.

Mr. McNerney. Good, thank you.

Mr. Hopkins, from your perspective, how important is it to encourage multiple builds of the same design in order to drive costs down?

Mr. Hopkins. Well, in our particular instance, we are employing Sargent & Lundy, which is an engineering firm out of Chicago, to do our standard plant design. Now in terms of an actual standard plant there will be some nuances contingent upon where we are going to deploy, but the standard plant is a critical

piece to be able to drop these costs down significantly.

Most of our components currently are off the shelf. It is a very simplistic design. Our steam generators are basically 60 megawatts that are used in the oil field, so that standardization will drive costs down. And also, with the ability for our, to build in factories and ship and not to have them all over the location is going to also drive costs down.

Mr. McNerney. Well, I worked in industry for 20 years and when you double production you lower costs by ten percent, roughly, kind of a rule of thumb.

Mr. Hopkins. Right.

Mr. McNerney. So I see that taking place here.

Mr. Hezir, what might the technical breakthroughs in nuclear energy look like?

Mr. Hezir. I think we talked about them today. I think you are looking at two of those companies, here, represented at the table. There right now is a large number of new nuclear technologies that are being investigated and again as I indicated in my testimony a lot of it just with private investment capital and there needs to be a way to bring those forward.

I think it is a little premature right now to say with the advanced reactors, leaving aside NuScale for the moment, which ones would be the, if you will, the winner or not. But I think

as Mr. Cohen said that the market demand is large enough that -- is not necessarily need to be a single winning technology. I think they need some further evaluation, because all of these, right now, are pretty much just being developed on paper.

Mr. Merrifield. On that point, I travel extensively around the world and I can tell you, in many other continents if we had these technologies available to sell and deploy in the next several years there are a number of countries, dozens of countries out there that would buy them. This is a true opportunity for U.S. exports.

Mr. McNerney. Thank you.

Mr. Hopkins, again, judging by your experience at the NRC, do you believe they have sufficient resources to manage the licensing requests that they are getting?

Mr. Hopkins. Yes, sir, I do believe that. Back in 10, 20 years ago when the Oregon State University and Dr. Jose Reyes was, when DOE approached him, the intent was, we are going to build a small modular reactor utilizing the light water technology. The reason for that is the regulators around the world know light water technology.

Now having gone through the NRC process that being said, the NRC really didn't understand small modular reactors in the fact that every, their experience was oriented to larger scale.

Two-thirds of the components for us are not -- I mean of -- are not required within a large reactor, so there is an educational process. And people say, why did it cost you $500 million? Because we had to do numerous topical reports, numerous exemptions; our hope is in what we are doing we are going to pave the way for the next.

I don't view these people, the advanced, as my competitors. I want to see American technology around the world supplanting other foreign entities like China and Russia with extremely safe, advanced technology. So yes, the NRC, to Maria's point earlier, we went through a very long process, but we are seeing their understanding they are going to have to take a different approach for non-light water.

Mr. McNerney. Thank you.

In the time remaining, I would like to ask Mr. Levesque to elaborate on the VTR, the virtual training.

Mr. Levesque. Sure, sir. The Versatile Test Reactor that is currently going through concept design that is driven by Idaho National Lab will be a neutron-irradiation source so that we can test materials and components for advanced reactors and that is a very important capability for our country to have. I can tell you I have been to similar facilities in China and Russia. They have that capability, we don't. So if we are going to move forward

and continue to be the leaders in innovating nuclear technology, we need the VTR.

Mr. McNerney. And that is a government item, or is that a private industry item?

Mr. Levesque. That began as a government-funded project, but recently we were glad to see that the Department of Energy opened up the VTR as a public-private partnership in several countries, including TerraPower and GE-Hitachi and Energy Northwest from Washington came forward with suggestions on how to transition the VTR into a public-private partnership.

Mr. McNerney. I yield back. That sounds pretty exciting. I yield back.

Mr. Rush. The gentleman yields back. The chair now recognizes that fellow from West Virginia, Mr. McKinley, for 5 minutes.

Mr. McKinley. Thank you, Mr. Chairman. I am just -- Doyle back there mentioned a while ago, maybe a 1/2 hour ago on this panel about the Shippingport facility being the first in America. And, interestingly enough, it was under the, Eisenhower proposed it in '53 and then they broke ground on it in '54 and then they commissioned it by '57. So it just took 3 or 4 years to build and less than a year to get a permit.

And we have heard how in 1979, and I hope there is something

more recent but the CBO did a report on how long does it take to get permits to a nuclear power plant, because we saw how Shippingport did it, but in '79 they came out with a very exhaustive report and said then it was 10 to 11 years to get a permit. And they said prior to that back in the '60s that it might take 7 to 8 years. So it is just, we go from 1 year to 7 to 8, now 10 to 11 years. It seems like the regulators or whatever the process is, is extending longer and longer.

So I know that we have had -- Rodgers has, Cathy McMorris Rodgers has talked about hydro is 10 years to get a permit. I am curious to know what is the length of permit today to start a nuclear power plant?

Mr. Hopkins, if I just go to you, do you have a sense of what time it takes to get a permit to actually break ground on a nuclear power plant?

Mr. Hopkins. Well, for us going to the NRC, we started the process in Design Certification Application in 2016. We will be through in 2020, and so it was an exhaustive process. And the owner who has to also apply to get through their Construction and Operations License will generally take 2 years beyond that, so I think it is enhancing. There is a process that is willing to speed it up, but it is just a lengthy process.

Mr. McKinley. That is why my point, if I could, Mr.

Merrifield, what I want to drive home, because no one has talked about that. If we are going to drive down the price of nuclear energy and use more, we have got to streamline the permitting process. It is outrageous the length of time that it takes. We should be able to do that because in the past we were able to accomplish in a short period of time.

And it is no wonder with Watts Bar, how long that took to be able to get the permitting through that and increased the price of their $12 billion to build those two units out there. And the Vogtle unit that Southern has put out, $25 billion. And think about that is almost 12 years for the permitting process for them to go to that extent. We have got to find a way to shortening this permitting process.

So I am curious, are we missing something on this? What is a way? Is it because we know, and maybe more pointedly, there are opponents out there to nuclear energy? Primarily, I guess, it would be environmentalists. I don't know how else to categorize them, but let's just say people that -- what is their problem? Why do we have -- why is this dragging out?

So, Merrifield, if you could -- what is the problem? Why do the environmentalists have such an angst when it comes to nuclear energy when we know it is clean? And if that is their objective to get us down to where we have low emissions,

zero-emission carbon emission, why in God's name aren't they supporting that to be able to achieve that?

Mr. Merrifield. Well, I am going to look at it positively. I mean there are, I think there is probably ten percent of the American people who are dead set against nuclear power. There are a number of leading environmentalists who have made a more recent decision that given the importance of addressing global climate change that they reversed their position on nuclear power and are now for it.

Carol Browner, a friend of mine, she and I used to spar in the Senate back when she worked for Al Gore and I worked for the Senate Environment Committee. She was not someone who was supportive of nuclear power at that time, but today she recognizes it is a critically important piece for us to deal with this issue.

To your question about the permitting process, there is no question that the track record that the NRC has had in the past has not been what it should be in terms of getting these reactors approved. GE with its ESBWR reactor took 10 or 11 years to be permitted by the NRC, not the right way to do it. I think they made a significant amount of progress. They are looking at a more risk-informed program, recognizing that these reactors have a much-reduced source term, amount of radiation that can be reduced. They made a very good decision recently relative

to the Clinch River Site.

Mr. McKinley. If I could interrupt, the only thing because the time is limited on this. You mentioned about the spent fuel rods with how we can store them someplace, wherever, I guess not -- the quantity and how safe it has been. You talk about in America, it is safe.

Mr. Merrifield. Yes.

Mr. McKinley. But what happens overseas in an unfriendly nation that potentially could have access to spent fuel rods, how safe is that?

Mr. Merrifield. As a general matter, and this is overseen or clarified by the International Atomic Energy Agency in Vienna, there are international standards and expectations for how that fuel is going to be stored whether it is in a spent fuel pool or in dry cast storage. U.S. has exported a reactor, has exported cask technologies all over the world. The fuel from the Chernobyl reactors is being stored in Holtec, dry storage canisters that originated from the United States. So I feel the technology, it is not complicated and it is well-run.

Mr. McKinley. Thank you very much. I yield back.

Mr. Rush. The gentleman yields back. The chair recognizes the gentleman from New York, the chairman of the Subcommittee on Environment, Mr. Tonko, for 5 minutes.

Mr. Tonko. Thank you, Mr. Chair. And welcome to our panel. As you all heard, our committee is working on economy-wide decarbonization. One of the biggest challenges will be clean sources of heat for industrial applications. So, Mr. Cohen, how can advanced nuclear be complementary to efforts to decarbonize the industrial sector?

Mr. Cohen. There are at least two ways that nuclear can do that. First, is provision of direct heat. I mentioned some of this in my written testimony. There is experience with higher temperature reactors that can meet the temperature requirements of a steel plant or a cement plant, so there is that capability.

The other capability that was mentioned earlier is the ability to produce very, very efficient electrolysis, processes that produce hydrogen, the hydrogen can then be burned for industrial heat. So you have two avenues where nuclear could be extremely important for decarbonization. And that is important because industrial heat and process is about twenty percent of global emissions of CO2.

Mr. Tonko. Thank you. And can small modular reactors be sited near facilities that will need clean thermal energy?

Mr. Cohen. Certainly. I know these gentlemen have looked more at the site specifics, but obviously there is an opportunity to couple nuclear reactors directly to the industrial sources

that need them and you gain greater efficiency that way.

Mr. Tonko. Thank you.

Mr. Merrifield. And one of the benefits you can have is with this very high heat you can pair that with a molten salt, a solar molten salt which has no radiation to it, and you can transport that three, four, or five miles with a very small reduction in efficiency. So there is a lot of creativity that advanced reactors allow for manufacturing processes.

Mr. Tonko. Thank you. Thank you very much.

And, Mr. Hezir, any additional thoughts on how these solutions may open up opportunities across sectors?

Mr. Hezir. Well, across sectors, I think we just touched on one right now, which is the industrial one. And, clearly, as I mentioned earlier, with changes in demand for electricity and changes in the load curve due to things like electrification of transportation, that will definitely be a need for more generation that has 24/7 capabilities such as advanced nuclear, so there is a very close connection there. I think in the case of buildings it is a little more uncertain right now how far one might go in terms of electrification. Buildings, there is some more difficult tradeoffs there and some of the technologies, particularly for electric heat, really need much more innovation than what we are currently seeing. But, clearly,

in industry and transportation there is a very good set of synergies there with advanced nuclear.

Mr. Tonko. Thank you. And I am very interested in maintaining the United States' excellence in STEM. Continuing our U.S. leadership in nuclear engineering and physics starts in our schools and higher education systems. If nuclear energy goes away we could see many of these programs follow. So, Ms. Korsnick, how important are these educational programs for innovation in advanced nuclear and what role should the federal government play in supporting nuclear-related STEM education and training for the next generation of reactor designers and plant operators?

Ms. Korsnick. Thanks for the question. I think education is critical. And when we talk about U.S. leadership, the education program that we have here is an example of U.S. leadership. And the engineers that we will need for these, they are not all nuclear engineers. There are a variety of disciplines. We have excellent schools here in the United States not only at the collegiate level, but as the secondary school programs as well, and it is absolutely critical that we maintain our focus on STEM to produce that workforce of the future.

Mr. Tonko. Sure.

Mr. Merrifield. One thing I would use as an example, we

have two individuals, Jake DeWitte and Caroline Cochran, a husband and wife duo, both doctors from MIT, who have the first reactor design, Oklo, 1.5 megawatts advanced reactor, put in front of the NRC. These are people that came out of a U.S. university, created those ideas, and are putting it to work. That is really a demonstration of where advanced nuclear is going.

Mr. Tonko. Thank you very much. And does everyone agree that there are potential federal policies, for example, carbon pricing that would correct market failures and reward the zero-emissions generation of nuclear which is not currently recognized by markets? Anyone?

Mr. Cohen. Absolutely. The Smith-Lujan bill is one example of that, that which sets a clean energy standard, which by the way has been adopted now in six states and several others are considering that would move power sector emissions down to zero carbon over a period of decades. So that is an example of a policy that would --

Mr. Tonko. And would something like that help the competitiveness of existing nuclear?

Mr. Cohen. These gentlemen would have their own opinion. I think any economist would say yes.

Mr. Hezir. And I would just add that a carbon pricing policy such as a carbon tax would also accomplish the same thing as a

clean energy standard in terms of creating that additional incentive for nuclear. It would price in the clean energy attributes of it. I would also just add that I know that Secretary Moniz has recently stated his support for a carbon tax, but also in the context of combining it with a tax and dividend program so that we address the social equity issues that might be associated with a carbon tax.

Mr. Tonko. Thank you very --

Mr. Merrifield. I was just going to -- in the jurisdiction of your subcommittee, one of the other fixes that could be made is the Clean Air Act currently does not allow nuclear power plants that have power uprates to qualify for NOx and SOx treating. That is a change that your subcommittee could initiate that would enhance the ability to have more power generation from existing units.

Mr. Tonko. Thank you. Thank you very much. With that, Mr. Chair, I yield back.

Mr. Rush. The gentleman yields back. The chair now recognizes the gentleman from the great state of Virginia, Mr. Griffith, for 5 minutes.

Mr. Griffith. Thank you very much, Mr. Chairman, I appreciate it and we are having a good discussion.

I do appreciate Secretary Moniz. He was one of the few folks

in the Obama administration that I thought really tried to think through problems for Central Appalachia and not just look at one-size-fits-all. And you just made mention of that in your comments about his thoughts in relationship to taxes, which I probably won't support, but if we are going to do it, let's make sure we are not crippling an already economically-distressed area that I happen to represent as does Mr. McKinley.

So I appreciate his always looking out for the long term and for the facts that you can't change one part of the formula without hurting somebody. Let's make sure we protect people.

Mr. Hezir. Thank you for your comment. I will make sure I pass that along.

Mr. Griffith. Well, you know, he has got to be delightful to work for, one of the brightest individuals I have met up here in D.C., just a great guy.

That being said, nuclear power plants like my coal-fired power plants are robust structures that can reliably provide much-needed electricity during extreme weather events. For example, nuclear power plants continued to operate during extreme cold caused by the polar vortex, and hurricanes like Harvey in Houston and Maria in Puerto Rico showed how long it can take to bring electricity back to impacted areas where solar farms were destroyed in the severe wind.

I actually saw that when we went down to visit Puerto Rico afterwards, you know, one of the solar farms survived without a scratch and the other one was just totally twisted and torn up. You still have to have, of course, a grid to connect it to.

But, Mr. Merrifield, how could small modular reactors also continue to provide power in extreme weather events such as polar vortexes and hurricanes?

Mr. Merrifield. Well, thank you for asking that. I am actually part of a project called the Nuclear Alternative Project that is looking at the possibility of putting in small modular and advanced reactors in Puerto Rico for that very purpose, recognizing that the issues and challenges that occurred. We have completed the first phase of that study. We are waiting potentially to get a second phase awarded by Idaho National Labs.

But the report clearly indicated that nuclear power generation facilities could have assisted Puerto Rico in working their way through that and we certainly believe it would be important in that regard. A number of hurricanes have demonstrated the reliability that nuclear power provides in that regard and I think it is well said. In terms of the polar vortex, I mean, I am originally from New Hampshire. We call it Appalachia, not Appalachia, but the point being Seabrook Station Nuclear Power Plant was a critical resource for New England in

making sure that that grid stayed up during that vortex.

And I do have to remind folks, Canada, particularly Ontario, which is a hundred percent carbon-free because of principally their nuclear assets and some hydro, recognizes that for that part of North America nuclear is critically important as well. So you have pointed out very well, they are absolutely critical assets in making sure our grid stays stable.

Mr. Griffith. And following up on that, I like to bring up microgrids and I think Puerto Rico is a great test bed for microgrids. Do you see scenarios where small modular reactors could be connected to a microgrid in a situation like Puerto Rico or in Central Appalachia if we are cut off from the rest of the world by certain storms?

Mr. Merrifield. Absolutely. Absolutely, and that is a specific issue that we are looking at relative to Puerto Rico. A lot of folks don't recognize the importance that Puerto Rico plays particularly these days in the supply of pharmaceuticals and medical equipment. If you go to the northern part of the island, there is a series of manufacturing facilities for those drugs and other pharmaceuticals. Having well-placed, small modular nuclear reactors in those locations could well provide a difference between providing those necessary drugs or not having that provided in the event of a catastrophic emergency.

Mr. Griffith. And it would certainly be good to have a secure location to be producing some of those things, whether it be drugs or oxygen or things, the bags that hold various devices or items that we need, and could we have it on American soil.

Mr. Merrifield. No, you make a great point. And I think one of the things we really haven't talked about today, which is critically important, is the work that the U.S. military is doing right now in looking at the potential for deploying modular reactors for forward operating locations that would use many of these same technologies to make sure that we reduce the number of our troops who are killed trying to transport liquids and really provide the opportunity for enhanced laser and other weapon systems that will project the force of the future.

Mr. Griffith. I appreciate that very much, and I have just another second and not enough time to get another question off. So I will save those for the written follow-up questions that the committee often offers us the opportunity to do. Appreciate you all being here. And thank you, Mr. Chairman, for this important hearing.

Mr. Rush. Thank you. The gentleman yields back. The chair now recognizes the gentleman from Arizona, Mr. O'Halleran, for 5 minutes.

Mr. O'Halleran. Thank you, Mr. Chairman, for having this

hearing today. Thank you to the panel for being here. It is a most, I have felt that I have gotten a lot of information from you today that is going to ask more and more questions for the future. But our nation's existing power, nuclear power fleet produces clean energy power for many communities. In fact, Arizona's Palo Verde Generating Station is the largest nuclear energy producer in the country, producing almost eighty percent of Arizona's clean electricity to over four million customers.

While Arizona continues to grow its power generation from solar and hydro, today's hearing has informed us how smaller nuclear reactors of the future may develop to serve rural and underserved communities with clean and affordable power. While the U.S. imports almost ninety percent of its enriched uranium for nuclear power and most of that comes from Canada today, we cannot forget the toxic environmental contamination that has devastated the Navajo Nation from domestic uranium mining for nuclear power during the Cold War. This has left over 520 abandoned mine sites on Navajo land to this day. I think it would be helpful if the industry helped us pressure our government to make sure that area gets cleaned.

Mr. Hopkins, in your testimony you state that small modular reactors are well positioned to replace aging coal-fired power plants. I have three more to go. I just lost Navajo the last

year, providing continued employment for workers and tax revenue for the community. I will stop the other paragraph, but I guess in scale the Navajo Generation Station, I have school districts, I have fire districts, I have cities and towns and counties, the state. Everybody lost a tremendous amount, not to mention the 400 jobs that were lost also.

How do you envision the tax structure of that scale of a plant, a nuclear plant, to the scale of coal generation plant in the ability to understand what the tax level is going to be, potentially?

Mr. Hopkins. Well, I mentioned earlier, sir, that we had just completed a study that dealt with aging fossil fuels for us to be able to, or the advanced community to go in there and retrain those people in those jobs. And I will be licensed this year. I mean, we are in the process right now, particularly working with the CEO of Utah Associated Municipal Power to go out and have discussions, as you with the Navajo Nation, in what is occurring and the opportunity for small modular reactors to, in fact, go in there and redeploy and recross-train those people in your community.

Mr. Merrifield. Congressman, I mean, to answer part of that question, the tax base is typically a thousand-megawatt nuclear power plant is going to be taxed at a much higher rate than a

thousand-megawatt coal unit. And so, I think to the extent you are able to replace some of those coal units with nuclear facilities, they are going to probably be taxed at a higher rate due to their technological capabilities.

Mr. O'Halleran. Mr. Merrifield, I guess, do you see any barriers that specifically limit the potential development of small modular reactors in rural communities?

Mr. Merrifield. In rural communities, no. I think, I mean at the end of the day, I think one of the things that this industry has had to do, and certainly we appreciate the work that Congress and the administration have done as well, that is to educate people in the kind of discussions we have been having today. And we know full well that there are some folks who don't fully appreciate these technologies and we need to have a dialogue. We really need to help work with them to better understand it.

I come from a rural town. I grew up in a town of 2,000 people. I recognize that those areas may not be as familiar, but many, many of the nuclear power plants that we have in America, including the very fine Palo Verde Station, are in rural America and I don't see there being an issue overall with putting those reactors in those locations.

Mr. Hopkins. It is a good point you bring up because the -- going through the Nuclear Regulatory Commission, one of the

area focus exactly where you are talking about is the reduction of the so-called Emergency Planning Zone, which typically is a ten-mile radius. Tennessee Valley Authority used the NuScale methodology and calculations for Clinch River to go before the NRC, and the findings were that assuming everything what we say is going to be accurate that the Emergency Planning Zone could, in fact, be reduced close to site boundary limits, which is a significant cost reduction and also allows us to go in closer to communities as facilities and population density have grown up, be able to utilize that site.

Mr. O'Halleran. Thank you very much. And I yield, Mr. Chairman.

Mr. Rush. The gentleman yields. The chair now recognizes the gentleman from Texas, Mr. Flores, for 5 minutes.

Mr. Flores. Thank you, Mr. Chairman, and I appreciate all of you joining us for this. This is a hugely important issue. This is the only dispatchable baseload energy source that we have with zero emissions, so I appreciate your involvement with that. We have talked about several issues today including financing, foreign competition, waste, fuel availability, the regulatory environment, the licensing environment. I want to spend my time talking about fuel with Ms. Korsnick and Mr. Merrifield.

But that will be in a minute because, Mr. Hopkins and Mr. Levesque, you all brought up some things that I hadn't really thought about and that is the talent pool for the next -- well, for the nuclear industry in general and for the next generation nuclear industry and also the supply chain. Can each of you spend about 30 seconds talking about the challenges with those two issues? Again, supply chain and talent pool.

Mr. Levesque. Sure. You know, one strong point I would like to make in the area of talent is that is yet another reason we have to get back into demonstrating the new technologies. I mentioned earlier what talented, especially the young people, we have people of all demographics at TerraPower, but sometimes we worry about the young people the most. We are a 13-year-old company and some of our great minds joined the company thinking that we would be building reactors by now. And we really need to create U.S. projects or our great talent is going to leave the field of nuclear energy.

Mr. Flores. Okay, and how about the supply chain? Mr. Hopkins, why don't you talk about the supply chain?

Mr. Hopkins. Yes, sir. What we are finding is we, in terms of -- well, just to comment quickly, we have been engaged with over seventeen universities and laboratories through this process over 20 years. We find that being able to go into these

universities, it is an amazing opportunity the brain trust to be able to tackle areas such as energy requirements for desalinization, energy requirements for hydrogen. Also, from a supply chain perspective as I said earlier, we lost a lot of that capacity.

Mr. Flores. Right.

Mr. Hopkins. And to get that capacity back there needs to be market certainty. What we are finding within the suppliers as I mentioned, we are in twenty-five states now with our suppliers, and could we build twelve of these, right now with our capacity, absolutely. But we have to be able to mass produce them, because for us it is not building a one-off plan. It is going to be multiple plans concurrently.

Mr. Flores. Sure.

Mr. Hopkins. And so we need to continue to build up that supply chain. And what we are finding also, this is a global play. This is going to be a global market. So our ability for suppliers to understand there is market certainty and we are going to spend the money to tool up to accommodate what you need that they have an opportunity to go internationally with all of us.

Mr. Flores. Thank you. Earlier this year or, excuse me, last year, this committee and also the House passed my bill that I introduced along with Mr. McNerney from California, the Advanced

Nuclear Fuel Availability Act, in order to have a public-private partnership to produce high-assay, low-enriched uranium.

Mr. Merrifield and Ms. Korsnick, I have a question for each of you all. Mr. Merrifield, what are the civilian, military, and space needs for HALEU both in the United States and abroad?

Mr. Merrifield. First of all, I want to thank you for the leadership that you have taken on HALEU and certainly the leadership of this committee in moving that forward. We certainly hope that your Senate counterparts move expeditiously.

Mr. Flores. Yes, sure.

Mr. Merrifield. The elements of your bill that will fund the ability to look at a lot of those transportation issues are critically important. Those aren't included in some of the other bills, and so we really think this needs to move forward. Having said that, we are looking right now at both military uses both domestically and potentially locating those outside of the United States as well as space utilization of high-assay LEU. Those we do have some inventory in our government to produce to supply some of that, but long-term we are at a disadvantage as a country because of an inability to produce high-assay LEU that can be used for those purposes or other military needs.

So this is a critically important function. The Department of Energy has moved forward on centrifuges with Centrisys. That

needs to move forward.

Mr. Flores. Ms. Korsnick, as your members look to the future and to the adoption of next generation nuclear, what are some of the issues that DOE and the NRC need to work on in order to move forward with HALEU?

Ms. Korsnick. Well, yes. And as he just mentioned, yes, some of these next generation reactors are going to use that higher assay LEU. It is a little bit of a chicken and an egg.

Mr. Flores. I know.

Ms. Korsnick. Once there is enough market signal, then the market will respond and go ahead and create enrichment that will do this. But before that market signal is sent, it is too much uncertainty and so why would you make that investment? So this is the case where I think the government very much can step in and create that bridge where they can supply interim some high-assay LEU, while there then is that signal that is sent and give the market a chance to build the necessary supply.

Also, higher enriched. Think about it. Not only do you have to make it, you have to get it to where you want to use it.

Mr. Flores. Exactly.

Ms. Korsnick. So there is transportation. There is permitting. There is regulation. Right now, it is all really centered on the fuel that we use today, which is five percent

and less enriched. So as soon as you go higher than that there needs to be a broader infrastructure and that is something that we are working on with our members, but we would, we will need NRC as well as government support for making that happen.

Mr. Flores. I will submit additional questions and ask you all to supply that to the record.

Mr. Cohen, I have a question about the impact of the environmental. I am out of time, but the environmental impact of the battery storage for the 3.3 terawatts that we need -- we do that later.

Mr. Rush. The gentleman yields back. The gentleman yields back. The chair now recognizes the gentleman from Oregon, Mr. Schrader, for 5 minutes.

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

Mr. Cohen, can decarbonization of our power sector be achieved without the use of the nuclear sector?

Mr. Cohen. As a logical matter, yes. I think as a practical matter, probably not. I mean there are other options, but again as I showed you, they are extremely expensive and probably unlikely to be implemented at that scale.

Mr. Schrader. Ms. Korsnick, would you agree with that?

Ms. Korsnick. I would say we can't do it without nuclear.

Mr. Schrader. Very good. Very good. All right.

Shift gears a little bit, Mr. Hopkins, thank you for all the work you are doing, your company. I appreciate the work in our home state of Oregon and, you know, forward thinking, and all the hoops you have had to go through, the $500 million in fees.

So, can you describe a little bit how significant it is for the first of a kind technology like this to get through the marketplace and through the regulatory framework on time and on budget, how important the cost-sharing of the funding was to your success at this point?

Mr. Hopkins. Sir, it is absolutely critical. There is no room to fail here. The industry in general has not been able to meet the obligations for the most part in cost and schedule. When we build this first plant it has to be on time, on schedule. The other is that a lot of the countries and companies that we are in discussions with don't necessarily want to be first. That doesn't say I have to build a 12-module plant, but they want to see one module up and running so we can showcase internationally.

Mr. Schrader. Very good. Well, you know, and in our home state nuclear has had a checkered history for a variety of good and sometimes not so good reasons, if I may so. Talk a little bit about nuclear waste vis-a-vis SMRs and what opportunities there are perhaps in dealing with nuclear waste as a result of

the SMR technology and other advanced nuclear technologies.

Mr. Hopkins. Well, having looked at as an example, the Trojan facility in the state of Oregon that has been 17 years now, when you go out there and you look at the rigor of what interim storage has done, people who have gone out there have told me, I don't have a concern anymore about waste. But I think what I mentioned earlier about unused energy, there is some of these new waves of advanced reactors are going to be able to use that for their fuel source. So it is an interim storage currently today, but no telling what could happen future state when some of these come on line and use that as their future energy source.

Mr. Schrader. Mr. Levesque, would you agree with that?

Mr. Levesque. I definitely agree, Congressman. I think you need to begin with what Mr. Merrifield described with the great story on how little volume there is of used nuclear fuel given that nuclear energy has, you know, powered millions and millions of homes for decades. There is no smokestack. It is a very small amount of used nuclear fuel that is tracked very closely. But if you think about new technologies like ours, we have the potential to reduce that waste stream by eighty percent, so taking a good story and reducing that waste stream by eighty percent and that is accomplished by things like, we call it advanced physics. You know, the computer models that we have

today -- you know, no secrets, some of this has been funded by Bill Gates; that shouldn't surprise people -- allow you to design a core that burns the fissile material much, much more completely, so at the end of the day when the plant is ready to be shut down you have cut your waste by eighty percent.

And also, there is even chances to use nuclear fuel. The DOE is starting to look at, you know, whether we should use some of that fissile material that is in used nuclear fuel. And advanced reactors just open up many different fuel cycle possibilities that if we are not moving forward with advanced reactors, we are not really innovating on the fuel cycle either.

Mr. Schrader. Mr. Merrifield, a quick comment?

Mr. Merrifield. No, I think Mr. Levesque has captured that well.

Mr. Schrader. All right.

Next question, Mr. Hopkins, and I guess this could be for anybody, how can nuclear energy, even SMRs, compete with the low cost of natural gas in this day and age?

Mr. Hopkins. Some of it we talked about earlier. We looked at our market predominantly as, and still today, a significant amount of energy, or international, a lot of it has to do with movement towards climate disruption and energy security. But what we are seeing again are states that are gravitating to clean

air initiatives.

The state of Washington, I just mentioned in fact where Energy Northwest commissioned a study called E3 where they basically said, in fact they named NuScale in that study as potential, non-greenhouse gas emitter as an alternative. And they also looked at could we, in fact, in an entire state do it with renewables and they found you are going to have to have both.

Mr. Merrifield. Let me just add, I think the other issue is when you look at a nuclear power plant it has to account for the cost of the plant, the cost of the decommissioning plan, and the cost for taking care of the fuel. If you compare that with the natural gas plant, and that it the bogey for a lot of these technologies, decommissioning costs are not built-in and there is no accounting for the amount of carbon that is released in the atmosphere, which is a pollutant frankly.

Mr. Schrader. Thank you. My time has expired. I appreciate it very much.

Mr. Rush. The gentleman yields back. The chair now recognizes Mr. Walberg, for 5 minutes.

Mr. Walberg. Thank you, Mr. Chairman, and thanks to the panel as well. It has been interesting and appreciated the last line of questioning also about the nuclear waste. It is being used already in other places and we have to find ways to go past

the political issues to get the right thing done. Also, coming from the state of Michigan, now which is on a very aggressive, aggressive goal track toward zero carbon, it isn't going to happen without having nuclear as part of that mix. I certainly haven't seen that as well.

Ms. Korsnick, while we are focusing this morning on advanced reactors, there are innovations underway that can assist the existing fleet, at least I hope there are. Having the DTE, Fermi 1, Fermi 2 in my district, and hanging on to a license for Fermi 3 that is debatable when and if they will use it, but the capability certainly is there.

Would you talk about the development and regulation of accident-tolerant fuel, specifically what are the safety and operational performance benefits of these fuels and what is the status of deployment? And then second, how will development of these fuels help the development of advanced reactors?

Ms. Korsnick. Sure. Thank you for the question.

Yes, I would say advanced or accident-tolerant fuel is a great innovation for the industry. In some of the cases it is going to be able to operate in a way that these plants can run longer between outages, so you can think if they are placed in current operating reactors that it allows them flexibility relative to their schedule and that actually could help reduce

costs overall.

And we have already actually started to test some of this and we put some accident-tolerant fuel in an operating reactor. It was just recently removed and now that will be tested and analyzed, so I would say, absolutely, things are moving forward. There is future investment that is being looked for, for again public-private partnership take things to advance accident-tolerant fuel, but this also is laying the groundwork for new fuel technologies that can be used in advance reactors.

Mr. Walberg. Any other insight on what is necessary to accelerate progress in this area? I am thinking of DTE, Fermi 2 now having a major shutdown coming that will be extensive in a number of days, weeks it will be out. How do we accelerate the progress on these fuels?

Ms. Korsnick. Well, it generally comes down to money. And so, I know that there are companies that are very interested in accident-tolerant fuel and investing in that, but that is an area that we look to for additional investment.

Mr. Merrifield. On that notion, Congressman, you know, that is another area where high-assay, low-enriched uranium is going to be important. There are technologies underway right now, Lightbridge has one, where they want to use HALEU in order to power that future fleet, the existing reactors, and that fuel

also has extreme capabilities to deal with accident tolerance. So a lot of these things weave together, but a very important point in that regard.

Mr. Walberg. Thank you. Thank you.

Ms. Korsnick, you reference in your testimony subsequent license renewals. Why is this important for the existing fleet?

Ms. Korsnick. Well, it is critically important. These plants initially were given a license of 40 years and since we have really operated these plants extremely well, in fact I would say the United States is the premier operator of nuclear plants around the world, and as part of operations we have changed out components, we have analyzed things, we have taken extremely good care of these plants, and in analyzing those looked at possible licensing extension.

We have gone from 40 years to 60 years, almost the entire fleet, and now most recently have gained approval to go from 60 years to 80 years. And again, very safely, everything has been monitored. There are additional inspections that you put in place. I would say there is nothing magic about 80 years. It is a matter of monitoring correctly and operating these plants with the ultimate safety that they are.

Mr. Walberg. Well, maybe there is a future for Yucca yet. Thank you. I yield back.

Mr. Rush. The gentleman yields back. The chair now recognizes the gentlelady from Delaware, Ms. Blunt Rochester, for 5 minutes.

Ms. Blunt Rochester. Thank you, Mr. Chairman, and thank you to the witnesses here today. Prior to being elected to Congress, I served as Delaware Secretary of Labor and also as the head of state personnel for state government and I know that the workforce is the lifeblood of any organization or any industry. And because of this, I recently launched the House bipartisan Future of Work Caucus so that we can proactively be ready for the changing jobs that we inevitably face in our growing economy. So I want to start there.

Ms. Korsnick, one of the issues that we need to keep in mind with industry transitions is ensuring that the workforce is also transitioning. Are there people trained and ready to work in an advanced nuclear industry and can you speak to the workforce demands for building and operating advanced nuclear technologies at a large scale?

Ms. Korsnick. Sure. Thank you. So your question about transitioning the workforce, and I would say much of the workforce that we have today would be used in building these and just look at the type of workforce that we used to build the Vogtle plant, and so many of it comes from the trades as well the engineers

from the technical side.

I just don't want there to be the view that when we talk about building something advanced that it means all 4-year degrees, because it doesn't. And so, I think there is the capability of us to put that in play, but let's be honest. When the Vogtle plant was being built, there were very much, challenges to find all of the talent that they need and so we have to look hard at this pipeline if we were to do a large build.

On the positive side, these things, and they were mentioned earlier, are going to be more factory built and so that should be helpful in getting to that nth of a kind and getting, if you will, quickly up to speed. So we have the capability, we have the talent, and I think there are some good pipelines and training programs that can be put in place.

Ms. Blunt Rochester. And as a follow-up to that, are there substantial opportunities for workers who are displaced from fossil fuel industries to transition into advanced nuclear?

Ms. Korsnick. Absolutely. Just think about the plants when we initially built. We got folks that worked from the fossil side. The entire secondary side of a plant looks the same whether you are fossil or whether you are nuclear and so all of that talent can be redeployed.

Ms. Blunt Rochester. Excellent. Thank you.

Mr. Cohen, while nuclear energy is carbon-free in terms of generation, emissions from plant construction and spent nuclear fuel management must also be considered. What are the differences in terms of environmental impact between advanced nuclear technologies and conventional nuclear reactors? And I will just add on to this, how does advanced nuclear technology address the environmental concerns of conventional nuclear plants?

Mr. Cohen. So there are two different questions there. I think that on in terms of the footprint, let's put aside the issue at the output, the Intergovernmental Panel on Climate Change looked at the total CO2 emissions footprint of various power resources including the entire lifecycle from construction to mining. Nuclear came out, I mean it is barely detectable on the chart, you know, it is like orders of magnitude lower than anything else.

So I mean every, any time you build anything you are going to have, you know, impacts. But I think maybe the second part of your question was perhaps safety and was safety related, is that where you were going?

Ms. Blunt Rochester. No, it was more related to addressing the environmental concerns.

Mr. Cohen. Well, you know, I think this has been addressed,

I think, extensively in the testimony, but there are, including my own there are about five or six attributes of these various reactors that suggest an accidental release of radiation would be vastly diminished as compared to a conventional reactor, which is not to say that conventional reactors are problematic, but this, we are talking about step changes in safety.

Ms. Blunt Rochester. Great, thank you.

And, Mr. Hopkins, small modular reactors are being designed with a whole new generation of digital instrumentation and controls compared to the nuclear plants operating today. How can we ensure that these reactors will not be vulnerable to cyber threats?

Mr. Hopkins. Yes. We actually just recently completed a study both on cybersecurity and the impact of an electromagnetic pulse on our plants, and working with a company called Ultra Electronics, we have devised and it went to the NRC a digital instrumentation control process that doesn't hook to the internet, it is on a programmable array. And so, we believe strongly that from a cyber perspective we are pretty secure.

Ms. Blunt Rochester. Thank you.

Mr. Hopkins. In fact, we wrote a paper on it recently if you have an interest.

Ms. Blunt Rochester. Thank you so much. And I yield back

the balance of my time.

Mr. Rush. The gentlelady yields back the balance of her time. The chair now recognizes the gentleman from Michigan, the ranking member of the subcommittee, Mr. Upton, for 5 minutes.

Mr. Upton. Well, thank you, Mr. Chairman, and I apologize for not being here earlier. We had a bipartisan meeting down at the White House on coronavirus, and anyway it was a very productive meeting as we are working together.

So I have -- so I missed your testimony. I won't ask you to give it again, but I do have a couple of questions. In Michigan, two of our major utilities have announced goals to reduce carbon emissions by eighty and ninety percent by 2040. Good thing. And for states like us, the loss of nuclear generation certainly makes it harder to meet those goals, and costs and delays in transmission siting for wind and solar may slow the deployment for other renewables.

So, Mr. Merrifield and Ms. Korsnick, can you speak to the importance of preserving the existing generation and the electricity reliability benefits of doing so, and do you think that state officials and other policymakers in fact are getting the message?

Mr. Merrifield. The answer is yes, absolutely critical. If we are to meet carbon emissions targets, we are going to have

to keep these plants and keep them for a long period of time. They operate safe. They operate in a ninety-two-plus percent capacity factor and they are critical national assets. I think many states get that message. There are some that still don't. California, for example, is shutting down two perfectly good nuclear plants at Diablo Canyon, which, frankly, is a crying shame.

But I think we need to make sure and this committee needs to oversee efforts on the part of the Federal Energy Regulatory Commission and make certain that they are not undertaking policies that put nuclear at a disadvantage.

Mr. Upton. Ms. Korsnick?

Ms. Korsnick. I would just say, you know, many of the utilities that are making pledges that directionally get them to carbon-free, whether it is 2040, 2045, 2050, they notionally can have an appreciation to get maybe sixty or seventy percent, but that last piece you have to have dispatchable carbon-free energy. And it is really the partnering of that like a nuclear plant with the wind and solar that ultimately is the answer and that is going forward. So if you start closing down your nuclear plants, you are just digging a deeper hole upon which to get out. So it is absolutely critical that you maintain the current fleet.

Mr. Cohen. I offered some math earlier. Just think of this

round number. If you retired the U.S. nuclear fleet, you would lose about a decade in your effort in the pace you need to decarbonize the grid. It is pretty simple. It is a big thing to lose.

Mr. Upton. Yes. Thank you.

Mr. Hopkins, you talked about placing your units at the site of former coal facilities. Obviously, that is going to reduce the need for new transmission siting, which has been an issue as we have looked particularly at renewables and, you know, taking places in the desert and places, other places where you would think that it would be pretty good as it relates to solar. How do you address the question that coal plants and other facilities were not sited for nuclear as well?

Mr. Hopkins. I am sorry, sir. What was the question?

Mr. Upton. So you talk about using the existing siting.

Mr. Hopkins. Right.

Mr. Upton. For coal, so would that not be a good place to look at renewables and use those same transmission lines for those facilities?

Mr. Hopkins. Oh, yes, sir. I mean renewables, in fact we wrote a paper on, and it was mentioned throughout this analysis what we talked about today. Advanced reactors and renewables complement one another. If I look at, you know, currently --

I have built offshore wind farms. We have built PV, solar, and you have capacity factors of twenty-five to thirty percent.

Generally, today it is augmented by natural gas, which is fine, but some of these states that are gravitating to non-greenhouse gas emissions, small modular reactors are a natural to assist in load-following. So they in fact could go there, but we are also saying that we can complement renewables.

Mr. Upton. So the last question I have is, as we look at coronavirus and the impact it has on so many different things including the supply chain, as we look for material that is coming from China whether it be solar panels or other things, has there been any analysis in the last just couple weeks as it relates to this for deployment here in the U.S.? Has anyone got any numbers or any --

Mr. Merrifield. I don't have numbers. I have spoken to utility clients as recently as Sunday who said that they had wind assets that were being sourced in China that have been delayed as a result of the coronavirus. So it clearly is impacting the energy supply chain today.

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

Mr. Rush. The gentleman yields back. And now the chair now recognizes the gentleman from Virginia, Mr. McEachin, for 5 minutes.

Mr. McEachin. Thank you, Mr. Chairman, and thank you for convening today's discussion on advanced nuclear technology in our efforts to decarbonize the power sector. I also want to thank our panelists for sharing your expertise and your testimony.

As we all know, climate change is the single greatest threat to our planet, our health, our national security, and the well-being of all our friends and neighbors. And recent reports have indicated that we are running out of time to address our climate crisis. It is more important than ever that we transition to a hundred percent clean economy. That is why I introduced the 100% Clean Economy Act of 2019, which directs federal agencies to use all existing authorities to put the United States on the path toward meeting the hundred percent clean energy economy goal while remaining technology neutral.

This transition will mean the deployment of numerous current and emerging technologies. Nuclear energy has the capacity to reduce our dependence on fossil fuels and it can be a great asset toward our shared goal of decarbonizing our economy. At the same time, however, nuclear energy faces many challenges including high cost of delays, safety, and waste disposal and long-term storage.

Mr. Cohen, in your testimony you speak about some of the challenges facing the nuclear industry including safety, waste

disposal and storage. How will this nuclear waste be stored? When I say nuclear waste, I am talking about in the advanced setting, advanced nuclear plants, be stored on site, and how do we best mitigate the potential health and environmental concerns for all communities?

Mr. Cohen. I mean, ultimately, and some of the other panelists may correct me, I mean it is going to be the same kind of product, so we are going to have to deal with it probably in a way similar to what we do with the existing reactors. Now I know there are some technologies and I don't know whether TerraPower is one of them where the waste has perhaps different composition, maybe a faster decay rate of toxic material, but we are still probably looking at some kind of geologic storage over time. But I would invite my fellow panelists to correct me if I am wrong on that.

Mr. Levesque. No, you captured that well. You would expect the spent fuel storage-type containers to be similar, but again our technologies will enable that waste stream, initially, to reduce that waste stream by eighty percent. And again, I will mention the Department of Energy is also looking at, you know, ways to use the remaining fissile material in that spent fuel and we will see where that policy decision leads. But advanced nuclear does and moving forward in nuclear innovation does offer,

you know, many new ways of looking at that, at that fuel cycle problem.

Mr. Merrifield. I would add sort of two things. One, I think a number of the advanced technology developers are looking at trying to make sure that as they build and design, or as they design and build their facilities that the long-term storage at least while it needs to be onsite is integral to the building, rather than today where you have to build a pad on the outside and place a bunch of dry storage canisters.

I think the other thing is that some of the fuel types with these advanced reactors may provide opportunities to be more creative in terms of how that material is either treated, whether it is reutilized for additional power or is stored. It may be in some cases easier to store in different types of containers given the properties of the specific fuel types.

Mr. McEachin. Anyone else?

Ms. Korsnick. I guess I would just add because nuclear waste has come up, you know, several times, I would just ask for your consideration that what we consider waste is really future nuclear fuel. So the waste that we have today, it is simply transitioned to a different type of fuel and there is ninety-five percent good energy still in those fuel bundles that today we call waste. So it is important that we think about that. Your kids, your

grandkids, and their kids, they are going to want to understand how to use this in the future for the designs that they are going to have, so we should be thoughtful about the fact that this is a resource that can be used again.

Mr. McEachin. Are we capable of using it again now or do we need some emerging technology to use it?

Ms. Korsnick. Some of the technology that is being discussed here will in fact be able to use the fuel and there will be more of that as this technology gets developed.

Mr. McEachin. For decades, low-income communities, communities of color, and tribal and indigenous communities -- well, is that right? Is my time gone?

Mr. McEachin. Okay. You said no, sir? Yes, sir.

Mr. Rush. The gentleman will continue your --

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

Mr. Rush. The gentleman yields back the balance of his time.

This concludes our witness questioning, and I want to congratulate this panel. You have been a superb panel and we thank you for your patience and for your participation in this hearing. And I want to remind members that pursuant to committee rules, they have 10 business days to submit additional questions for the record to be answered by the witnesses who have appeared. And I ask each witness to be diligent to respond promptly to

any such questions that you may receive. And I see a participant in the audience with his hand raised. I am not sure the purpose of that, but we will not entertain any questions or any comments from the audience. And now at this time the subcommittee is adjourned.

[Whereupon, at 1:12 p.m., the subcommittee was adjourned.]