SOLVING THE CLIMATE CRISIS: RAMPING UP RENEWABLES

HEARING

BEFORE THE

SELECT COMMITTEE ON THE CLIMATE CRISIS HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

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SOLVING THE CLIMATE CRISIS: RAMPING UP RENEWABLES

THURSDAY, JUNE 13, 2019

U.S. HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON THE CLIMATE CRISIS,
Washington, DC.

The committee met, pursuant to call, at 10:03 a.m., in Room 2318, Rayburn House Office Building, Hon. Kathy Castor [chairwoman of the committee] presiding.

Present: Representatives Castor, Bonamici, Brownley, McEachin, Levin, Casten, Graves, Griffith, Palmer, Carter, Miller, and Armstrong.

Ms. CASTOR. The committee will come to order.

Without objection, the chair is authorized to declare a recess of the committee at any time. Today we will discuss the linchpin of any serious plan to address the climate crisis, ramping up renewable energy in the electric power sector.

Good morning, everyone. Welcome to our outstanding witnesses who are here with us this morning.

I now recognize myself for 5 minutes to give an opening statement.

I am excited to talk about renewable energy this morning. But before I start, I want to acknowledge what has been happening with the climate crisis just since our last meeting.

The headline of my local newspaper back in Florida last week read "Florida Got Hot in May, like Record-Breaking Hot."

According to the National Oceanic and Atmospheric Administration, the State of Florida experienced its hottest May in more than a century. And it wasn't just a little hotter. The new record is nearly four degrees hotter than the previous record. And while Florida was the only State to break the May temperature record, Virginia had its third hottest May on record, while North Carolina, South Carolina, and Georgia all had their second hottest May ever.

Record-breaking heat in the Arctic also pushed temperatures in Finland to levels never recorded before. In America's Arctic, the abnormal heat has led to fatal accidents in Alaska's rural villages. San Francisco, on Monday, hit 100 degrees. Yes.

In India, heat waves have driven temperatures higher than 120 degrees. And when it is hot, people can't go outside. When it is that hot, they can't go outside anyway. They can't get to work, they can't go to school, they can't go shopping or buy food for their family.

Last week also saw the release of a new scientific study examining the epidemic heat waves in 2018. The scientists concluded

that these heat waves would not have occurred without human-induced climate change. They warn that we have entered a new climate regime, featuring heat waves of a scope and intensity not seen before.

And of course deadly heat isn't the only danger. Right now, America's Midwest is still struggling with flooding, and wildfires are burning in Northern California despite a wet winter.

Scientists say that we can expect more extreme events. And insurers say plan for greater risks. And as policymakers, we know with greater risk comes greater costs for families we represent back home. These are the stakes of the climate crisis.

So I am glad we finally passed a disaster relief package with climate resilience included last week. But we can't adapt our way out of this crisis. We have to cut carbon pollution. Carbon pollution is what is causing this problem in the first place.

So today we are focusing on renewable energy because it is such a big part of the puzzle. Renewables used to provide just a fraction of our electricity, but now they are up to 17 percent and growing.

In the past 10 years, wind power has quadrupled and costs have fallen by nearly 70 percent. Utility-scale solar has increased 30 times over, and costs have fallen by 88 percent. Now more than 350,000 people are working in the wind and solar industries.

Renewable energy has flourished because we finally started giving wind and solar some of the same support that the fossil fuel industry has enjoyed for over a century.

States have also led with renewable energy standards. California, Washington, Hawaii, Nevada, and New Mexico have committed to an energy grid powered by 100 percent clean energy. The new Governors of New Jersey, Minnesota, and Illinois have called for similar levels of ambition.

South Carolina also passed the South Carolina Energy Freedom Act to promote solar energy just a couple months ago. It was bipartisan and unanimous and a pro-jobs and pro-economic growth bill.

States have been in the lead, but we know here in the Congress we need to do more. The time is now.

And we heard in our second hearing, we need to achieve net-zero carbon pollution across our entire economy by the year 2050. We have to do that to avoid catastrophic harm from the climate crisis.

When scientists do the math, it is clear that the United States will have to generate much of its electricity from renewables to get there. Many experts see a continued role for nuclear power and fossil fuel plants with carbon capture, but renewable sources are crucial. Clean, renewable energy is the linchpin for solving the climate crisis.

We need to move more quickly, to put more wind, solar and other renewables online. That means making sure that everyone has access to clean energy in their communities, whether they own a rooftop or not. And it means making sure that more jobs in clean energy are good, family-sustaining jobs, and it means providing good careers for young people who want to solve the climate crisis.

This crisis is daunting. But the opportunities we have in front of us for good jobs, clean air, and a just future are boundless. So it is time for resolve, and it is a time for hope. We have the tools and the technology we need to succeed. We just need to decide to do it.

With that, I will recognize the ranking member for 5 minutes.
[The statement of Ms. Castor follows:]

Opening Statement (As Prepared for Delivery), Rep. Kathy Castor (D–FL), U.S. House Select Committee on the Climate Crisis

Solving the Climate Crisis: Ramping Up Renewables, June 13, 2019

I'm excited to talk about renewable energy today, but before we start, I want to acknowledge what's been happening with the climate crisis since our last hearing.

The headline of my local newspaper last week read: "Florida Got Hot in May—Like Record-Breaking Hot." According the National Oceanic and Atmospheric Administration, the State of Florida experienced its hottest May in more than a century. And it wasn't just a little hotter. The new record is nearly four degrees hotter than the previous record. While Florida was the only state to break its May temperature record, Virginia had its third-hottest May on record, while North Carolina, South Carolina and Georgia all had their second hottest May ever.

Record-breaking heat in the Arctic also pushed temperatures in Finland to levels never recorded before. In America's Arctic, the abnormal heat has led to fatal accidents in Alaska's rural villages. And San Francisco hit a record-breaking 100 degrees on Monday.

In India, heat waves have driven temperatures higher than 120 degrees. When it's that hot, people can't go outside. They can't get to work. They can't go to school. They can't go shopping and buy food for their family.

Last week also saw the release of a new scientific study examining the epidemic of heat waves in 2018. The scientists concluded that these heat waves "would not have occurred without human-induced climate change." They warned that we've entered a "new climate regime" featuring heat waves of a scope and intensity not seen before.

And of course deadly heat isn't the only danger. Right now, America's Midwest is still struggling with flooding, and wildfires are burning in Northern California despite a wet winter. Scientists say we can expect more extreme events. Insurers say plan for greater risk. As policymakers, we know greater risk comes with greater costs for families we represent back home. These are the stakes of the climate crisis.

So I'm glad we finally passed disaster relief with climate resilience last week. But we can't just adapt our way out of this crisis. We have to cut the carbon pollution that is causing the problem in the first place.

Today we're focusing on renewable energy because it is such a big part of the puzzle. Renewables used to provide just a fraction of our electricity. But now they're up to 17 percent and growing. In the past ten years, wind power has quadrupled and costs have fallen by nearly 70 percent. Utility-scale solar has increased 30 times over and costs have fallen by 88 percent. Now more than 350,000 people are working in the wind and solar industries.

Renewable energy has flourished because we finally started giving wind and solar some of the same support the fossil fuel industry has enjoyed for more than a century. States have also led with renewable energy standards. California, Washington, Hawaii, Nevada, and New Mexico have committed to an electricity grid powered by 100 percent clean energy. The new governors of New Jersey, Minnesota and Illinois have called for similar levels of ambition. South Carolina also passed the South Carolina Energy Freedom Act to promote solar energy. It was bipartisan and unanimous and a pro-jobs and economic growth bill.

States have been in the lead. But we know here in Congress we need to do more. As we heard in our second hearing, we need to achieve net-zero carbon pollution across our entire economy by at least 2050 to avoid catastrophic harm from the climate crisis. When scientists do the math, it's clear that the United States will have to generate much of its electricity from renewables to get there. Many experts see a continued role for nuclear power and fossil-fuel plants with carbon capture, but renewable sources are crucial. Clean renewable energy is the linchpin for solving the climate crisis.

We need to move quickly to put more wind, solar and other renewables online. That means making sure everyone has access to clean energy in their communities, whether they own a rooftop or not. And it means making sure that more of the jobs in clean energy are good, family-sustaining jobs. And it means providing good careers for young people who want to solve the climate crisis.

The climate crisis is daunting. But the opportunities we have in front of us for good jobs, clean air and a just future are boundless. So, it is a time for resolve and

it is a time for hope. We have the tools and technology we need to succeed. We just need to decide to do it.

Mr. GRAVES. Thank you, Madam Chair. And I want to thank you for your statement.

I think it is important for us to point out that certainly the climate change and the temperature changes are very concerning. And it is exciting to look back at the United States' record of being the Nation that has had the greatest reduction in emissions of any country in the world.

And it is also important, as we continue to move forward to address this challenge, important to recognize that during that same period of time, that China has increased their emissions by 4 billion tons, so quadrupling the reduction in emissions that we have reduced. And so we must continue to look at this as the global challenge that it is.

Madam Chair, there is no question that renewable energy sources are—have and will continue to play a very important role in our energy future. It is important for us to recognize that there are challenges with achieving this energy future that many of us do envision, challenges associated with the regulatory structure, the challenge associated with updating our grid system in order to facilitate this expansion of clean energy solutions.

And many of the witnesses here today have—have run into these challenges of trying to get through this regulatory process, to bolster or to increase the role that renewables play. Making sure that we fully understand what role energy storage technology plays in an objective to expand the utilization of energy—renewable energy technologies. Some of the challenges associated there—certainly we have seen some of the rare earth news stories in recent weeks and what challenges those pose, some of the limits of battery storage technology and the role—the complementary role that natural gas and other energy streams will play and recognizing that solar energy isn't an option perhaps at night, Ms. Hopper, as we can talk about a bit more.

And understanding how these interplay, understanding some of the challenges associated with a renewable energy strategy that has been pushed in the Northeast that actually resulted in dependence upon Russian energy being imported to address some of the issues there.

We need to ensure that as we move forward with this—this all-of-the-above energy strategy, as we move forward in improving the role that renewable energies play, that we are looking to ensure that we can balance all of these resources properly, that we don't just have energy available to us when the wind blows, when the sun is out, and that we are ensuring that the investments we are making in science and technology are truly complementary to the assets and the opportunities and the innovation in the United States.

My home State of Louisiana, it has been fascinating, we have one of greatest coastal land-loss challenges in the Nation. We have lost about 2,000 square miles of our coast. We have a very aggressive plan to come in and restore our coastal wetlands. One of the biggest impediments to that plan, believe it or not—it is not the money, it is not the sediment, it is not the fresh water—it is the

regulatory process. The very process that is designed to protect our environment is actually impeding our efforts to restore the environment.

And I think that we are seeing similar challenges here with some of efforts that you are working on, some of the efforts to continue to build upon our emissions reduction successes by increasing the transition to natural gas in some areas, and our ability to transport the natural gas and ability to relay the electricity from renewable sources to the areas where it is needed.

So looking forward to having this discussion today, looking forward to future discussions on nuclear power, on energy storage, on carbon capture storage and utilization and other tools that I think are going to be a really important part of our overall recommendations from this committee.

So with that, I will yield back.

Ms. CASTOR. Good, and I thank my friend for his statement.

Without objection, members who wish to enter opening statements into the record have 5 business days to do so.

At this time I would like to introduce our outstanding witnesses who are with us today.

Abigail Ross Hopper is president and CEO of the Solar Energy Industries Association. Before joining SEIA, Ms. Ross Hopper was the director of the Department of the Interior's Bureau of Ocean Energy Management, where she led the agency that oversaw the leasing and development of all offshore energy, including wind. She served formerly as the director of the Maryland Energy Administration.

Tom Kiernan, president and CEO of the American Wind Energy Association. Prior to joining AWEA, Mr. Kiernan was president of the National Parks Conservation Association for 15 years.

Christine Tezak is managing director at ClearView Energy Partners. Prior to joining the firm, Ms. Tezak was a senior research analyst at Robert W. Baird and Company and a senior vice president with the Washington Research Group.

Katherine Hamilton is chair of 38 North Solutions, a consulting firm. Ms. Hamilton is co-chair of the World Economic Forum's Future Advanced Energy Technology Global Future Council and immediate past president of GRID Alternatives Mid-Atlantic.

Without objection, the witnesses' written statements will be made part of the record.

And with that, Ms. Ross Harper, you are now recognized to give a 5-minute statement.

STATEMENTS OF ABIGAIL ROSS HOPPER, ESQ., PRESIDENT AND CEO, SOLAR ENERGY INDUSTRIES ASSOCIATION; TOM KIERNAN, PRESIDENT AND CEO, AMERICAN WIND ENERGY ASSOCIATION; CHRISTINE TEZAK, MANAGING DIRECTOR, CLEARVIEW ENERGY PARTNERS, LLC; AND KATHERINE HAMILTON, CHAIR, 38 NORTH SOLUTIONS

STATEMENT OF ABIGAIL ROSS HOPPER, ESQ.

Ms. ROSS HOPPER. Great. Thank you very much. Good morning.

Thank you, Chairwoman Castor, Ranking Member Graves, and all of the other members of the committee.

I am so happy to be here. Thank you for inviting me, thank you for your interest in solar energy, and most importantly, thank you for your interest in addressing the climate crisis that we face.

As you just heard, I am Abigail Ross Hopper, the president and CEO of the Solar Energy Industries Association, or SEIA. We really like acronyms in the energy world.

Before I begin to talk about solar, I just want to sort of address one thing that Ranking Member Graves said. I think we all are committed to clean, reliable, and affordable energy system, right? That is what consumers want, that is what they demand, that is what they expect, and I think what you will hear today is that is what we can deliver.

So I am so proud to represent the solar industry. We represent about 250,000 Americans who work in the solar energy industry, about $17 billion that we invest in this Nation.

We recently celebrated the two millionth U.S. solar installation in May. And while that is all exciting, I would invite you to buckle up, because we are about to enter the Solar + Decade. Solar generation currently provides about 2.3 percent of the Nation's electricity generation, but by 2030, we think that will be 20 percent. And while that is certainly an aggressive goal, I think it is certainly doable, and we certainly cannot afford to wait.

Today the solar industry reduces carbon emissions by 73.3 million metric tons per year, which is equivalent to taking 15.6 million vehicles off the road.

So if we achieve this 20 percent in the next decade, we will add more than $345 billion to our economy and 350,000 additional solar jobs, proving that a clean economy is a strong economy.

So what makes me so confident about our ability to do this? Well, it is based partly on what we have accomplished to date. At the Federal level, I am going to talk a little bit about what has worked.

The investment tax credit has created hundreds of thousands of jobs literally and spurred billions of dollars in economic growth. As 2019 ends, the ITC—again another acronym that we like—the ITC will begin an annual stepdown that will lead to an eventual phaseout of the credit for residential solar and a much-reduced credit for commercial and industrial and utility-scale solar.

So until Congress passes a carbon tax or comes to some consensus on how we address climate change, the ITC is literally the most effective policy to deploy clean energy and solar energy. So it is not just a pro-solar policy, but it is literally a pro-planet policy, and we think it should be extended.

Solar has benefitted from other Federal policies as well, including the Public Utility Regulatory Policies Act, or PURPA, which encourages the deployment of small-scale renewable and cogen. And in addition, Federal solar research plays an important role in solar development and continued deployment.

So at the State level, as the Chairwoman said, there are lots of examples. I would point you to my written testimony. But I would—I just can't help but also highlight South Carolina, because I think it is so illustrative of the bipartisan nature of solar energy and renewables in general. But just in May, Governor McMaster signed the law that clears obstacles, clears away some of the red tape that we have talked about, to greater adoption of rooftop solar

and also allows more large-scale solar. We think it will create jobs and encourage investments for all South Carolinians.

So what are some of the things I would ask you to take a look at to help further the deployment? I am going to name four, but there is clearly more in my written testimony.

One, as I said, extend the investment tax credit as we seek consensus on a larger carbon policy. We think that is one clear thing that Congress can do. Two, I would echo the interest in energy storage. That is such a transformative part of this transformation to a clean energy economy. And so we think that passing support for storage is a critical act that Congress can do.

Third, I would suggest that we invest additionally in our electric infrastructure. Our Nation's grid is in dire need of upgrade, specifically around transmission and so we can make sure we can get the electrons to the folks that need it, and then as we think about distributed generation and ensuring that our grid is equipped to handle that two-way traffic.

And then fourth, I would suggest that we need to invest in workforce development. Solar does provide well-paying careers, and we are going to literally need hundreds of thousands of workers in the next decade. We must work deliberatively to build an industry that is diverse and inclusive, reaching into communities that have not yet benefitted from renewable energy. We must ensure that every American has the opportunity to enter this sector. And we also support programs that allow veterans to transition from military service into solar jobs.

So I would suggest that the benefits of deploying renewable energy and solar specifically are enormous. And as we create this clean energy vision, this solar plus vision, solar plus wind, solar plus storage, solar plus grid modernization, that it will lead to investment, jobs and opportunities.

So thank you very much for asking me to be here.

[The statement of Ms. Ross Hopper follows:]

Testimony of Abigail Ross Hopper, Esquire, President & CEO, Solar Energy Industries Association

U.S. House of Representatives Select Committee on the Climate Crisis, June 13, 2019

INTRODUCTION

Chairwoman Castor, Ranking Member Graves, and members of the Select Committee, thank you for inviting me here today and for your interest in solar energy.

I am Abigail Ross Hopper, president and CEO of the Solar Energy Industries Association (SEIA). SEIA is the national trade group for America's solar energy industry with 1,000 member companies. Approximately 250,000 Americans work in the $17 billion solar industry. We recently celebrated the two millionth U.S. solar installation in May. It took us 40 years to reach the first million installations in 2016 and only three years to double that number. And buckle up because we are about to enter the Solar+ Decade. What do I mean by that? Solar generation currently provides 2.3% of our electricity in the United States; by 2030, we aim for solar energy to be 20% of the electricity generation mix. To get there, SEIA has designated the 2020s the Solar+ Decade, recognizing the fact that the industry will need to both aggressively pursue policies to facilitate solar deployment while also collaborating with other technologies to make it happen.

Our target is aggressive, but we cannot afford to wait to address the climate crisis. That 20%, or something close to it, is what we as an industry need to achieve if we are to meaningfully address climate change and fulfill our role in keeping glob-

al temperature rise below 2 degrees Celsius. Climate scientists are clear that electricity generation plays a large part in carbon emissions. Solar deployment can help reduce emissions, support local economies and good jobs, reduce air pollution, and provide low-cost energy to American families and businesses. The solar industry today, at just 2.3 percent of our nation's electricity production, reduces carbon emissions by 73.3 million metric tons per year. That is the equivalent of taking 15.6 million vehicles off the road or planting 1.2 billion trees. The carbon reduction attributes of solar are significant.

To reach our aggressive 20% by 2030, we will need to install an average of 39 gigawatts (GW) each year through the 2020s. That's up from 10.6 GW last year. We'll need an average annual growth rate of 18% and cost reductions across all market segments of nearly 50%.

If we achieve this goal, we will create 350,000 additional jobs and build more systems annually than we have installed to date. That means there will be a total of 600,000 solar jobs in 2030. That's more workers than every single U.S. company except for Walmart, more than the utility industry, and more than the mining and oil and gas extraction industries combined. And when we grow this workforce, it will be with an eye toward diversity and inclusion.

In this scenario, our industry will add more than $345 billion into the U.S. economy over the next ten years, reaching $53 billion annually. Our success will prove that climate solutions don't hurt the economy, but instead, are some of the strongest economic growth engines we've seen in decades.

Your Committee is charged with a special task—to advise Congress on opportunities and policies that exist to help address the climate crisis. That's why I'm pleased to be here today representing this vibrant industry. Solar offers Americans options and answers on climate change, as well as tremendous opportunity for economic growth and job creation across the country.

WHAT HAS WORKED

How has solar grown so rapidly and successfully? What makes me so confident about the Solar+ Decade? Let me share with you a few examples of policies that have made a real difference, at both the federal and state levels.

Federal

At the federal level, the leading policy that has led to the deployment of solar nationwide is the Investment Tax Credit. To put it simply, the ITC has worked and worked well. The ITC has helped to create hundreds of thousands of jobs and spurred billions of dollars in economic growth. As we come to the end of 2019, we approach an annual step-down in the ITC which will lead to an eventual phaseout of the credit for residential and a much-reduced credit for commercial and utility-scale solar.[1]

With the solar industry facing cost increases from tariffs and the most recent Intergovernmental Panel on Climate Change report indicating that rapid decarbonization is necessary to mitigate some of the worst effects of climate change, the timing is not right for a stepdown or phaseout of this extremely valuable tax credit that spurs increased development of renewable energy. Until Congress passes a carbon tax or other comprehensive legislation that addresses climate change, the ITC is the most effective policy we have to deploy clean energy. In short, the ITC is more than just a pro solar policy. It is a pro planet policy.

Solar has also benefitted from other federal policies, including the Public Utility Regulatory Policies Act, which encourages the development of small-scale renewable and cogeneration facilities. Additionally, federal investments in energy research through the Department of Energy have long paved the way for commercialization of technologies. Federal solar research has made the United States a global leader in solar technology development. This includes research on battery storage, which is absolutely part of the future of additional renewable deployment.

State

At the state level, there are numerous examples of state policy that has accelerated the deployment of solar energy. States like Arizona, Texas, Nevada, California, North Carolina, New Jersey and Massachusetts have had enormous growth in solar energy deployment, largely because of policy incentives and programs that support the new development of solar projects.

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[1] The ITC for both commercial and residential is 30% until Dec. 31, 2019. Thereafter it steps down to 26 percent in 2020 and 22 percent in 2021. After 2021, the residential credit will drop to zero while the commercial and utility credit will drop to a permanent 10 percent.

One example of effective state policy is renewable portfolio standards. In Maryland, for example, the Clean Energy Jobs Act passed in 2017, enacting a 25% renewable electricity standard by 2020. This legislation was a broad success, prompting the creation of thousands of solar jobs. Earlier this year, Maryland doubled down on its commitment, raising Maryland's requirement for renewable energy to 50% by 2030, including a 14.5% requirement for in-state solar by 2030. This legislation had bipartisan support and will continue to catalyze job growth and solar development across the state.

In South Carolina, Governor McMaster signed legislation in May that lifted caps on the amount of rooftop solar allowed in certain areas and eliminated restrictions on solar-leasing programs. The Energy Freedom Act, passed unanimously by the Republican-led South Carolina House and Senate, also improves opportunities for utility-scale solar developers, including provisions to require the Public Service Commission to review and approve rates and terms provided to utility-scale solar facilities which will ensure contract terms are reasonable for such projects. In addition, the new law will allow large energy customers to negotiate directly with renewable energy suppliers and provide for more transparency and competition in long-term utility-generation planning.

In the Midwest, Illinois passed the Future Energy Jobs Act (FEJA) in 2016 which aimed to grow the solar workforce in the state. FEJA authorized a total of $30 million to develop three clean energy job training programs. The Act established a solar installation training pipeline. Despite a national trend of contracted solar job growth in 2018 due in part to solar tariffs, Illinois added over 1,300 solar jobs in 2018, and is projected to continue growing.

California also made headlines last year with its enactment of a requirement for newly constructed homes to either have solar panels on the home or be connected to a shared solar system that serves multiple homes. This code will allow homeowners to experience lower energy bills and a projected overall savings when factoring in the cost of the solar array. This standard was groundbreaking and will provide immense benefits to California and its residents when it goes into effect next year.

Two other policies that have supported residential and small commercial solar are net metering and rate design. Net metering, which provides a credit to a system owner for power sent to her neighbors, has been critical in fostering rooftop markets in many states. Similarly, rate design that does not unfairly burden solar owners with unwarranted fees and charges simply because they installed solar, will be critical to this sector as the industry moves forward. Although states with high levels of rooftop solar are rightly beginning to explore successors to net metering, we have unfortunately seen actions in states with very small rooftop markets that attempt to use rate design to stymie a growing industry before it takes hold.

CHALLENGES TO FASTER DEPLOYMENT OF SOLAR AND POLICIES THAT CAN HELP

Despite these shining examples of federal and state policies, we must acknowledge that our industry still faces major challenges as we drive towards 20% of generation. Despite the solar industry's growth, future deployment still faces challenges. While the cost of solar has dropped dramatically in recent years, added costs from tariffs, extended and unpredictable timelines for permitting and interconnection, uncertainty about the future of tax policy, slower than needed deployment of storage resources, the need for infrastructure investment, and workforce needs pose potential roadblocks to solar growth across the country. There's a lot at stake in getting renewable energy deployment right and facilitating it as rapidly as possible. As the Committee considers options to include in its report, we recommend your attention to the following:

Extend the ITC as We Seek Consensus on Broader Carbon Policy

As I mentioned earlier in my testimony, the federal solar ITC has been an outstanding success and continues to drive major growth in our industry. It has created hundreds of thousands of jobs and, at last count, $140 billion dollars of investment. And yet, just as Americans demand action on climate change and new markets in areas like the Midwest are opening up and growing, the ITC is scheduled to begin to step down in its value at the end of 2019, phasing out entirely for residential solar by 2022, and falling to just 10 percent for commercial and utility-scale solar. This is a challenge for our industry and for our climate.

One thing that Congress can do now that will absolutely help deploy renewables faster is to extend the Investment Tax Credit. It's that simple. Solar comprises only 2.3% of generation nationwide and we are at an inflection point where strong and proven tax policy can make a difference in the clean energy economy. In order to get where we need to be, and meaningfully cut emissions, the ITC extension is a

must. Given the focus of Congress on new sources of economic growth and jobs, as well as renewed spirit in genuinely addressing climate change, now is not the time to diminish support for a core part of U.S. climate policy. SEIA is also participating in ongoing conversations in Congress about broader climate policies through the tax code—from next generation tax credits, such as a technology neutral tax credit, which we have endorsed, to thinking critically about a carbon tax that appropriately prices the externalities of energy generation. As an organization, we are generally supportive of these approaches and think they would comprise a wholistic approach to carbon policy.

However, until there is bipartisan consensus on what comes next to tackle our climate challenges, we urge Congress to use the proven tools it has available. The stakes are far too grave. Tax credits like the solar ITC work and will continue to work if extended. Let's put it in perspective—as mentioned earlier, the solar industry today, at just 2.3 percent of our nation's electricity production, reduces carbon emissions by 73.3 million metric tons per year. That is the equivalent of taking 15.6 million vehicles off the road or planting 1.2 billion trees. Just imagine the impact solar energy can have in the future if we reach our goal of 20 percent of electricity generation by 2030.

Invest in Energy Storage

Energy storage coupled with solar will be a critical part of achieving 20% solar by 2030. Solar + storage is the future of our industry and vitally important for getting more solar on the grid. Storage can ensure that the solar resource can be optimized and provide the reliability required on the grid. Already, solar + storage projects are being built across the country in residential, commercial and utility-scale contexts. In fact, major corporations like Target and Wal-Mart have made significant investments in solar + storage in recent years.[2]

The Energy Storage Association forecasts that we will reach 35 GW of new storage by 2025.[3] That has far-reaching implications for solar and other renewables. However, energy storage needs support to grow and deploy as rapidly as we need.

Congress can help by facilitating energy storage research and deployment through research funding, infrastructure, and tax policies, like the current bipartisan legislation that will codify storage within the Investment Tax Credit. As our nation becomes more energy independent, eliminating the 70% cliff for storage under the solar ITC or full ITC treatment for storage will help integrate renewable energy resources into the larger utility network. Infrastructure legislation can incentivize integrating storage on the grid. Federal research dollars can also help support the development of the next generation of energy storage technology we will need to continue to deploy more renewables.

Foster Trade Policies that Support Renewable Energy

Americans now pay more for solar panels than the rest of the world. Last year, President Trump imposed tariffs on most imported solar modules and cells. These tariffs raised prices of panels by 30% in 2018, and, despite the rate of tariff stepping down annually, will remain an added cost of panels and cells for developers of solar projects across the United States.

This policy was a major challenge for SEIA's member companies and the industry. Not surprisingly, the industry saw a contraction in deployment, investment, and hiring as a result of the price uncertainty and increases that the Section 201 trade case imposed over 2017 and 2018. As a result of the tariffs, solar lost 8,000 jobs as well as potentially 10,000 more jobs that were never created. We deployed 2 GW fewer than we had expected, and the American economy lost out on billions of dollars of potential investment. Trade policies must support deployment of clean energy and not create roadblocks.

Maintain and Expand Competition in Electricity Markets

Congress and regulatory agencies need to maintain and expand opportunities for competition in electricity markets. In places still served by vertically integrated utilities, discriminatory interconnection practices and other anti-competitive behavior must not be tolerated. Congress should maintain the regime established by PURPA, under which qualifying facilities bring competitive pressure when they can serve load for less than the utility's avoided costs. Attacks on PURPA are attacks on competition; any changes made to PURPA should enhance competition, not stifle it. The Federal Energy Regulatory Commission (FERC), with strong oversight from Con-

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[2] *Solar Means Business,* Solar Energy Industries Association. Available at https://www.seia.org/solar-means-business-report.

[3] *35X25: A Vision for Energy Storage,* Energy Storage Association. Available at http://energystorage.org/vision2025.

gress, should ensure that PURPA is implemented in a transparent and non-discriminatory manner, and that adequate enforcement follows any improper action on the part of utilities or their state regulators.

In regions with wholesale electricity markets, competition must expand to include storage assets and distributed energy resources to bid into and fully participate in those electricity markets. FERC has taken some initial steps with Order No. 841, which addresses storage assets, but we are still waiting for similar action to establish the participation rules by distributed energy resources.

Overall, we must have wholesale market rules that value all the services that solar—whether connected to the transmission or distribution grid—can provide, from energy to frequency regulation, and that anticipate a future with solar + storage resources. Of note, FERC's recently finalized storage rule does not require regional transmission organizations (RTOs) to identify how they will interconnect and accommodate bids from solar + storage resources. This gap must be remedied soon, as the private sector is already deploying assets in this configuration. Capacity market rules must fairly account for solar and solar + storage assets. FERC and RTOs should resist calls to support aging, uneconomic generation resources with out-of-market payments. Even the rules that govern who is allowed to participate in RTO stakeholder processes merit review. In a recent decision, FERC rightly concluded that certain rules for stakeholder participation constitute a barrier to entry for generators and small load-serving entities, and are therefore unjust and unreasonable and must be changed.[4] Congress and FERC must continue to ensure robust competition in all wholesale markets, as we know competition delivers lower costs to end-use consumers.

Finally, there is room for more competition at the retail level, too. We see corporate buyers and homeowners choosing more solar every year; it is critical that customer demands can be easily met by solar generation.

Invest in Electric Infrastructure

Our nation's electric grid is in dire need of upgrades, and a push to electrify the economy necessitates additional investments in generation, transmission, and distribution lines. The United States needs massive infrastructure investment to update the grid, improve resilience, and expand transmission. We need to modernize the grid to allow for distributed energy assets to be better integrated and we need to build more transmission infrastructure to allow for more utility-scale solar to be delivered. Moving clean electricity from remote areas onto the grid is a key component of our ability to deploy more renewable energy. One of the primary barriers to solar is the lack of transmission capacity serving areas with quality utility-scale solar resources which are often located in remote rural areas. As demand for electricity grows, transmission will become a more critical issue. Leadership is required to create coordinated and cooperative planning efforts to ensure transmission capacity for renewable energy generation resources like solar. The federal government can also develop guidance and information-sharing portals that make it easier for solar to connect to the distribution grid and reduce interconnection wait times.

As the transportation sector is further electrified, federal policies should also support using renewable energy to power surface transportation infrastructure like the many new charging stations that will be required. These stations must be in every community and take into consideration existing community assets and accessibility.

Analyze Renewable Portfolio Standards

As we have seen in the states, renewable portfolio standards help to spur considerable investment in renewable energy. More than half of all U.S. states have some type of renewable portfolio standard or goal in place. Most state targets are between 10% and 45%, but a growing number, including California, New York, and New Jersey, to name just three, have requirements of 50% or greater. Several pieces of legislation exist to create Renewable Portfolio Standards at the federal level. If Congress chooses to consider a federal standard, we know solar energy will be an important part of any proposed solution.

Cut Red Tape

In some states, installing solar is becoming as common as getting a new air conditioner. While installing solar is routine, safe and simple, the process of getting permits, inspections and permission to interconnect a solar system can often stretch into months. These delays drastically increase the cost of solar deployment compared to other developed countries such as Australia and Germany.

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[4] *See* American Wind Energy Association and The Wind Coalition v. Southwest Power Pool, Inc., 167 FERC ¶ 61,033 (April 18, 2019).

We can do better and are working to improve these processes in the United States, but it is a big challenge that needs support from the federal government. The United States has about 15,000 different permitting jurisdictions and about 3,000 electric utilities that all have their own processes, leading to a highly fragmented and inefficient business environment. To meet our climate goals, we need to drastically streamline these permitting processes to cut as much as 40% off the cost of rooftop solar energy systems. Congress can assist by funding research and initiatives that create voluntary streamlined permitting for solar.

Modernize Policies around Federal Property and Lands Management

The federal government must also look at policies to improve permitting for solar projects on federal lands and make additional opportunities available for solar investment in areas that may be challenging. One of the great things about solar is that it can be installed in a variety of places—rooftops, in fields, and even on previously-developed property known as brownfields. EPA has a Brownfields Program that provides grants and technical assistance to sustainably reuse contaminated property, and several states have similar offerings, including Massachusetts, New Jersey, New York.

Federal buildings can also benefit from solar and save taxpayers money. But additional reform is needed for federal contracting practices that often prevent federal buildings from installing solar. An unintended consequence of the current federal acquisition law is the limited authority of the executive branch to enter into long-term clean energy contracts. For example, most federal agencies cannot enter into Power Purchase Agreements (PPA) with terms longer than 10 years. Unfortunately, this truncated timeline hinders the financial viability of projects that could reduce federal energy costs, meet clean energy requirements, create jobs and promote energy security for the country's most important missions.

Invest in Workforce Development

Solar is also limited by the ability to attract, train and retain a skilled workforce that can meet the industry's growing demands. In the future this issue will become even more dire. For example, rural areas have available land needed to develop utility-scale solar projects. But these companies have challenges building the robust workforce needed to construct a large solar array, making it difficult to expand solar to new areas or markets.

Solar jobs are well-paying careers. In fact, eight states such as Florida, California, and New Mexico list solar installer as their fastest growing job, according to the Bureau of Labor Statistics. Construction workers, project managers, electricians, and engineers are in high demand and labor requirements for a solar project can vary state to state.

Both solar-specific job training and the workforce itself are needed to build the solar needed to reduce emissions from the energy sector and spread the economic benefits of solar to communities across the country. SEIA is also leading work to make sure that as the solar industry grows, we deliberately reach into communities that have not benefitted from renewable energy in the past, to train workers, and bring jobs, economic investment, and clean solar energy opportunities to every zip code. SEIA recently co-published with The Solar Foundation the 2019 Solar Industry Diversity Study as well as a companion guide on diversity best practices.[5]

Congress should support policies that make training for renewable energy jobs more accessible to a wide range of people and communities. SEIA is also working on a diversity initiative through Historically Black Colleges and Universities to ensure there's a pipeline of strong candidates in a range of disciplines that are ready to join the solar workforce. Workforce policies can also build on the skills of veterans, many of whom have grown familiar with solar through their service in the military. Additional policies and programs, like Solar Ready Vets, can help facilitate the transition from military service to clean energy jobs.

Incentivize Solar on New Construction

Building codes have made new homes and buildings safer, more comfortable and efficient. The next step in building evolution is solar. Solar can help meet the energy needs of new homes and make home ownership more affordable. Including solar on new construction may be the most cost-effective way to build residential solar and can cost less than a dormer window or granite countertops. Including solar on new construction saves homebuyers the extra costs associated with retrofitting solar after construction. Unfortunately, the most recent model building energy codes pe-

[5] The Solar Foundation and SEIA, *U.S. Solar Industry Diversity Study*. Available at: https://www.thesolarfoundation.org/diversity/.

nalize the use of solar as a compliance measure. This imposes unnecessary costs for homebuyers. Congress can explore ways to eliminate barriers and incentivize solar on new construction to save energy and costs down the line.

Support Clean Energy for All Communities

Too often, renewable energy has not been available to help every community, particularly those that are low-income, urban or rural. Leadership and investment are necessary to make sure that every community is included in the clean energy economy. The benefits in terms of cleaner air, jobs, economic investment and resilience will far outweigh any initial cost.

Community anchor institutions, such as schools, community centers, libraries, post offices and other public buildings can play an important role in meeting renewable energy goals. While some of these institutions are already using solar, much more can be done. The federal government can provide incentives for additional solar installations on these buildings, which not only create an added layer of resilience to communities, but also reduce costs to the local taxpayer through energy savings.

We also urge the Committee to recommend support for community solar deployment, which makes solar energy available to people who cannot put solar on their own homes or who live in multi-unit dwellings. In addition to streamlining interconnection processes and upgrading the distribution system to allow for more deployment of distributed/community solar (both of which are discussed above), the federal government can incentivize states to develop their own community solar programs by providing technical assistance and funding.

Low-income energy assistance programs to help families install solar will also help ensure that every American has access to clean, renewable energy. These programs can be vital for bridging gaps for communities to benefit from clean solar energy. Investments that help low-income communities benefit from solar help make sure that no community is left behind in the clean energy economy. Such programs also ensure we remedy the mistakes of the past, when low-income communities too often bore the brunt of the environmental costs of more traditional energy production and distribution.

Rural America and our nation's farmers also benefit from solar energy. SEIA supports the Rural Energy for America Program (REAP) within the Department of Agriculture. This program can help farmers reduce input cost with a range of renewable energy options, including wind and solar. At a time when many agricultural producers are struggling, REAP creates additional revenue streams and helps support farmer incomes. Some farmers have even begun to co-locate their solar investments with other forms of agriculture production, including sheep grazing and beekeeping.

The Committee must also be certain to consider the unique energy needs of Native American tribes and people living on tribal lands. Policies should be supported that center tribal members in the development and execution of renewable energy projects and help tribes benefit from the jobs and economic opportunities that come with them. This is especially critical in communities that have historically focused on fossil fuel extraction and where many jobs are at stake. Solar projects already exist on tribal lands to provide solar jobs and solar energy. Two such examples include a project Swinerton Renewable Energy is working on with the Navajo Nation in Kayenta, Arizona, and the work of a company called Native Renewables to both provide clean electricity to the Navajo Nation and create sustainable energy knowledge among all age groups. With additional support for hard and soft costs, microgrid development, job training and technical assistance, Congress can help speed deployment on Native lands across the United States.

CONCLUSION

The benefits of deploying additional renewable energy are enormous. Together, our technologies will provide options for clean energy, offer solutions on climate change, grow the economy, and create hundreds of thousands of jobs.

Over the next 10 years, the Solar+ Decade will be about collaboration and building the partnerships and expertise needed to overcome systemic challenges preventing the widescale adoption of solar. To achieve this goal, solar, wind and storage must work together to transform a complex and interrelated world of markets, customers and electricity systems.

It is incumbent upon renewable industries to create a shared clean energy vision. It won't be just the Solar Decade, but the Solar+ Decade where Solar + Storage, Solar + Grid Modernization, Solar + Wind, and Solar + Overwhelming Public Support combine to define our nation's clean energy future.

Renewable energy industries like solar, wind and storage must work together to aggressively pursue policies to deploy more renewables on the grid and increase access to consumers and businesses looking to lower their energy costs across the country. Together, we'll write a new story for American energy in the 2020s. We invite Congress to join us in sharing this vision. I am confident that together we will provide countless benefits to the American economy and the American people while also creating a livable climate for future generations.

I thank you for this opportunity to testify before the Select Committee on the Climate Crisis. I look forward to answering any questions you may have.

Ms. CASTOR. Thank you very much.

Mr. Kiernan, you are recognized for 5 minutes.

STATEMENT OF TOM KIERNAN

Mr. KIERNAN. Chairwoman Castor, Ranking Member Graves, members of the committee, thank you very much for the opportunity to testify.

Again, Tom Kiernan, CEO of AWEA, pleased to represent our roughly 1,000 members in the full spectrum of the supply chain of the wind industry.

In summary, wind energy is an American success story. We have grown now to 114,000 jobs, and the wind turbine technician is either number one or number two fastest growing profession over the last three years. We are kind of dueling it with the solar technician. So we are thrilled with the career growth opportunities in our industries.

We are also pleased that we are helping to lower the cost of electricity for consumers. Per Lazard, wind energy is the cheapest source of new electricity, and in many parts of the country, actually new wind is cheaper than the marginal cost of existing generation.

We are also in all 50 States and in 70 percent of all of the congressional districts, whether it is one of our 500 manufacturing facilities or one of our 54,000 turbines throughout the country.

And lastly, as far as this American success story, we are thrilled that we are reliably on the grid. There are six States that have currently have over 20 percent of all of their electricity provided by wind energy. SPP, one of the larger regions, recently reported that last year 24 percent of all their electricity was wind energy, and there are times of day this last year where 50, 60, or 65 percent of all the electricity in some States or regions was provided reliably by wind energy.

What I want to do this morning is first share a couple of the policies that have led to this American success story and then share a couple of policies that we would suggest to add to that list.

First policies that have succeeded, the production tax credit. The PTC has been and is an important mechanism for the wind industry to access capital. I am sure you well remember the December 2015 5-year agreement, bipartisan agreement, to phase down the PTC. And that 5-year, multi-year clarity and certainty of policy is one of the key reasons that we have more wind under construction now than we have ever had before, because of that clarity in policy and certainty. So the PTC first.

Second, renewable portfolio standards. There are currently in 29 States and DC RPS policies, and eight additional States have renewable energy goals. And both of those are important drivers for our industry.

It is also important to note that an RPS does not handpick a technology. Rather, all renewables are able to compete to incentivize cost reductions and efficiency gains in homegrown electric sources.

The third policy I want to point out that has been so helpful, in addition to PTC and RPS, State procurement for offshore wind. We have got world class wind resources onshore and offshore, especially off the East Coast and very much though in the Great Lakes and off the West Coast.

States like Maryland, Massachusetts, New Jersey, New York, Rhode Island, and others have set procurement requirements, and these are vital drivers for our blossoming offshore wind industry.

Now, with those three, let me talk about some of the barriers we have going forward and some of the policies that we need to add to those first three.

First, we have an old and inadequate transmission system. Electricity is the lifeblood of a modern U.S. economy, yet our grid is old and in need of investment. Three quick datapoints on that. Consumers currently are paying $6 billion every year in, in essence, congestion costs, because they are not able to get the inexpensive, affordable clean wind energy from where it is generated to load, because we don't have sufficient transmission. That is point one.

Point two, American Society of Civil Engineers gave our grid a D-plus. That is not the grid you want to build the future modern economy on a D-plus grid.

Lastly, SPP and MISO have both found that the benefits of transmission are three times greater than the cost of those upgrades.

So a solution for Congress is to direct FERC to create workable policies in what we have referred to as the three Ps of transmission: How to plan for it, how to pay for it, and the permitting of transmission.

The second policy I want to talk about that we need to address is creating an implicit or explicit price on carbon. Currently different energy technologies receive varying levels of support across different time periods without any unifying policy rationale. A simple way to fix this barrier is for Congress to put a price on carbon, whether explicitly or implicitly, so that carbon is appropriately valued and so electric generators have a level playing field to compete. And one such example is a technology-neutral tax incentive, among many ways of getting at that.

So to summarize, policies that have been beneficial, the PTC, renewable portfolio standards, and procurement policies for offshore wind. And we would add to that list, to address these barriers, transmission policies and a price on carbon.

Thank you very much.

[The statement of Tom Kiernan follows:]

House Select Committee on the Climate Crisis, Solving the Climate Crisis: Ramping Up Renewables, June 13, 2019

Testimony from Tom Kiernan, President and CEO, American Wind Energy Association

Chairwoman Castor, Ranking Member Graves, Members of the Select Committee, good morning. It is my privilege to be here today on behalf of the 114,000 men and women working in the U.S. wind industry. I look forward to discussing the tremendous contributions American wind power is making, and how we can continue growing as part of the solution to the climate crisis. As the President and CEO of the American Wind Energy Association, I am proud to represent our 1,000+ member companies with a common interest in encouraging the expansion of wind energy in the United States. Our members include wind turbine manufacturers, component suppliers, project developers, project owners and operators, financiers, researchers, utilities, marketers, customers, and their advocates. Today wind energy is lowering the cost of electricity for American families and businesses, enhancing rural economies, and actively reducing U.S. emissions. Wind energy is an American success story, providing jobs, investment, manufacturing and economic and environmental benefits across the country. A few highlights:

- Today a record 114,000 Americans spread across all 50 states have jobs supporting the wind industry.
- Over 500 American factories in 42 states build many of the 8,000 parts found in a modern wind turbine.
- The industry is proud to hire America's veterans at a rate 67 percent higher than the national average.
- At least 69 percent of U.S. congressional districts have either an operating wind farm or wind-related factory, or both.
- The U.S. now has 97,223 MW of installed wind capacity, enough to power over 30 million homes. Wind supplied 6.5 percent of the country's electricity in 2018.
- At the state level, six states now generate at least 20 percent of their electricity using wind.
- In 2018, the U.S. wind industry invested $12 billion in new projects and paid over $1 billion in state and local taxes and landowners lease payments.
- As wind technology advances we're experiencing previously unseen levels of productivity. Wind farms built over the last five years have seen average annual capacity factors of 40 percent, with some individual projects in more recent years achieving over 50 percent, on par with certain types of conventional power plants.
- The U.S. offshore wind industry is primed to scale up. At the end of 2018, the U.S. had a potential offshore wind pipeline of over 25,700 MW spanning 10 states in the Northeast, Mid-Atlantic and Great Lakes regions.

POLICIES THAT HAVE HELPED DEPLOY RENEWABLES

Federal and state policies—such as the production tax credit (PTC), state renewables portfolio standards, state procurements for offshore wind, and funding for Department of energy R&D—have helped to spur wind energy development.

PRODUCTION TAX CREDIT

Just as tax treatment for other energy sources has enabled growth and development, the PTC is an incentive that helped wind developers access the capital needed to build new wind projects. This incentive is phasing out this year. The PTC helped launch the wind industry as we know it. However, at times a lack of policy certainty around the PTC hampered the growth of American wind power. For many years, Congress cycled through the tax credit in one or two-year stints and allowed it to expire multiple times. This cyclical pattern resulted in boom-bust cycles of development. In December 2015, with strong bipartisan support, Congress agreed to an orderly phaseout of the PTC. This multi-year policy certainty created a business environment primed for growth, where investments in people, infrastructure, and manufacturing took hold.

STATE RENEWABLE PORTFOLIO STANDARDS

State renewable portfolio standards (RPS), policies that require electric utilities to gradually increase the amount of renewable energy that they deliver to their customers, have also helped spur the development of this robust industry. By design, an RPS does not hand pick a technology; rather all renewables are able to compete,

incentivizing cost reductions and efficiency gains. As a result, RPS policies encourage the growth of additional homegrown electricity sources that diversify our energy portfolios, spur local economic development and job creation, reduce pollution, cut water consumption, and save consumers money.

Today, 29 states plus the District of Columbia have RPS policies in place, while another eight states have non-binding renewable energy goals. State RPS targets range widely from 10 percent to 100 percent renewable energy. Many states have been expanding their targets in recent years and several others are considering future increases, showing the success of RPS programs to date. Historically, wind energy has been the top renewable energy technology of choice to meet RPS targets, accounting for 64 percent of all RPS-related renewable capacity additions to date.

Most importantly, the impact of RPS policies on consumers has been minimal, with many actually seeing lower electric bills because of them. Because wind's costs have fallen by 69 percent since 2009, it's the cheapest source of new electric generating capacity in many parts of the country.

STATE PROCUREMENT FOR OFFSHORE WIND

The U.S. has a vast offshore wind energy resource, possessing a power potential of more than 2,000 gigawatts (GW), nearly double the nation's current electricity use. This potential presents an enormous opportunity to deliver large amounts of clean and reliable electricity to the country's largest population centers, where it's needed most.

With world-class wind resources on the East and West Coasts and in the Great Lakes, infrastructure, and offshore energy expertise, the U.S. is primed to scale up offshore wind power. The U.S. Department of the Interior is charting a path forward for additional offshore wind lease areas. That will transform offshore wind's enormous potential into a concrete pillar of American energy dominance while spurring new manufacturing and shipbuilding.

State policies that require the purchase of offshore wind in Maryland, Massachusetts, New Jersey, New York, Rhode Island, and others are vital drivers for the offshore wind industry. These policies will help achieve scale and develop an American supply chain. With stable policy in place, the Department of Energy found that the U.S. could install a total of 22,000 megawatts (MW) of offshore wind projects by 2030 and 86,000 MW by 2050, creating thousands of well-paying jobs in coastal communities. A recent study by the University of Delaware's Special Initiative on Offshore Wind projects America's growing offshore wind industry represents a $70 billion capital expenditure revenue opportunity for businesses in the offshore wind power supply chain over the course of the next decade. And according to a study from the Workforce Development Institute, 74 different occupations are needed to build, operate and maintain an offshore wind farm.

IMPEDIMENTS TO GROWTH IN WIND ENERGY INDUSTRY

The difficulty in building transmission, the lack of a level playing field for all renewables, and the introduction of tariffs on the wind energy industry are impediments to the continuation of a robust industry.

TRANSMISSION

Electricity is the lifeblood of the modern U.S. economy. The ability to get electrons from where they are generated to where they are consumed is essential to virtually everything Americans do. Yet, our electricity grid is aging and needs sustained attention and investment in order to provide reliable, affordable service to families and businesses. Consumers currently pay approximately $6 billion in annual transmission congestion costs. In fact, the American Society of Civil Engineers rates the country's electric grid an unacceptable D+.

Transmission provides dozens of quantifiable benefits, such as facilitating access to lower-cost electricity generation, reducing the need to build additional generation to hold in reserve, facilitating robust electricity markets, providing economic development and jobs, and helping meet public policy requirements, among other benefits. In short, expanding transmission access provides consumers with lower cost electricity while enhancing the reliability and resiliency of our power system.

Fortunately, dozens of studies from across the country show that transmission line investments pay for themselves many times over by reducing electric bills, and real-world examples bear this out:

- SPP found that the transmission upgrades it installed between 2012 and 2014 created over $16 billion in gross savings—3.5 times greater than the cost of the transmission upgrades.

- MISO found that recent transmission investments will provide $12 to $53 billion in net benefits over the next 20 to 40 years, or between $250 and $1,000 for each person currently served by MISO—2.2 to 3.4 times greater than the cost of the transmission.

Wind energy continues to be the lowest-cost source of new generation in many parts of the country, even compared to rooftop solar. Wind is also one of the most cost-effective means to reduce carbon emissions, and cut 43 million cars' worth of carbon emissions in 2018 alone. Transmission is critical to accessing this reliable, low-cost, location-constrained zero-carbon resource. When congestion occurs on the transmission system, wind generators are sometimes curtailed, which means that more expensive and dirtier generation is dispatched to meet customers' demand. With a robust transmission grid, regional grid operators can cost-efficiently and reliably balance variable resources across diverse geographic areas, allowing carbon reduction to be more cost-effective.

The key to expanding and upgrading the transmission grid is workable policies for how transmission is planned, paid for, and permitted. In 2011, the Federal Energy Regulatory Commission (FERC) took an important step in the right direction with Order No. 1000, which established further requirements and principles related to how transmission is planned and paid for on a regional and interregional basis. While Order No. 1000 made some strides, more must be done to ensure efficient and cost-effective transmission solutions are available. Congress should encourage FERC to take steps to better deliver on Order 1000's promise and ensure a regulatory environment that incents transmission infrastructure, aligning it with the future needs of the grid, such as meeting climate goals.

THE COST OF CARBON EMISSIONS IS NOT REFLECTED IN MARKETS

The societal cost of emitting carbon is not currently captured in today's markets. Pricing carbon dioxide, especially on the national level, would remedy this market failure. Society faces a dual energy challenge: we need to expand energy supplies to support economic growth and improve living standards, and we must do so in a way that addresses the clear risk posed by carbon emissions contributing to climate change. Fortunately, these goals are not mutually exclusive because of the rapid decline in zero-emitting technology's costs, in particular renewable energy.

Strong and consistent policy signals at the national, regional and state levels that internalize the cost posed by carbon emissions can promote a smooth and affordable transition to a cleaner, more sustainable, economy.

UNLEVEL PLAYING FIELD

In absence of broad federal policy, the U.S. tax code has been a de facto source of energy policy for the last century, but the numerous energy-related incentives in the tax code have made the energy tax landscape unnecessarily complex. Different energy technologies still receive varying levels of support across divergent time periods without a unifying public policy rationale and fairness across the technologies. Congress should further simplify energy tax policy and create a level playing field by providing a widely applicable, transferable technology neutral tax incentive, based on carbon emissions, that thereby puts an implicit or explicit price on carbon to build our economy and lower prices for consumers. There are multiple legal and regulatory approaches that can accomplish this goal. This approach would create a more level playing field among energy generation technologies. Further, the clear goal of greenhouse gas reductions forming the basis of the credit would provide a stable incentive that increases business certainty.

TARIFFS

The U.S. wind industry supports 114,000 high-paying jobs spread across all 50 states, many at more than 500 factories that build wind-related parts. While AWEA appreciates the administration's actions to remedy unfair trade practices and increase American competitiveness, the enacted high and sweeping tariffs on products and component parts used in wind energy development will substantially increase the cost of doing business for U.S. wind energy developers. This hurts U.S. manufacturers and makes energy less affordable for the millions of Americans who rely on wind power to provide affordable energy. It also hampers the administration's progress on goals concerning U.S. economic development, energy dominance, infrastructure improvements, job creation, and support for rural communities. The potential increase in wind energy's costs and, in turn, the potential reduction of future wind deployment, if the Section 301 and Section 232 steel and aluminum tariffs are not soon lifted, will:

1. Eliminate thousands of American jobs, mostly in rural America where these jobs are desperately needed; including the loss of domestic manufacturing jobs as the wind industry reduces U.S. manufacturing of wind components in states like Colorado, Texas, and Ohio; and

2. Devastate already struggling farming and ranching families in states like Iowa, Kansas, Oklahoma, North Dakota, and South Dakota, who count on turbine land-lease payments as a drought-resistant cash crop.

I appreciate the opportunity to participate in the conversation on how to continue the growth of wind energy and contribute to addressing the climate crisis.

Ms. CASTOR. Thank you.

Ms. Tezak, you are recognized for 5 minutes.

STATEMENT OF CHRISTINE TEZAK

Ms. TEZAK. Thank you, Chairman Castor, Ranking Member Graves, and distinguished members of the committee.

My name is Christine Tezak, and I lead the power, pipelines, and environmental policy practice at ClearView Energy Partners, LLC. We are an independent research firm here in Washington that serves institutional investors and corporate strategists.

Thank you for inviting me here to contribute to your important discussion regarding the growth of renewables in the U.S. power portfolio. I am grateful for your diligent consideration of climate issues on behalf the Nation's citizens, corporations and stakeholders.

As mentioned earlier by Ranking Member Graves, USEIA calculates that U.S. electric power sector carbon dioxide emissions declined 28 percent since 2005 due to a slower electricity demand and changes in the mix of fuels used to generate power. This occurred for a variety of reasons.

Our resource base has limited nuclear and hydropower capability relative to the other G20 nations, as we showed in figure 1. So building renewable capability that nature didn't provide can help us make further improvement.

Second, as mentioned already, State renewable portfolio standards support and accelerate renewable deployment. Individual States establish targets and mandates directing their utilities to procure renewable energy resources based on a percentage of energy delivered over the course of a year.

We summarize these programs in figure 2. Structuring these programs as targets to meet overall needs is important, as power requirements often differ on an hourly, daily, and seasonal basis.

Third, solar contributed 14 percent of California's needs in 2018, leading the Nation's organized markets as we showed in figure 3. But natural gas has been important in balancing renewable power variations. Non-hydro renewables provided 26.6 percent of the gigawatt hours consumed in the Golden State last year. However, the top 50 demand hours, California continued to rely heavily on in-State natural gas resources, even as renewable resources shouldered a larger share of demand at peak times.

In 2018, 48 percent of California's top 50 peak hour needs were met by in-State gas plants. That is down from the 53 percent average over 2015 to 2017, yet natural gas is still needed to keep the lights on, as we illustrated in figure 4.

So far in 2019, wind is up to 25 percent of daily power needs in SPP. Wind output over the last 12 months is—moves over a range,

though, from a low of 148 megawatts to a high of 16-and-a-half gigawatts. The maximum one-hour ramp observed to date is 3.7 gigawatts, and the largest swing in production was a drop of 14.8 gigawatts over 18 hours. Natural gas and coal resources ramped up and down to meet the shifts in wind production. Both markets have a significant number of new renewable projects planned.

To meet State level climate objectives, we expect electric storage technologies to help provide the balancing needs that natural gas plants currently provide. Natural gas sector participants continue to explore carbon capture and sequestration or beneficial reuse technologies. Currently, storage alternatives are more expensive than installed and new natural gas units but are growing swiftly off a small base.

Last week, former Mayor Bloomberg called for closure of the Nation's remaining coal plants by 2030 and opposes construction of new natural gas plants in an effort to address climate change on an even shorter timeline envisioned by the State programs that Chairman Castor already mentioned.

We built a cursory estimate of generation plant costs alone required to replace the 1.15 terawatt hours of electricity provided by coal facilities in 2018. Our assumptions are detailed in my testimony.

But assuming equal shares of wind, solar, and biomass, with storage to complement wind and solar only, our rough estimate implies as much as a $941 billion in plant-related CapEx alone to meet this objective at today's prices.

To fund such a broad societal goal, we looked at the potential impact of increasing electricity rates through the addition of a one cent per kilowatt hour surcharge. This approach could provide a modest level of funding but would have disparate rate impacts. That means bill increases of 3 to 11 percent, given differences in underlying costs of power in each State and differences in average consumption, as we show in figure 6. Therefore, reducing the cost of the transition appears very worthy of policymaker consideration.

Continued use of natural gas and progress on current State-identified timelines could meet power needs while delivering substantial emissions improvements, potentially at a lower cost.

Our firm sometimes frames energy security in three dimensions: Adequacy, attributes, and affordability. Our experience is that affordability can be a real-world constraint when it comes to policy formation. Put it another way, focusing on attributes to the exclusion of affordability can undermine security and program durability. We suggest that natural gas may still have a key role to play as the Nation deploys an increasing number of low-emitting resources to our portfolio.

I have also put in our testimony a 10-year analysis of the fuel mixes in each State for the members of the committee.

Madam Chair, this concludes my summary, and I look forward to your questions.

[The statement of Ms. Tezak follows:]

Testimony of Christine L. Tezak, Managing Director, ClearView Energy Partners, LLC, Before the U.S. House of Representatives Select Committee on the Climate Crisis

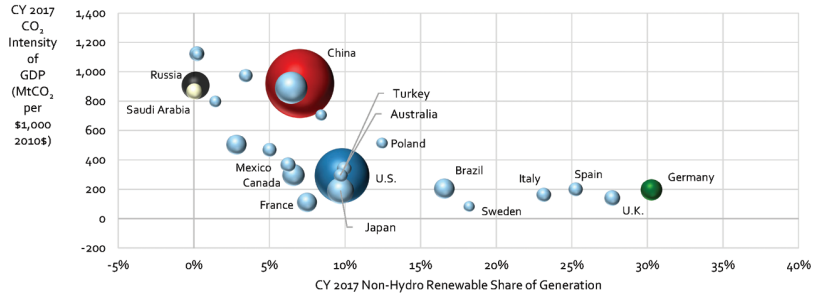
Good morning, Chairman Castor, Ranking Member Graves and distinguished Members of this Committee. My name is Christine Tezak, and I lead the power, pipelines and environmental policy practice at ClearView Energy Partners, LLC. ClearView is an independent research firm here in Washington, D.C. that serves institutional investors and corporate strategists. Thank you for inviting me today to contribute to your important discussion regarding the growth of renewables in the U.S. power portfolio. I am grateful for your diligent deliberation of climate issues on behalf of the nation's citizens, corporations and stakeholders.

My testimony today makes three points, which I will detail in the paragraphs that follow. First, the nation's electric generation fleet has seen a significant drop in its emissions intensity since 2005 as new generation resources entered and older units retired. Second, renewable energy resources are growing quickly, if unevenly, throughout the U.S., thanks in large part to state initiatives. Third, I discuss how the highly flexible operating characteristics of natural gas plants have complemented renewables' growth by playing a balancing role. Specifically, they have done so by ramping up and down to accommodate the variation in renewable resource production, whether hourly, seasonally or annually. Finally, I offer a few thoughts on natural gas' potential to economically facilitate the shift to a lower-emitting national power portfolio.

The U.S. Energy Information Administration explains that U.S. electric power sector carbon dioxide emissions (CO_2) declined 28% since 2005 because of slower electricity demand growth and changes in the mix of fuels used to generate electricity. In 2017, EIA calculated that CO_2 emissions from the electric power sector totaled 1,744 million metric tons (MM $MtCO_2$) in 2017, the lowest level since 1987. In 2018, they rose slightly to 1,762 MM $MtCO_2$.

In CY 2017, the world's ten cleanest power mixes accounted for 9.5% of power generation and averaged 84.3% emissions-free on a generation-weighted basis. On the same basis, however, they averaged 25.6% nuclear-powered and 48.1% hydro powered, and only 10.6% non-hydro renewable powered (the U.S. was 10.1% in CY 2018, according to our Firm's analysis of EIA data). In other words, most of the "green" power is blue. We're not all fortunate enough to have volcanoes and glaciers, so many nations—including the United States—find themselves installing the renewables that nature didn't provide.

Figure 1 – Carbon Intensity per unit of GDP vs. Non-Hydro Renewable Share (G20 countries)



Source: ClearView Energy Partners, LLC, using data from BP's 2018 Statistical Review of World Energy; *bubble size reflects global share of power generation*

MID-CENTURY "MAX-OUTS"

Under the *Federal Power Act*, states have the authority over electric generation adequacy within their borders. This means that siting and fuel mix decisions are under state authority. The federal Environmental Protection Agency (EPA) sets emissions standards for plants of different fuel types and all plants are required to meet them. Emissions standards have been put in place since the 1970s. EPA plans to finalize its *Affordable Clean Energy* program to address power sector greenhouse gas (GHG) emissions this month.

Individual states, at their discretion, have established targets or mandates directing their utilities to procure renewable energy resources based on the percentage of energy delivered over the course of a year. These programs differ significantly, some

states are very ambitious; others do not have any program in place at all. We summarize these programs below in Figure 2.

Figure 2 – State Power Generation Shares, Dynamics and Renewable Portfolio Standards

State	State Share of U.S. Coal Shut-Downs, CY 2012-18 (%)[1]	CY 2018 State Coal-Fired Power Share (%)[2]	CY 2018 State Gas-Fired Power Share (%)[2]	CY 2018 State NHR Power Share (%)[3]	CY 2018 State Non-Fossil Power Share (%)[4]	RPS Target Details[5]
AK	0.0%	10.5%	49.6%	2.9%	27.95%	
AL	5.7%	21.9%	40.5%	2.6%	37.48%	
AR	0.0%	44.7%	28.5%	2.5%	26.75%	
AZ	0.5%	27.4%	33.4%	5.3%	39.16%	15%/2025 *
CA	0.4%	0.1%	46.7%	29.6%	51.90%	60%/2030 ["state policy" of 100%/2045]
CO	1.1%	47.1%	30.0%	19.8%	22.73%	20% or 30%/2020
CT	0.3%	0.8%	50.6%	2.2%	46.43%	40%/2030
DC	0.0%	0.0%	28.8%	71.2%	71.17%	100%/2032
DE	0.5%	4.5%	86.5%	2.2%	2.19%	25%/2025-2026
FL	3.1%	12.3%	70.5%	3.1%	15.17%	
GA	4.6%	24.7%	41.1%	5.5%	33.75%	
HI	0.0%	13.1%	0.0%	13.8%	14.86%	100%/2045
IA	1.2%	44.5%	11.9%	34.2%	43.34%	105 MW
ID	0.0%	0.1%	18.0%	21.2%	81.50%	
IL	3.8%	31.8%	8.5%	7.1%	59.39%	25%/2025-2026 *
IN	6.1%	69.1%	22.6%	5.8%	6.06%	
KS	0.4%	38.6%	7.4%	36.5%	53.90%	
KY	5.2%	74.7%	18.4%	0.7%	6.65%	
LA	0.0%	11.6%	61.0%	2.7%	20.56%	
MA	2.4%	0.0%	67.2%	9.8%	28.04%	39.5%/2030 + 1%/Y
MD	0.8%	22.9%	31.7%	3.5%	44.05%	50%/2030
ME	0.0%	0.7%	19.7%	43.2%	74.68%	40%/2017 *
MI	3.1%	37.0%	26.3%	6.9%	34.00%	15%/2021
MN	0.7%	37.0%	14.5%	22.8%	47.79%	25%-26.5%/2025
MO	0.7%	72.9%	8.3%	3.9%	18.63%	15%/2021
MS	0.0%	8.3%	77.9%	2.8%	13.72%	
MT	0.3%	48.2%	1.7%	8.2%	47.29%	15%/2015
NC	3.9%	23.6%	32.9%	7.6%	42.72%	12.5%/2021
ND	0.3%	66.2%	1.6%	25.8%	31.82%	
NE	0.0%	62.9%	3.3%	14.4%	33.73%	
NH	0.0%	3.8%	17.0%	11.3%	77.89%	25.2%/2025
NJ	1.2%	1.6%	51.6%	3.0%	45.41%	50%/2030
NM	2.3%	41.1%	35.3%	23.0%	23.55%	100%/2050
NV	3.4%	6.2%	67.1%	21.8%	26.56%	50%/2030 [goal of 100%/2050]
NY	0.7%	0.5%	37.7%	5.3%	60.00%	50%/2030
OH	14.1%	47.1%	34.2%	2.1%	17.22%	12.5%/2026-2027 *
OK	0.7%	17.1%	48.1%	32.1%	34.72%	
OR	0.0%	2.3%	27.2%	13.8%	70.45%	50%/2040
PA	6.7%	20.5%	35.7%	2.8%	42.94%	18%/2021-2022
RI	0.0%	0.0%	93.3%	5.7%	5.80%	40%/2035
SC	2.2%	19.6%	22.1%	3.2%	57.98%	
SD	0.0%	21.0%	8.8%	24.5%	70.10%	
TN	4.9%	26.1%	16.0%	1.5%	57.72%	
TX	7.4%	23.5%	50.0%	17.0%	25.97%	10,000 MW/2025
UT	0.4%	65.0%	22.1%	9.0%	12.19%	
VA	2.8%	9.8%	52.8%	5.3%	36.10%	
VT	0.0%	0.0%	0.1%	40.6%	99.67%	75%/2032
WA	0.0%	4.6%	8.9%	7.8%	86.03%	100%/2045
WI	3.8%	49.5%	26.2%	5.2%	24.07%	10%/2015
WV	4.4%	92.3%	2.1%	2.6%	5.31%	
WY	0.1%	85.5%	2.0%	9.0%	11.43%	
US		**27.4%**	**35.1%**	**10.1%**	**36.24%**	

Note:
[1] Based on EIA Form 860 retirement data. The EPA finalized its *Mercury and Air Toxics Standards* (MATS) rule in December 2011.
[2] Based on EIA generation data.
[3] Based on EIA generation data. Non-hydro renewables (NHR) includes wind, solar, geothermal and biomass generation
[4] Based on EIA generation data. Reflects generation from fuels and technologies other than oil, natural gas, coal and petroleum.
[5] Summary-level data; some RPS programs include complex subsets subject to different standards. Asterisks (*) denote RPS targets subject to change and under active consideration by state policymakers.

Source: ClearView Energy Partners, LLC, using sources noted above

The details of these state-led programs differ, both in scope and in stringency. Washington, D.C. and Hawaii have requirements for their utilities to deliver 100% renewable energy by 2032 and 2045, respectively. The state of Washington and New Mexico also have binding requirements, but these programs require 100% "zero carbon" generation by 2045 and 2050, respectively. California and Nevada have established non-binding goals to procure 100% of electric power needs from zero carbon resources by 2050.

COMPLEX MARKET DYNAMICS AND OPERATIONAL CHALLENGES

In many areas of the country, renewable energy growth has been modest, and it has not presented significant challenges to the regional transmission operators (RTOs) that manage multi-state markets. However, some markets are seeing significant operational impacts and growing queues of new projects seeking interconnection.

Figure 3 – RTO Generation Mixes

PJM	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	256,614	239,612	31.75%	28.61%
Natural Gas	287,576	256,702	35.58%	30.65%
Nuclear	216,759	286,155	26.82%	34.16%
Solar	1,469	2,111	0.18%	0.25%
Wind	20,714	21,628	2.56%	2.58%
Hydro	14,868	19,416	1.84%	2.32%
Other	10,230	12,025	1.27%	1.44%
Battery Storage	25	14	0.00%	0.00%
Demand Response	63	49	0.01%	0.01%
Total	**808,230**	**837,648**		

MISO	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	288,474	296,900	48.37%	46.84%
Natural Gas	142,674	168,928	23.92%	26.65%
Nuclear	96,051	99,015	16.10%	15.62%
Solar	N/A	N/A	N/A	N/A
Wind	50,718	50,249	8.50%	7.93%
Hydro	9,598	9,328	1.61%	1.47%
Other	8,901	9,411	1.49%	1.48%
Battery Storage	NA	NA	NA	NA
Demand Response	NA	NA	NA	NA
Total	**596,416**	**633,830**		

CAISO	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	302	294	0.15%	0.15%
Natural Gas	89,588	90,691	43.41%	46.51%
Nuclear	17,925	18,268	8.69%	9.37%
Solar	24,359	27,266	11.80%	13.98%
Wind	12,867	14,244	6.23%	7.30%
Hydro	43,304	26,344	20.98%	13.51%
Other	18,034	17,901	8.74%	9.18%
Battery Storage	NA	NA	NA	NA
Demand Response	NA	NA	NA	NA
Total	**206,379**	**195,008**		

NYISO	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	567	692	0.43%	0.51%
Natural Gas	50,832	55,120	38.75%	40.65%
Nuclear	42,175	43,003	32.15%	31.72%
Solar	47	49	0.04%	0.04%
Wind	4,219	3,985	3.22%	2.94%
Hydro	29,554	29,045	22.53%	21.42%
Other	3,788	3,691	2.89%	2.72%
Battery Storage	NA	NA	NA	NA
Demand Response	NA	NA	NA	NA
Total	**131,182**	**135,585**		

ISO-NE	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	1,684	1,109	1.64%	1.07%
Natural Gas	49,198	50,511	47.98%	48.71%
Nuclear	31,538	31,385	30.76%	30.26%
Solar	880	1,212	0.86%	1.17%
Wind	3,280	3,367	3.20%	3.25%
Hydro	8,572	8,708	8.36%	8.40%
Other	7,382	7,410	7.20%	7.15%
Battery Storage	NA	NA	NA	NA
Demand Response	32	25	0.03%	0.02%
Total	**102,534**	**103,702**		

SPP	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	120,658	116,939	45.30%	42.40%
Natural Gas	50,874	64,537	19.10%	23.40%
Nuclear	17,846	14,893	6.70%	5.40%
Solar	NA	552	NA	0.20%
Wind	58,864	64,813	22.10%	23.50%
Hydro	17,047	13,238	6.40%	4.80%
Other	533	83	0.20%	0.03%
Battery Storage	NA	NA	NA	NA
Demand Response	NA	NA	NA	NA
Total	**266,354**	**275,800**		

ERCOT	By GWh		Portfolio Share	
	2017	2018	2017	2018
Coal	115,141	93,249	32.13%	24.80%
Natural Gas	138,844	167,206	38.74%	44.47%
Nuclear	38,504	41,125	10.74%	10.94%
Solar	2,258	3,240	0.63%	0.86%
Wind	62,203	69,796	17.36%	18.56%
Hydro	856	811	0.24%	0.22%
Other	571	592	0.16%	0.16%
Storage	NA	NA	NA	NA
Demand Response	16	15	0.00%	0.00%
Total	**358,377**	**376,019**		

Source: ClearView Energy Partners LLC based on RTO Annual Reports for CY2017 and 2018

We offer two examples. California and the Southwest Power Pool. The first has a high penetration of solar, the latter, of wind. California has seen significant changes in its market, as both its behind-the-meter (a.k.a., distributed, or "rooftop") and utility-scale solar deployments have grown. Solar power production has contributed to a "duck curve" phenomenon,[1] where net load (demand) in this market falls in the middle of the day, only to ramp up strongly in the late afternoon and evening. This differs from the prior load curve, which reflected a ramp up in the morning, fairly stable daytime demand, an incremental evening ramp and then a tapering off as most folks retired for the evening. Solar has been making strong contributions to California's electricity needs over the last several years, meeting 14% of annual demand needs in 2018. Even though renewables contributed 26.6% of the gigawatt hours (GWh) needed to serve California over the course of last year, the provision of peak service still relies heavily on natural gas facilities (see Figure 4).

California's natural gas fleet is becoming smaller, in part through retirements associated with age and a state-level regulation governing once-through cooling systems. We expect natural gas facilities to continue to play a key role going forward in the California market, even as the Golden State closes in on its 60%/2030 RPS goal. Modest natural gas prices, efficient production and flexible response time remain key operational characteristics relied on by the grid operator. During its top 50 demand hours, California continues to rely heavily on in-state natural gas resources, even as renewable resources shoulder a larger share of demand at peak times, as Figure 4 illustrates.

[1] For further information on the "duck curve," see https://www.nrel.gov/news/program/2018/10-years-duck-curve.html.

Figure 4 – Annual v. Peak Hour Energy Supply in California 2011 - 2018

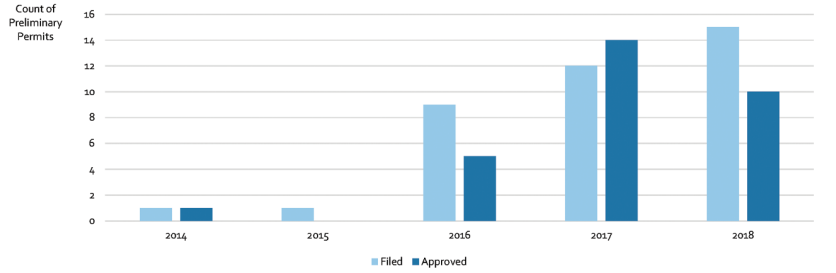
Source: ClearView Energy Partners, LLC, using California Independent System Operator Data

Over time, we expect electric storage technologies—including batteries and pumped storage—to seek to fill the balancing role that natural gas currently plays in markets such as California. Natural gas sector participants also continue to explore carbon capture and sequestration or beneficial reuse technologies. Batteries offer great promise in terms of meeting predictable system shifts (such as the increase in demand in the morning and evenings (morning and evening ramp), as the four-hour duration of many batteries could complement this need well.

Six states have storage adoption targets in place, and the Federal Energy Regulatory Commission (FERC) and the regional wholesale market operators are implementing a 2018 rule to facilitate the participation of storage resources in the wholesale markets that it oversees. Nationally, battery costs remain high relative to the operating profile of installed and new natural gas units. Rare earth mining for the key elements of battery technologies has environmental consequences of its own. It is also an industry that currently relies on foreign supply chains and could be unsettled during periods of trade tensions.

Longer-duration storage (around eight hours) such as pumped hydro, has also been eying this balancing role. The FERC has seen an uptick in preliminary permit applications for pumped hydro storage projects. However, like other large-scale industrial efforts, stakeholders have concerns about potential adverse environmental consequences and local community impacts. Such projects also require significant upfront capital investment. While the new applications are promising, it's not yet clear how quickly new projects will come online given that they are all still in the preliminary permitting stage. Eleven preliminary applications, representing nearly 11 GW of installed capability, have been filed at FERC in calendar 2019.

Figure 5 – Pumped Hydropower Early Permitting Applications at the FERC



Source: ClearView Energy Partners LLC, using FERC data

Natural gas assets can also fill in long-term supply gaps such as supporting hydropower-dependent areas particularly in the event of multi-year drought. Many hydropower resources lack pumped storage capability and are dependent on winter precipitation to refill their reservoirs.

Wind energy growth has challenged system operators in the Midwest in a different way. For example, wind production meets an average of 25% of daily power needs in the Southwest Power Pool (SPP). Wind served 48% of load on the morning of December 20, 2018. Twenty-four hours later, wind's contribution at the same time of day had eased to 17% of load, and the difference was accommodated with a doubling of natural gas generation and a 60% increase in coal-fired dispatch. Minimum wind output over the last 12 months in the SPP territory clocks in at 148 MW (August 2018) compared to a high of 16.5 GW on May 19. The maximum one-hour ramp (increase) observed to date is 3.7 GW, and the largest swing in production was a drop of 14.8 GW over 18 hours).

SPP has a significant number of new wind projects in its queue. These high penetration regions illustrate that operational challenges are likely to remain as renewables expand their participation in the organized regional markets. Balancing significant changes to wind loads currently is met by dispatchable natural gas (and other resources, including coal) while other options are developed and become more affordable.

CONSIDERING AFFORDABILITY

Last week, former New York City Mayor Michael Bloomberg announced a $500 MM commitment to advocate for the closure of the nation's remaining coal plants by 2030 and to work to prevent construction of new natural gas plants in an effort to address climate change on a shorter timeline envisioned by most existing state programs (and the judicially stayed *Clean Power Plan*).

We built a cursory estimate of hardware costs required to replace 1.15 TWh of electricity provided by coal facilities in 2018. This simplified *pro forma* estimate considered only power plant substitution (i.e., exclusive of financing, transmission interconnection, etc., but inclusive of storage capability for solar and wind). We also did not account for residual asset values assigned to retired fleet. Assuming equal-shares of wind, solar, and biomass, with storage to complement wind and solar (but not biomass) at 4Wh/W, our back-of-the-envelope estimate implies that plant facilities alone—at today's prices—could require as much as $941 B in capital expenditures.

Policymakers here at the federal level and in the states are cognizant of the impact higher electricity rates can have on consumers, whether individuals or businesses. In our analytical work, our Firm sometimes frames energy security in three dimensions: adequacy, attributes and affordability. Our experience is that affordability can be a real-world constraint when it comes to policy formulation. Put another way, focusing on attributes to the exclusion of affordability can undermine security. Natural gas may still have a key role to play as the nation deploys an increasing number of low-emitting resources in our portfolio.

Our annual *Energy Policy by the Numbers* report, due to be released this month, estimates state-level, average gasoline, home heating and electricity expenses as a percentage of *per capita* disposable personal income (DPI), a proprietary statistic we call "consumer energy leverage" (CEL). In preparing our CEL estimates, we rely on EIA's state-level, residential retail electricity rate data.

Applying those data to this discussion, we looked at the potential impact of increasing electricity rates through the addition of a $0.01/kilowatt hour (kWh) sur-

charge on our estimated average residential bill for each state. A surcharge of this sort might notionally be used to fund the replacement of existing generation assets such as the plan proposed by former Mayor Bloomberg. Our analysis shows that this uniform charge has disparate rate impacts (bill increases of 3–11%), given differences in the underlying cost of power in each state and differences in average consumption, as we illustrate in Figure 6. In other words, a uniform surcharge could exert disparate economic impacts on different regions.

Taking advantage of the geographic diversity here on this Committee, I also included data summarizing the resources and technologies that comprise the power generation mixes in each of your home states (Figures 7–17).

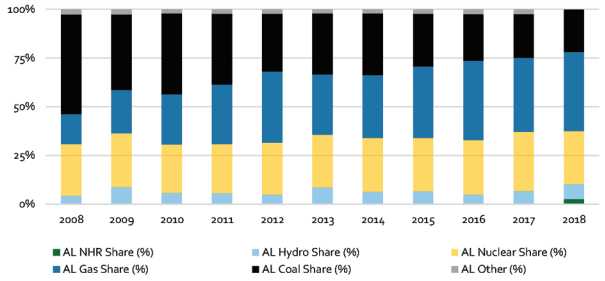
Madam Chair, this concludes my written testimony. I look forward to any questions you or your colleagues might have at the appropriate time.

Figure 6 – Key Residential Rate Statistics 2018

State	Average Usage kWh/Mo	Average Rate/ kWh	Average Monthly Bill	Average Disposable Personal Income	Impact of $0.01/kWh charge on Electric Bill (Hypothetical)
AK	1,230	$0.22	$127	$54,951	4.52%
AL	1,144	$0.12	$151	$38,369	8.13%
AR	1,034	$0.10	$112	$38,540	10.21%
AZ	545	$0.13	$132	$39,345	7.83%
CA	693	$0.19	$102	$53,944	5.33%
CO	724	$0.12	$84	$49,801	8.26%
CT	787	$0.21	$154	$63,893	4.70%
DC	980	$0.13	$102	$70,045	7.74%
DE	1,104	$0.13	$125	$45,786	7.86%
FL	1,139	$0.12	$129	$44,609	8.59%
GA	518	$0.11	$129	$40,870	8.83%
HI	867	$0.32	$168	$48,905	3.08%
IA	942	$0.13	$110	$43,770	7.88%
ID	744	$0.10	$96	$38,826	9.78%
IL	993	$0.13	$94	$50,157	7.93%
IN	923	$0.12	$120	$41,915	8.29%
KS	1,156	$0.13	$121	$45,171	7.63%
KY	1,283	$0.10	$121	$37,441	9.53%
LA	607	$0.09	$120	$41,487	10.72%
MA	1,003	$0.22	$131	$59,681	4.63%
MD	551	$0.13	$134	$54,780	7.49%
ME	664	$0.16	$89	$43,291	6.20%
MI	774	$0.16	$103	$42,202	6.43%
MN	1,099	$0.13	$104	$48,858	7.46%
MO	1,237	$0.11	$121	$41,589	9.05%
MS	836	$0.11	$140	$34,949	8.81%
MT	1,117	$0.11	$94	$42,341	8.89%
NC	1,106	$0.11	$127	$40,779	8.83%
ND	1,005	$0.11	$117	$49,056	9.42%
NE	620	$0.11	$109	$46,879	9.21%
NH	690	$0.20	$122	$55,165	5.08%
NJ	640	$0.15	$107	$58,760	6.46%
NM	958	$0.13	$81	$37,655	7.88%
NV	603	$0.12	$115	$43,102	8.33%
NY	910	$0.18	$111	$58,256	5.41%
OH	1,133	$0.12	$113	$43,093	8.09%
OK	905	$0.10	$116	$42,011	9.74%
OR	863	$0.11	$99	$43,460	9.12%
PA	589	$0.14	$120	$49,042	7.16%
RI	1,162	$0.21	$122	$48,577	4.83%
SC	1,017	$0.12	$145	$38,487	8.03%
SD	1,280	$0.12	$119	$45,731	8.53%
TN	1,182	$0.11	$137	$43,218	9.33%
TX	739	$0.11	$135	$44,720	8.76%
UT	1,157	$0.11	$78	$40,291	9.52%
VA	560	$0.12	$137	$49,886	8.45%
VT	965	$0.18	$101	$48,206	5.55%
WA	686	$0.10	$93	$54,103	10.36%
WI	1,132	$0.14	$99	$44,953	6.91%
WV	831	$0.11	$128	$36,805	8.85%
WY	1,230	$0.11	$95	$54,657	8.74%
Range	**518-1,283**	**$0.09-0.32**	**$77-168**		**3.08-10.72%**
Median	**923**	**$0.12**	**$119**		**8.13%**
Average	**902**	**$0.14**	**$116**		**7.81%**

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

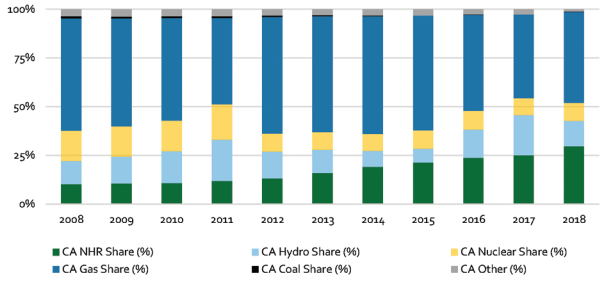
Figure 7 – Generation Mix 2008-2018, Alabama



Key Data (Residential)	
Avg. $/kWh (2018)	$0.12
Avg. kWh/Month (2018)	1,230
Avg. monthly bill (2018)	$151.24
Impact of $0.01/kWh charge	8.13%
Avg. *per capita* DPI (2018)	$38,369

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

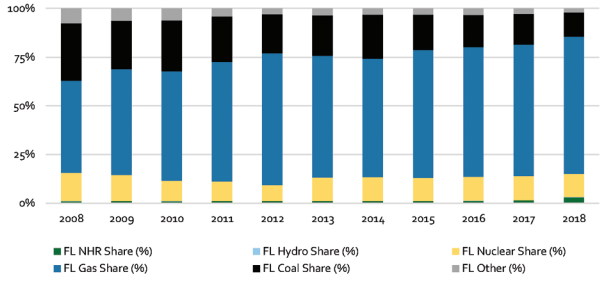
Figure 8 – Generation Mix 2008-2018, California



Key Data (Residential)	
Avg. $/kWh (2018)	$0.19
Avg. kWh/Month (2018)	545
Avg. monthly bill (2018)	$102.30
Impact of $0.01/kWh charge	5.33%
Avg. *per capita* DPI (2018)	$53,944

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

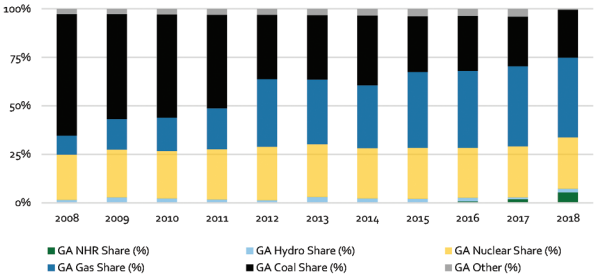
Figure 9 – Generation Mix 2008-2018, Florida



Key Data (Residential)	
Avg. $/kWh (2018)	$0.12
Avg. kWh/Month (2018)	1,104
Avg. monthly bill (2018)	$128.61
Impact of $0.01/kWh charge	8.59%
Avg. *per capita* DPI (2018)	$44,609

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

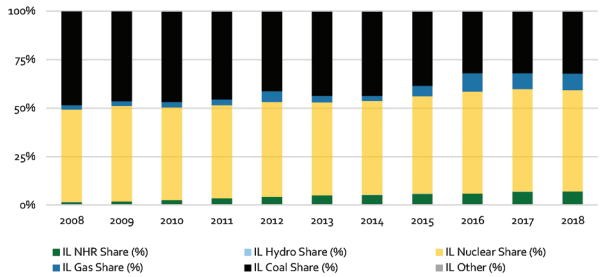
Figure 10 – Generation Mix 2008-2018, Georgia



Key Data (Residential)	
Avg. $/kWh (2018)	$0.11
Avg. kWh/Month (2018)	1,139
Avg. monthly bill (2018)	$128.94
Impact of $0.01/kWh charge	8.83%
Avg. *per capita* DPI (2018)	$40,870

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

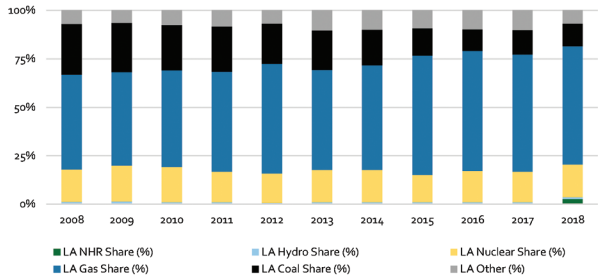
Figure 11 – Generation Mix 2008-2018, Illinois



Key Data (Residential)	
Avg. $/kWh (2018)	$0.13
Avg. kWh/Month (2018)	744
Avg. monthly bill (2018)	$93.78
Impact of $0.01/kWh charge	7.93%
Avg. *per capita* DPI (2018)	$50,157

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

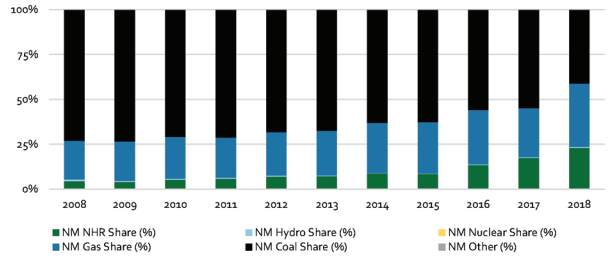
Figure 12 – Generation Mix 2008-2018, Louisiana



Key Data (Residential)	
Avg. $/kWh (2018)	$0.09
Avg. kWh/Month (2018)	1,283
Avg. monthly bill (2018)	$119.70
Impact of $0.01/kWh charge	10.72%
Avg. *per capita* DPI (2018)	$41,487

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

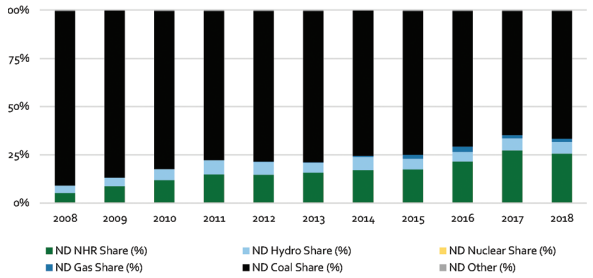
Figure 13 – Generation Mix 2008-2018, New Mexico



KEY DATA (RESIDENTIAL)	
Avg. $/kWh (2018)	$0.13
Avg. kWh/Month (2018)	640
Avg. monthly bill (2018)	$81.20
Impact of $0.01/kWh charge	7.88%
Avg. *per capita* DPI (2018)	$37,655

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

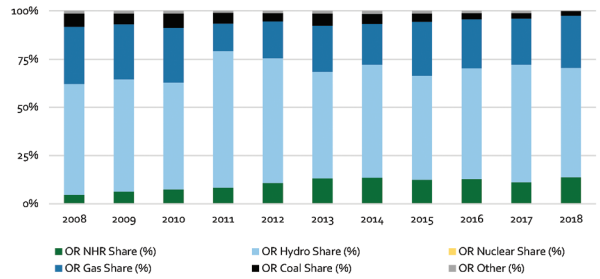
Figure 14 – Generation Mix 2008-2018, North Dakota



KEY DATA (RESIDENTIAL)	
Avg. $/kWh (2018)	$0.11
Avg. kWh/Month (2018)	1,106
Avg. monthly bill (2018)	$117.47
Impact of $0.01/kWh charge	9.42%
Avg. *per capita* DPI (2018)	$49,056

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

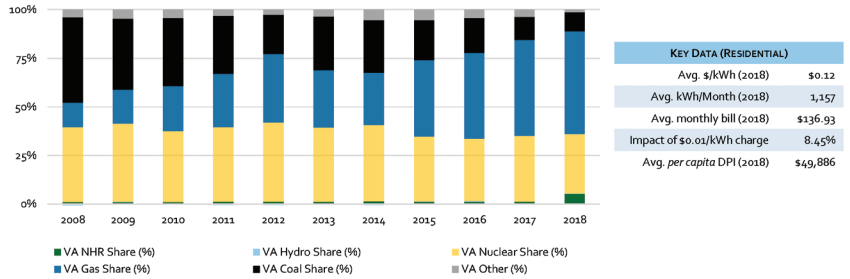
Figure 15 – Generation Mix 2008-2018, Oregon



KEY DATA (RESIDENTIAL)	
Avg. $/kWh (2018)	$0.11
Avg. kWh/Month (2018)	905
Avg. monthly bill (2018)	$99.20
Impact of $0.01/kWh charge	9.12%
Avg. *per capita* DPI (2018)	$43,460

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

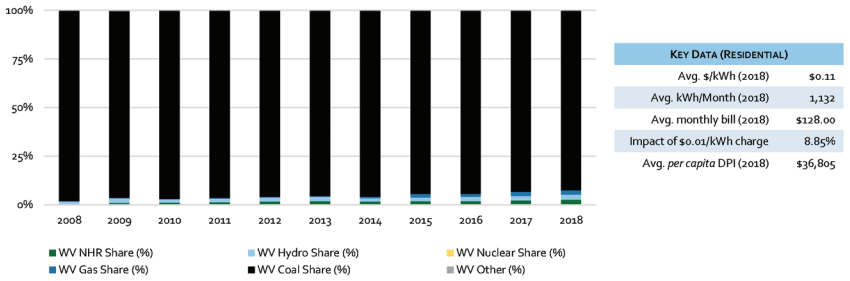
Figure 16 – Generation Mix 2008-2018, Virginia



Key Data (Residential)	
Avg. $/kWh (2018)	$0.12
Avg. kWh/Month (2018)	1,157
Avg. monthly bill (2018)	$136.93
Impact of $0.01/kWh charge	8.45%
Avg. *per capita* DPI (2018)	$49,886

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

Figure 17 – Generation Mix 2008-2018, West Virginia



Key Data (Residential)	
Avg. $/kWh (2018)	$0.11
Avg. kWh/Month (2018)	1,132
Avg. monthly bill (2018)	$128.00
Impact of $0.01/kWh charge	8.85%
Avg. *per capita* DPI (2018)	$36,805

Source: ClearView Energy Partners, LLC, using BEA, Census Bureau and EIA data

Ms. CASTOR. Thank you very much.

Ms. Hamilton, you are recognized for 5 minutes.

STATEMENT OF KATHERINE HAMILTON

Ms. HAMILTON. Good morning. My name is Katherine Hamilton, and I am the chair of the firm 38 North Solutions and the nonprofit Project on Clean Energy and Innovation.

Thank you to Chairwoman Castor, Ranking Member Graves, and the entire Select Committee for inviting me to testify before you today.

You have heard from the solar and wind industries, and I would offer that other renewable resources—hydropower, geothermal, ocean and tidal, and biomass—should also be considered part of the equation to provide clean energy.

Today I am here to talk to you about the flexible technologies and applications that will connect all of these resources, getting more value out of every kilowatt hour we generate, while allowing us to fully reach 100 percent clean energy deployment and enabling all Americans to benefit from this energy transition.

I started my career designing grids for a utility, an experience that taught me how our grid works and that more than generation and wires are needed to make it function at its full capacity.

In the decades since that time, innovation that has originally been limited to the utility has been democratized such that entrepreneurs throughout this country have developed technologies that change the way we participate in the electric grid. We now need

all of these technologies to work together to mitigate climate change. And the good news is that we have most of those today.

On the transmission side, flexible grid technologies, such as phaser measurement units, dynamic line ratings, capacitor banks, and volt/VAR optimization, allow for more efficient and effective sensing control and management of the power flowing through our transmission lines. Even broadband, to which many of our rural communities still do not have access, can serve as an enabler for renewable energy and energy efficiency technologies.

Grid scale storage, from batteries to flywheels to pumped hydro, enable renewable energy to be stored preventing overbuilding of these resources and allowing them to function as baseload generation.

Within the decade, we will see long-duration chemical storage plants able to drop into the footprint of and replace coal and gas fleets with inexpensive, nontoxic, and nonemitting grid scale solutions.

On the customer side, consumers from industrial plants to commercial businesses to homeowners can choose what kind of energy they consume while controlling their costs. Flexible distributed energy resources such as demand response, energy efficiencies, smart inverters, batteries, thermal storage, fuel cells, combined heat and power, microgrids, electric vehicles, and geothermal heat pumps, there are a lot of them, can all contribute to the customer not just being a load on the system but becoming part of resource, allowing the supply and demand sides to become interchangeable.

In other words, while we think of grid-side resources as being the only source of generation, customer resources can also provide electricity to themselves, to each other, and to the greater grid.

In addition to integrating renewables and providing more choices, these technologies save customers on their bills and enable a more resilient system.

But turning now to the policies that will allow these flexible resources to do their job and make the grid 100 percent clean.

Abby and Tom talked about tax credits, and it is extremely important that we enable energy storage to take advantage of a tax credit separate and apart from other generation sources. Financial instruments, like bonds or a green bank, will be important for directing capital toward clean energy investment, funding low carbon infrastructure projects, supporting community development, and providing a path like securitization to retire coal plants.

For lower-income communities, grants in lieu of tax credits and raising the cap on weatherization funds to install solar and other distributed resources could provide a financial means for these customers to access clean energy.

A Federal clean energy standard that allows flexible resources to participate and receive credit for integrating renewables would not only allow for full implementation of renewables but also would create economic benefits, enabling participation by customers of all types.

Research and development continues to be important, not only to test and demonstrate new technologies, but also to support modelling, analysis, planning, and technical assistance to regulators, utilities, customers, and solutions providers.

It is crucial that our Federal Energy Regulatory Commission issue a final rule on the distributed energy resource rulemaking to give these resources access to competitive markets.

Federal policy does not have to conflict with State goals, and in many cases distributed energy resources can provide services to both the utility on a local level while also delivering valuable services to the wholesale market.

Finally, and perhaps most importantly, we need to be thoughtful in designing our energy transition, ensuring that workers and the communities in which they live, and on whose shoulders our industrialized Nation was built, are taken into consideration.

My purpose here has not been to debate whether we can or cannot get to 100 percent, but instead to raise the possibility that we have the tools to do so and that by deploying flexible resources throughout the grid, we can fully integrate renewable energy.

Whether we combine demand response with wind turbines or energy storage with solar power, or whether we give consumers the ability to manage and use their electricity as they see fit, it is all part of the electricity system that can and should be 100 percent emission free.

Thank you for your interest in climate change solutions and the opportunity to present this testimony.

[The statement of Ms. Hamilton follows:]

Testimony of Katherine Hamilton before the House of Representatives Select Committee on the Climate Crisis, June 13, 2019

Good morning. My name is Katherine Hamilton. I am the Chair of the firm 38 North Solutions and the non-profit Project on Clean Energy and Innovation. Thank you to the Chair, Ranking Member, and the entire Select Committee for inviting me to testify before you today regarding the deployment of renewable energy in the United States.

Whether your goal is to mitigate climate change, increase resilience, improve the economy, or lower consumer costs, clean and renewable energy resources provide those solutions. You have heard from the solar and wind industries and I would note that other renewable resources—hydropower, geothermal, ocean and tidal, and biomass—should also be considered part of the equation to provide clean generation sources.

Today I am here to talk about the flexible technologies and applications that will connect all of these resources, getting more value out of every kilowatt-hour we generate, while allowing us to fully reach 100% clean energy deployment and enabling all Americans to benefit from this energy transition. I started my career with a decade designing grids for a utility, was a Certified Energy Manager and directed energy and water efficiency programs at the National Renewable Energy Laboratory, and later ran the GridWise Alliance, focused on deploying smart grid technologies. Those experiences taught me how our grid works and that more than generation sources and wires are needed to make it function at its full capacity. During those same decades, innovation that had originally been limited to the utility has been democratized such that entrepreneurs throughout this country have developed new technologies and applications that can change the way we participate in the electric grid. We now need all of these technologies to work together to mitigate climate change, and the good news is that we have most of those technologies today.

Let us look first on the grid side of the system. Flexible grid technologies such as phaser measurement units, dynamic line ratings, capacitor banks, and Volt/VAR Optimization allow for more efficient and effective sensing, control, and management of the power flowing through our transmission lines. Even broadband, to which many of our rural communities still do not have access, can serve as an enabler for renewable energy and other energy technologies. Grid scale energy storage—from batteries of all chemistries, to flywheels, to flow batteries and longer duration pumped hydro and chemical storage—will enable the storage of vast quantities of renewable energy generation, preventing overbuilding these resources and

essentially allowing them to function as what we think of as "baseload" generation. Already, energy storage batteries have been installed to replace natural gas peaker plants in California,[1] proving the cost-effectiveness of a technology that produces no greenhouse gases. Within the decade we will see long duration chemical storage plants able to drop into the footprint of and replace entire coal and gas fleets with inexpensive, non-toxic, and non-emitting grid scale solutions.

On the customer side of the meter, consumers—from industrial plants to commercial businesses to homeowners—can choose the type of energy they consume while controlling their costs. Flexible distributed energy resources such as demand response, energy efficiency, smart inverters, batteries, thermal storage (from hot water heaters, for example), fuel cells, combined heat and power, microgrids, electric vehicles, and geothermal heat pumps can all contribute to the customer not just being a load on the system, but actually becoming part of the resource, allowing the supply and demand sides to become interchangeable. In other words, while we think of grid side resources as being the only source of generation, customer resources—whether by reducing demand or by actually generating energy—can also provide electricity to themselves, each other, and the greater grid.

These flexible resources on both the grid side and the consumer side of the system can be seen as "Non-Wires Alternatives," meaning that they can be installed to defer capital outlay of new lines and substations, saving utility investment and in turn customers money on their bills.[2] For example, in the Brooklyn-Queens Demand Management project, the utility, ConEdison avoided a $1.2 B substation upgrade by deploying demand response, energy efficiency, and distributed resources.[3] On the transmission side, under FERC Order 1000, in the transmission planning process, flexible technologies that can avoid build-out of transmission should be considered.[4]

Customers have seen tremendous economic benefits from flexible demand-side resources. On the PJM grid in the mid-Atlantic, customers collectively saved $11.8 billion in one year alone through demand response.[5] In another example, in its Distributed Energy Resource Roadmap, the New York Independent System Operator stated it "believes that providing resources with the flexibility to meet wholesale and distribution system needs will deliver the maximum benefit to New York electricity consumers."[6] Baltimore Gas and Electric's SmartEnergy Rewards program, in which Maryland customers lowered their energy usage in response to signals from the utility, is estimated to have avoided $93 million in transmission capital expenditures and $72 million in distribution capital expenditures—savings that are then passed along to the customers.[7]

Resilience is a key component of a flexible clean energy future. The ability to fail fast, and then recover fast, is particularly suited to distributed energy resources. As far back as Hurricane Sandy, microgrids in New York and New Jersey enabled university campus facilities to continue operation in the face of massive power outages.[8] When hurricanes hit Texas, Florida and North Carolina, distributed solar and demand response were able to stabilize the grid and prevent surges when power was restored. During heat waves in California, hundreds of energy storage facilities at office buildings in San Francisco were called to operate collectively as a "virtual power plant," reducing demand on an over-taxed grid. During the solar eclipse in 2017, over 750,000 programmable thermostats were lowered by their consumers to reduce demand by 700 MW as solar systems across the country were displaced in the temporary darkness.[9] Those thermostats alone provided as much grid service as seven gas peaker plants, often the most inefficient and emitting resources. Given the start of wildfire season in California and the calling of public safety outages,

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[1] Article on peaker plant replacement projects can be found here: https://www.utilitydive.com/news/storage-will-replace-3-california-gas-plants-as-pge-nabs-approval-for-worl/541870/.

[2] A collection of case studies of Non-Wires Alternatives projects can be found here: https://e4thefuture.org/wp-content/uploads/2018/11/2018 Non-Wires-Alternatives-Report_FINAL.pdf.

[3] Article about BQDM program can be found here: https://www.utilitydive.com/news/despite-failures-coned-targets-more-energy-savings-from-non-wires-pioneer/547725/.

[4] Summary of Order 100 can be found here: https://www.ferc.gov/industries/electric/indus-act/trans-plan.asp.

[5] Link to PJM Market Monitor report can be found here: https://aem-alliance.org/aema-reacts-strongly-market-monitor-report/.

[6] "DER Energy Market Design: Dual Participation". New York Independent System Operator, Feb 2018, 2019. https://www.nyiso.com/documents/20142/5256593/DER%20Energy%20Market%20Design%20Dual%20Participation%20022819.pdf/cfaf3647-4b77-a706-b86d-24129d460ecf.

[7] Report on this program can be found here: https://www.utilitydive.com/news/behavioral-demand-response-gives-baltimore-gas-and-electric-a-business-reas/546895/.

[8] Article on Princeton's microgrid can be found here: https://www.princeton.edu/news/2014/10/23/two-years-after-hurricane-sandy-recognition-princetons-microgrid-still-surges.

[9] See blog from Nest thermostats: https://nest.com/blog/2017/08/10/solar-eclipse-meet-the-nest-thermostat/.

microgrids and other distributed resources will only become more important. Flexible distributed energy resources have proven to provide resilience when the grid needs it the most.

Now the question becomes, what can Congress do to support these flexible technologies? We know from experience that tax policies like the Investment Tax Credit and Production Tax credit have been instrumental in deploying solar and wind energy, bringing down costs through scale and allowing more consumers to have access to these resources. In the same manner, clarifying the tax code such that energy storage can have access to the Investment Tax Credit will be important to driving down the cost of energy storage of all types, opening up new markets in dozens of states and offsetting the cost of deployment in states like California, New York, Massachusetts, and New Jersey that already have energy storage targets in place.

In addition to tax policy, financial instruments will be important to providing certainty and driving investment in U.S. grid innovation. Those tools could include a federally-managed financial institution like a Green Bank to provide capital for low carbon infrastructure projects, supporting community development and providing a path like securitization to retire coal plants.[10] Public-private partnerships and cost-sharing, originally required with the Recovery Act grants, defrayed the cost of advanced metering and other smart grid technologies to utilities and their consumers. Grants in lieu of tax credits and raising the cap on Weatherization funds to install solar and other distributed resources, could provide financial means for lower income customers to access clean energy.

Goals for deployment of clean energy, such as with Renewable Portfolio Standards and Clean Energy Standards, have been implemented in 29 states, three territories, and the District of Columbia and have spurred development of renewable energy.[11] States like New Mexico, Nevada, California, and Washington; mayors of 216 cities as diverse as Madison, Wisconsin, Salt Lake City, Utah, and Orlando, Florida; utilities like Xcel, Idaho Power and Green Mountain Power; and corporations[12] like Bank of America, Anhueser-Busch, and Walmart, have all made commitments to transition to 100% clean energy. Based on the Sierra Club's Ready for 100 campaign, one in five Americans lives in a community that has committed to 100% clean energy.[13] Targets for energy storage in states like California have created tangible economic opportunities—over 200 companies doing business in the state—supporting good union jobs while lowering consumer bills from demand charges. A federal clean energy standard that allows flexible resources, such as energy storage and demand response, to participate and receive credit for integrating renewables, will not only allow for full implementation of renewables, but also will create economic benefits and enable participation by customers of all types.

Research and development programs at the Department of Energy ("DOE") and other federal agencies have been crucial to developing renewable energy technologies. In my seven years at the National Renewable Energy Laboratory, I worked with scientists and engineers developing new chemistries and technologies, and then testing them in partnership with innovators in the private sector. Programs like ARPA–E have asked questions about big problems and supported start-ups with solutions to these problems.[14] The DOE Offices of Electricity and Energy Efficiency and Renewable Energy and the national laboratories still play an important role in testing and demonstrating new flexible grid technologies. In addition to basic research and development, our federal government has a role in programs that are cross-cutting and that support modeling, analysis, planning, and technical assistance to regulators, utilities, and solutions providers. "Soft" costs like interconnection and permitting continue to be barriers and increase the cost of integrating clean energy resources; the DOE can be instrumental in providing assistance in those areas.

The federal government is the nation's largest landlord and should be positioned to lead by example in the energy transition. Ensuring that the government's own facilities are deploying flexible resources will increase their resilience to both natural disaster and physical threat. The Federal Energy Management Program at DOE serves an important role in developing best practices for federal buildings and

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[10] In Colorado, a bill was introduced in the state legislature to securitize the closure of coal plants with a bond mechanism: https://leg.colorado.gov/bills/hb19-1037.

[11] Map of states with RPS goals can be found here: http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2018/10/Renewable-Portfolio-Standards-2018.pdf.

[12] Corporations with 100% renewable energy commitments can be found here: http://there100.org/companies.

[13] Ready for 100 website with list of mayors can be found here: https://www.sierraclub.org/ready-for-100.

[14] Testimony before Congress on success of ARPA–E can be found here: https://science.house.gov/imo/media/doc/Testimony%20to%20Subcommittee%20on%20Energy_Williams.pdf.

partnering with agencies, utilities, and the private sector to deploy clean energy projects. The Department of Defense has several initiatives, including the Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP),[15] that test technologies that will allow their permanent bases as well as those in the field to become more efficient, secure, and clean. All of these programs should be supported to increase clean energy penetration while reducing emissions at sites.

The electric grid—whether from the transmission level or on the customer side—is part of our nation's physical and economic infrastructure. Access to electricity is considered a right of the citizens of the U.S. and it should be considered of national interest to implement policies supporting the efficient, cost-effective, safe, equitable, and clean build-out and use of the electric grid. Broadband for all consumers should be a priority; Internet access allows consumers to fully participate in renewable and all of these flexible distributed resources. In addition to consumers needing information to understand and control basic energy use, solar installers also prefer to monitor systems via internet and automatic demand response cannot operate without an on-line connection. Standards and codes are also critical to moving industry forward, providing a baseline of certainty and best practices for innovative and efficient products and solutions, while lowering the cost of those products for consumers.

It is crucial that our Federal Energy Regulatory Commission ("FERC") issue a final rule on the Distributed Energy Resource rulemaking to give flexible resources access to competitive markets. Over the past decade, Orders on demand response (Order 745) and energy storage (Orders 755, 784 and 841) have allowed resources that provide specific services to the grid to be paid for those services. In the case of demand response, states like Pennsylvania and Maryland have been able to aggregate consumer load, offsetting the cost of peak power while allowing consumers to directly benefit from lower prices. These state-based programs do not have to conflict with federal policy; in many cases distributed energy resources can provide services to both the utility on a local level, while also delivering other or similar services to the wholesale market. All of those flexible services should receive appropriate compensation, no matter what part of the grid they serve.

Finally, and perhaps most importantly, we will need to be thoughtful in designing our energy transition, ensuring that workers and the communities in which they live that were built around mines and other fossil fuel facilities—and on whose shoulders our industrialized nation was built—are taken into consideration. These talented and motivated people of all ages and skill sets should be brought into the future of our electricity grid with training programs and access to these technologies.

For nearly a decade, the National Renewable Energy Laboratory has been working collaboratively with other laboratories, universities, industry, and non-governmental entities on the Renewable Electricity Future Study to analyze high penetration of renewable energy on the U.S. electric grid.[16] In those publications, flexible resources such as those I have been discussing are seen as key to getting close to 100% renewables. My purpose here has not been to debate whether we can or cannot get to 100%, but to instead raise the possibility that we have the tools to do so and that by deploying those flexible resources throughout the grid, we can fully integrate renewable energy. Whether we combine demand response with wind turbines or energy storage with solar power, or whether we give consumers the ability to manage and use their electricity as they see fit—it is all part of the electricity system that can and should be 100% emission free.

As my friend and colleague Jigar Shah wrote in his book, *Creating Climate Wealth*, climate change solutions pose the greatest wealth creation opportunity of our time.[17] By setting public policies that incentivize both renewables as well as all the flexible resources that connect those resources throughout the grid, we will be able to use U.S. innovation to become 100% clean, manage our costs, allow for consumer choice, increase resilience in the face of natural disaster—all while providing certainty and stimulating economic growth for all. I am an eternal optimist, but I fully believe that with smart policy and political will, our nation has the ingenuity to make that transition.

Thank you for your interest in climate change solutions and in the opportunity to present this testimony. I look forward to your questions.

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[15] For more on these programs, see: https://www.serdp-estcp.org.

[16] See more on the RE Futures Study and subsequent papers here: https://www.nrel.gov/analysis/re-futures.html.

[17] Shah, Jigar, *Creating Climate Wealth: Unlocking the Impact Economy*, ICOSA Publishing, 2013.

Ms. CASTOR. Well, thank you all very much. Your testimony was compelling. So I know the committee is going to have a lot of terrific questions for you.

So I will recognize myself for 5 minutes to start the questioning.

Modernizing and cleaning up the electricity grid by deploying more renewables is important for a whole host of reasons. The top two that come to mind first, the energy sector, the electricity sector, even though emissions have fallen somewhat, remains a significant part of the U.S. carbon pollution problem.

And then when you turn to the transportation sector, industrial sector, we are going to have to electrify those industries that currently rely on burning fossil fuels. Electrification will be a more potent climate solution with a cleaner, more efficient grid.

Ms. Hamilton, in your testimony you just shared with us, you described the potential benefits of flexible grid technologies and distributed energy sources. How can these flexible technologies lead to potential benefits for all of us in the United States? How can we achieve our renewable goals on a faster timeline?

Ms. HAMILTON. Thank you for the question.

It is a really important question, because part of this is about how do we really engage consumers in part of the solution and give them a path forward on that. And I think that is all part of the equation.

And as I said before, this is about allowing the supply and demand side to work together and independently. That is going to require a lot of planning. It is going to require tools that allow us to manage these systems. But what it will do for customers, it will lower their costs and it will allow for greater resilience, because it will allow for technologies that will, while failing fast, will also be able to recover fast.

Ms. CASTOR. Mr. Kiernan, I think I saw you nodding your head when—when Ms. Hamilton said that the ITC has to include energy storage. So talk to us about that. You agree with that? And explain your position.

Mr. KIERNAN. Yes, we do agree with that. There is a bill, I believe in both chambers, the House and the Senate, supporting a storage ITC. AWEA is supportive of that. We do believe that wind, solar, and storage and natural gas can work very, very effectively together. We do think storage costs have come down dramatically. But it would benefit by a tax credit that would further stimulate cost reductions and deployment of storage, whether on the grid or with particular projects, particular solar or wind projects or all of the above. But storage is very much part of the solution, and ITC would help deploy it.

Ms. CASTOR. So wind energy is growing by leaps and bounds now. But with the storage piece, you could accelerate deployment and cleaner electricity across the country?

Mr. KIERNAN. Absolutely. And I would add with transmission. Yes, we need to storage on the grid, and we absolutely need additional transmission, because it is transmission that allows you to get clean wind energy or clean solar from where it is generated to load. Storage is part of the answer; transmission is the other very big part of the answer.

As I said earlier, our current grid is a D-plus. We have got to get better if we are going to have an economy of the future.

Ms. CASTOR. So, Ms. Hamilton, battery storage is a big part of this as well. Everyone knows that we have got to do better.

How would you prioritize R&D in battery storage and leverage public/private partnerships here?

Ms. HAMILTON. All right so there are a couple of ways. One is to continue on basic R&D for new technologies, new chemistries. So ARPA-E is looking at long-duration storage, for example.

Another piece is some of the issues around the cost of storage are interconnection and permitting. And those are costly. They are called soft costs. And being able to have some assistance on that from the Department of Energy would be incredible. As I had mentioned before, also modeling and analysis.

But I think throughout the system, whether it is from basic R&D, all the way to really providing tools to energy storage and other developers to lower the costs of permitting an interconnection will be really valuable.

Ms. CASTOR. And then how do we build in the growing clean energy workforce, whether it is training initiatives that create good jobs all across the country, but especially in parts of the country that will need those good family-sustaining jobs?

Ms. HAMILTON. Yeah, absolutely. That is a super important question, because there are a lot of parts of this country right now that have not been able to take advantage of the energy transition. And so we have to think about how to build capacity very locally, to ensure that we are all able to participate, whether it is in Appalachia, where I am from, or whether it is in other parts of the country.

We have to think—and it doesn't necessarily mean you convert everybody to a solar job. That may not be the skill set. It may be some other type of job. But I do believe that we can do that. We just have to be very purposeful about the way we do it.

Ms. CASTOR. Okay. Thank you very much.

I recognize the ranking member now for 5 minutes.

Mr. GRAVES. Thank you, Madam Chair.

I think we are going to go to Mr. Armstrong first.

Mr. ARMSTRONG. Thank you, Madam Chair.

And I appreciate everybody particularly talking—Ms. Hamilton in talking about permitting and how we deal with this. And I think that is something that runs industrywide, whether dealing with all of those issues and fast-tracking this.

My question—and I also appreciate the conversation about storage. And one of the reasons I think that is important and we have to have this conversation.

So—and I am from North Dakota. We do—we have a tremendous wind energy. We actually just permitted our first solar panels—I don't know—solar farm? Solar farm. And so we are excited about that, too.

But earlier this year, I had the opportunity to go on the USS *North Dakota*, which is a *Virginia*-class sub. And *Virginia*-class subs require over about 9,000 pounds of rare-earth metals. And as we have this conversation and we are moving forward, one of things I think we have to talk about is the national security interests that are involved in how we produce this energy and the fact

that the United States is essentially 100 percent reliant on importing rare-earth metals. I think at this point in time—well, Interior has found that we are 100 percent net importer of over 20 critical rare-earth metals.

And rare-earth metals are limited to a few countries. There is some—obviously some of the world's biggest polluters are where we import this stuff from, not to mention some human rights issues. And, I mean, when we are participating in a global economy, these are important.

But, you know, Mountain Pass is, I think, the only place we have in the United States right now that does that. And it is actually a consortium that is owned particularly by Chinese importers, and we actually ship about 50,000 tons of the rare-earth concentrate to China each year for processing.

So when we are having this conversation, we are talking about grid, we are talking about batteries, we are talking about all of this. Are we also including in that conversation seriously talking about creating a situation where we are not so dependent on other countries?

I mean, you mentioned tariffs in your opening testimony, about increasing the cost on producing solar. Are we having a conversation about making sure that we are, I mean, dealing with these issues here? And I mean, how—how are we addressing that?

And I will start over here. Thank you.

Ms. ROSS HOPPER. I am going to assume over here means—because you are looking at me.

Well, thank you for the question. I agree with you wholeheartedly that it is an important piece of the conversation. I would suggest it is not limited, certainly, to renewable technologies, but those rare-earths, right, we use them in so many of our products.

Yes, we are having an honest—I think an honest conversation as we think about what are the elements that are important. And so one of the sort of facts or that—at least in solar, in the solar/photovoltaic market, over 90 percent of the material is silicon, which is the second most abundant resource in the Earth's crust. So we are talking about small amounts.

I know there is legislation—the last time Tom and I testified together, a part of that bill was looking at rare-earths and doing an inventory and sort of understanding what our assets are here, where we get them from, and other places and how do we—how do we sort of increase our thoughtfulness about that.

So that is what I would say.

Do you have an addition?

Mr. KIERNAN. If I could just add, for the wind industry, actually it is a very small percent of wind turbines need rare-earths. It is only what are called direct-drive turbines. And we can get you the number, but it is probably less than 5 percent of the deployed wind turbines in the U.S. are direct-drive, have magnets, and need a small amount of rare-earths. The vast, vast majority are geared and do not use rare-earths. So not an issue, essentially, for wind energy.

Mr. ARMSTRONG. And I am going to let Ms. Hamilton answer, too. But I think the problem with all of this is—is that that might be true, except whether you are moving towards electric cars—I

mean, a Tesla needs 7 pounds of lithium. And when we are dealing with energy storage on the grid and—I agree our grid needs updating, too—batteries are a part of that conversation.

So whether it is a turbine or a battery or a battery in a house for a solar panel, rare-earth metals are a part of that conversation. And we don't produce them here.

So, Ms. Hamilton, you have—you wanted to answer.

Ms. HAMILTON. Yeah, thank you so much for this question. This is a really, really important issue.

And it is rare-earths and also critical materials, all of those platinum group metals, lithium, cobalt, that is often sourced from the Congo that does have terrible practices, human rights practices.

So what we have to do is think holistically. And there is an executive order that just came out with a report on critical materials for the United States and where they are.

A big huge piece of this that we have not thought about yet is recycling. And it can be done. There are six companies around the globe that recycle critical minerals. They recycle lithium and cobalt, yet they are not in the U.S. We need to figure out how to develop policy both to mine in the U.S. but also to develop recycling facilities for rare-earths and critical materials.

Mr. ARMSTRONG. And I just—I think that is a great point, and I agree with that. I just don't think that conversation is happening as fast as the other one is, and we have to be very, very careful not to put ourselves in a situation where—we are energy independent as a Nation right now and create a situation where we are not, while we try and catch up.

So thank you-all for your answers.

Ms. CASTOR. Ms. Bonamici, you are recognized for 5 minutes.

Ms. BONAMICI. Thank you, Chair Castor and Ranking Member Graves. And thank you to the witnesses.

I represent Northwest Oregon. And certainly back at home, but across the country, people are really calling for comprehensive action to address the climate crisis. And I thank Chair Castor and the committee for really talking about a transition to a 100 percent clean energy economy.

And we know the importance of the investment, especially the Federal investments, but the new technologies and the new possibilities are there as well.

Just this week, Representative Deutch from Florida and I introduced the Marine Energy Research and Development Act to accelerate research and development like the work that is being done by Oregon State University in the Pacific Marine Energy Center. They are building a wave energy test facility off the Oregon coast. It is very exciting. But it is—it is also going to rely on—as we have discussed, we need a workforce as well. And as someone who serves on the Education and Labor Committee, that is something that we need to have this conversation along with a transition.

So in Oregon, we are really leading the way to ramp up renewables. Portland General Electric and NextEra Energy just announced their efforts to develop the Nation's largest major renewable energy facility that is going to be integrating wind and solar generation and battery storage in a single location, the Wheat Ridge Renewable Energy Facility. It is going to create and store

safe, low-cost, clean renewable energy to power more than 100,000 homes. Kind of a trifecta—wind, solar and battery storage—to help balance the load, especially—efficiently transfer the energy.

And I know, Mr. Kiernan, you talked about the congestion costs, and I am going to ask you about that.

But also, Ms. Hopper, you talked about a shared clean energy vision in your testimony. So what are the current opportunities and challenges of integrating when you have the solar with wind or battery storage?

Ms. ROSS HOPPER. Thank you for the question.

Yes, we are very aware of that project in Oregon. Congratulations.

Ms. BONAMICI. It is exciting.

Ms. ROSS HOPPER. I think it is exciting. But it is also—it is a proof that the vision is coming to fruition now, right? And so this is—this is not just our clean energy future; it is our clean energy reality, which I find so exciting.

What can we do to help accelerate that clean energy vision? I think what sort of my fellow panelists have talked about, (a), establishing the vision. It can't be understated, the planning that Katherine talked about, to make sure that we are intentional about what we are doing.

I think we have highlighted some Federal policy, so around tax policy, around carbon policy certainly, around regulatory certainty, and predictability that we all share, that challenge both at the Federal level but also at the State level. You talked a little bit about soft costs. Like permitting these projects, whether it is on a roof or in a big field, it is challenging. And so getting clarity around there.

I think for—certainly from the solar perspective, as we think about new construction and we think about the fact that as we are—you know, as we are building homes and new buildings, we should have those equipped for solar already and sort of have that just be—just like you get a front door or a window, you also have solar on your roof. It will bring down the affordability of home ownership if we have that.

Ms. BONAMICI. We actually have in Northwest Oregon a 57-unit affordable housing building that was built to passive house standards in a multifamily dwelling, which is amazing. The costs are very, very low, the energy costs.

Mr. Kiernan, when you talked about the congestion costs, what are the barriers? Is it funding? Do we need more research? How do we address that?

Mr. KIERNAN. It is mostly enabling FERC, empowering or directing FERC, to take the next steps in facilitating more transmission. So I mentioned earlier, one direction that Congress can give to FERC is for more interregional planning.

Right now we have got these different regions—PJM, MISO, SPP—and they do planning independently and at different times, as opposed to doing it at the same time where they can perhaps figure out, oh, actually you have got a resource that can, if we connect our grids over the seams, meet what we need over here.

So, for example, a simple direction from Congress to FERC to do more interregional planning or to give FERC back——

Ms. BONAMICI. Thank you.

Mr. KIERNAN [continuing]. Those are examples that help——

Ms. BONAMICI. Thank you. Perfect. I am going to try to get one more question in to Ms. Hamilton.

But I have to say, Ms. Tezak, I loved all of the data in your testimony. Thank you. Those charts were really helpful.

There is another project up in the Columbia River Gorge. It is a partnership of Federal agencies, industry, academia, National Labs—including the Pacific Northwest National Laboratory—working on the Wind Forecast Improvement Project to improve the caliber of the forecasting, especially in challenging terrain, if there are coastlines, mountains, canyons.

So, Ms. Hamilton, how can assessments of this resource potential help accelerate the deployment of clean energy? What difference would that make to have better forecasting?

Ms. HAMILTON. Forecasting is critical, and it is very locational specific. So there are microsystems. They are not just—you can't just do it from a broad area. You need to really get down to a very localized level. So I think having a National Lab involved and doing resource assessment is critical to making sure that you know exactly what the resource is, when it can be best used and deployed, and then how you are going to go about doing it and bringing the private sector——

Ms. BONAMICI. Do we need additional R&D in that area, or do we just need funding to do it?

Ms. HAMILTON. I think you can still have a program within the Department of Energy, say in the Office of Energy Efficiency and Renewable Energy or the Office of Electricity that could help manage that.

So, yes, you would still—having funding going to the National Labs to help with that is really important. I was at the National Renewable Energy Lab, so I am biased that way, but I still think that is really important.

Ms. BONAMICI. Thank you. And I am out of time.

Thank you, Madam Chair. I yield back.

Ms. CASTOR. Thank you.

Mr. Carter, you are recognized for 5 minutes.

Mr. CARTER. Thank you, Madam Chair.

And thank all of you for being here. A very important subject, and we appreciate your participation.

I want to start with you, Ms. Tezak.

I am from Georgia. And as we say in Georgia, there are two Georgias: There is Atlanta and then there is everywhere else. And it is true. And we have a lot of rural areas.

Now, in your testimony, you told us that—or you stated that renewable energy was growing, but you also said that it was growing unevenly and that it was growing more in the urban areas than it was in the rural areas. And I want to focus on the rural areas, because we have got a lot of rural area in Georgia, a lot of rural area in my district, in South Georgia, in Southeast Georgia.

And I can tell you, I served in the Georgia State Senate for many years. And during my time in the Georgia State Senate, I was one of first ones pushing for solar energy. And I am very proud of the fact that after having gone up against arguably one of the strongest lobbying groups in the State, in Georgia Power and Southern Com-

pany, that they have embraced it and that Georgia is now one of the top 10 States in solar energy in our Nation. And I think that is just phenomenal.

And kudos to Southern Company and Georgia Power for what they have done. They have actually not only—not only embraced solar power and other renewable energy, but even the CEO now, his compensation is tied directly to how much renewable energy they are using. And I just think that is a great step on their part.

But I wanted to ask you, what—this uneven growth that you talk about in renewable energy, particularly in solar energy, is it—is it specific State by State, or is it just rural/urban?

Ms. Tezak. I think it is State by State, and I think in part it is because of the natural resources available.

If you look at the 10-year chart that we put together for Georgia, you can see how the generation mix has shifted away from coal to increased natural gas and the renewables and hydro that have always—hydro, that has always been there, and the renewables that are coming on.

It takes time to make that transition. And one of the things that they have in SPP, for example, in the heartland of the country, is great wind. And that is not as readily available——

Mr. CARTER. Right, right.

Ms. TEZAK [continuing]. In Georgia as it is to——

Mr. CARTER. A lot of hot air down there sometimes, anyway.

Ms. TEZAK. Well, let's not get personal.

But I think that, you know, it—that is a clear illustration of where some of the challenges are. I mean, when you speak about wind energy, you know, you can speak in gigawatts. And, you know, for residential solar, you are talking about kilowatts.

And so, you know, each technology has a key role to play. And when you are talking about distributed load, then residential solar, I think, has a great opportunity to make a difference, as you pointed out.

Mr. CARTER. Right.

Ms. TEZAK. And it also can help the utility manage growth at the ends of the system, and that helps reduce the need for massive transmission investments.

Mr. CARTER. Well I want to mention—I don't mean to interrupt you, but I want to mention one company in particular in our district, Coastal Solar. And they have really found a niche here. In fact, they have—they have really—been able to really go into the rural areas, and particularly to the chicken farmers.

And they have actually—actually got solar panels where they have helped the chicken farmers. And a lot of the farmers there in the rural communities are using this and using it to great advantage. And it has helped us. They are one of the reasons—Coastal Solar is one of the reasons why we are seeing more—seeing Georgia as one of the top 10 States in solar energy. And not only that, they are creating jobs, renewable energy. All of this is just great.

I want to ask you about something else, and that is that Georgia is a number one forestry State in the Nation, biomass. This is something that we are producing a lot of in the first congressional district as well.

It is a big market in the European Union but not so much in America. And I am just wondering why it hasn't caught on more? Because, you know, it essentially is—it is carbon neutral. And not only that, but through sustainable forests, we are replanting these trees, and this is—and obviously trees are helping us in what we are trying to do here.

Any idea why this is something that the European Union uses heavily but we in America don't seem to have adopted it as much?

Ms. TEZAK. Well, anecdotally, I think there has been a bit of concern about the harvesting of mature trees and the change you have from a carbon profile perspective, when you substitute older trees for, you know, new trees and saplings.

And so I think that the——

Mr. CARTER. But you have to do that anyway.

Ms. TEZAK. Right. But I think that there has been an evolution in thought that has biomass more agreeable here in the U.S. than perhaps it was 10 years ago.

The wonderful thing about biomass that makes it competitive as a renewable technology is that it often doesn't need the same level of backup in terms of storage that solar and wind would, because it is a more stable power generation resource.

And so I think that acknowledgment and the carbon neutrality of it is becoming more accepted, but I think that we—there was such a focus 10 years ago on being better than carbon neutral, that I think it took a little while for things to catch up. I mean, we have had an experience where, you know, plastic bags were better than paper bags, and now we don't like plastic bags. So I think that, you know, as we become more informed as a society, we get better—you know, we get better information.

Mr. CARTER. Right. Well, my time is up. But I just want to state for the record, Georgia is doing our part, and I am very proud of that.

Ms. TEZAK. Yes sir you are. I can assure you.

Mr. CARTER. Very proud of our State. Thank you.

Ms. CASTOR. Yeah, Mr. Carter, Georgia may be outperforming the Sunshine State, the State of Florida.

Mr. Levin, you—speaking of renewables, and exceeding everyone's projections, Mr. Levin from California.

Mr. LEVIN. I will get to that. I am going to get to that.

Thank you, Chair Castor. Thank you to our witnesses.

Before coming to Congress, I cofounded a clean energy nonprofit called CleanTech Orange County. Now, it is called Sustain Southern California. And we have grown the clean tech economy in Southern California tens of thousands of jobs in the last decade. And we have put in place a number of policies that have enabled that to be the case, many of which I heard discussed on this panel.

I also have to brag about California for a second, Madam Chair. And with all deference to Georgia and Florida, I encourage everybody to download the Cal ISO app. It is called "ISO Today."

And as of right now, 45 percent of the current demand in California is being served by renewable energy. And of that, 54.1 percent is solar. Good job, 29.1 percent is wind. Good job. So 45 percent right now, currently, is being served by renewables.

And we are the fifth largest economy in the world. And as we have continued to increase the percentage of load being served by renewables, our economy has improved. We have created incredible clean energy jobs, not hurt the economy.

So I always try to dispute the false narrative that if you protect the environment, if you take steps proactively to combat the climate crisis, that somehow you will hurt the economy. In fact, the exact opposite is true. It is the greatest wealth creation opportunity of our time, if only we would lead as a Nation as we do in California. So with that, I will turn to questions.

Ms. Ross Hopper, I would like to see greater deployment of distributed energy resources. With my colleague, Representative Welch of Vermont, we have written to FERC, Federal Energy Regulatory Commission, urging it to finalize its rulemaking that will set rules for distributed energy resource participation in the wholesale energy market—markets.

Ms. Ross Hopper, how do you expect that a final DER rule would help you meet your solar deployment goals?

Ms. ROSS HOPPER. Thank you for that question. It is an important one.

And yes, California definitely leads the way. I was surprised you didn't talk about the solar mandate on new homes, because I think that is one of the other ways in which California is really leading. And it goes directly to your question, right? Which is——

Mr. LEVIN. I only get 5 minutes.

Ms. ROSS HOPPER. Well, as you think about how do you aggregate those distributed resources, right? And if we are going to put solar in all new homes in the great State of California, how do you use that—sort of to Katherine's point earlier, how do you use that as an asset so it is not merely benefiting the homeowner but it is benefiting the system?

And so how do I think the rule will help? I think the rule will help because it will allow business models where you can aggregate that demand, put it into the wholesale market, get revenue back from it, so that customers can benefit but also the grid can benefit. And once we have clarity on that, it will drive deployment.

Mr. LEVIN. Thank you.

Ms. Hamilton, how do you think such rulemaking would help consumers?

Ms. HAMILTON. Well, this goes to the heart of—these are all consumer-sided resources. So I will give you an example of—15 percent of the spinning reserves in the Midwest ISO are from one facility, Alcoa, the smelter, and they are doing demand response. That is participating directly in the grid.

But right now customers with resources that are cited behind the meter are not allowed to aggregate those resources into the grid, whether it is energy storage or solar and storage, whatever those resources are. This will directly enable them to benefit financially, because they will be able to actually provide resources that are then compensated. And that is super important.

It is also going to be important to the grid. It will be important to the utility on a very local level, but it will also provide services to the greater grid that will enable more penetration of all of these renewables.

Mr. LEVIN. Thank you. Yesterday, Chairman Chatterjee said that the Commission hasn't finalized the rulemaking because of, quote, "complex legal questions."

Ms. Ross Hopper, Ms. Hamilton, how would you respond to that assertion?

Ms. HAMILTON. So I am not an attorney, but I think a lot of the questions are solvable. The technology questions, I think, are solvable, and I think the market questions are solvable, too.

I think you can allow States to have jurisdiction at the same time and allow them to go forward with whatever goals they have within the State, while allowing their consumers and utilities to participate fully in the wholesale market in a competitive way.

Ms. Ross HOPPER. I am a lawyer, and I would agree with Katherine.

Mr. LEVIN. I wanted to also echo my strong support of energy storage and that the Federal Government should be doing everything possible to get storage deployed across the country. I am a cosponsor of Representative Doyle's bill to expand the ITC to include storage.

Ms. Ross Hopper, how is the solar ITC driving storage innovation today, and how would expanding the ITC to cover storage help innovation in the future?

Ms. ROSS HOPPER. Sure. I will answer very quickly. The solar ITC—when storage is paired with solar, they can take advantage of it. So when we co-locate, that is permissible. And it has clearly changed the marketplace, right? Because you can—you can deploy these systems together and deal with a lot of—sort of the intermittency or reliability—I never called it reliability—the intermittency aspect of solar. The sun does not shine at night, Representative Graves.

But if we disaggregate the two so that solar storage can stand on its own and be deployed in ways that are separate from a specific generation source, it just increases the options that we have and increases the flexibility to—to locate storage in different parts of our grid.

Mr. LEVIN. Thank you. And I am out of time. But I thank you, again, for innovating and leading in this critical area.

Ms. CASTOR. Mrs. Miller, you are recognized for 5 minutes.

Mrs. MILLER. Thank you, Chairwoman Castor, and Ranking Member Graves.

Ms. Tezak, if the government right now mandated that we had to shut down all coal plants to move to renewables, how much would that cost?

Ms. TEZAK. We haven't actually fully modelled that in its entirety. We did take a look at the proposal that Mayor Bloomberg had suggested with shutting down the coal plants by 2030. And on an equipment basis alone, not including transmission upgrades, not including financing, just on swapping out all of those coal assets for an even split of solar, wind—and to Mr. Carter's interest, biomass—with the necessary storage to balance intermittency, we got to $941 billion.

Mrs. MILLER. Well, I have gotten to over a trillion.

Ms. TEZAK. Yes. By the time you put financing and transmission in and potentially residual cost for abandoned assets, easily.

Mrs. MILLER. How much do you think it would cost to finance it?

Ms. TEZAK. Well, in our theoretical, if you put a 1 percent—a 1 cent per kilowatt hour surcharge on every kilowatt delivered in the U.S. last year, you would raise about $34 billion towards that.

Mrs. MILLER. Given that the total spending in 2017 for electricity in West Virginia, for residential, commercial, industrial, and transportation, was only $2 billion, that would be a huge cost burden to my constituents. Wouldn't you say?

Ms. TEZAK. I would say that based on the analysis we provided in our testimony, it would weigh most heavily on your constituents.

Mrs. MILLER. It would.

Could you elaborate on how transitioning to renewables would impose further costs on consumers?

Ms. TEZAK. Well, I think it is a matter of pace and, you know, exactly what you want to achieve.

But more importantly, it is pace. You know, the more accelerated the timeline, the more compressed and limited your options are.

So to the extent that it took several years for cost declines to materialize in solar and wind, which they did, in no small part, because in spite of Federal support, natural gas became cheap as well, and so the competitive nature forced the cost direction down. That occurred over time.

And so very quick action can sometimes limit the ability to make use of cost declines, you know, that appear over time. For example, the R&D that Katherine has mentioned, that is going to take a little time to develop. If we find chemical solutions that take our reliance off rare-earth minerals so that we have something else that is available domestically, that may not be available on the same timeline that is foreseen, for example, under Mayor Bloomberg's thing.

So I think that you lose some economic benefit. Plus you have to reconcile the fact that you may have assets out there that you are still paying for. For example, in PG&E's bankruptcy, there is a question about whether or not they can reject early-stage—you know, some of the first renewable projects that were out there because simply on a cost basis.

So do you abandon those folks who brought you forward at the beginning? It is a very difficult set of equities to balance.

Mrs. MILLER. It is a very difficult set.

In West Virginia, in 2017, coal-fired electric plants accounted for 93 percent of my State's electricity. Renewables, mostly hydroelectric and wind, accounted for 4.6 percent, and natural gas provided the remaining 2.2.

This isn't just West Virginia. Nationwide, wind, solar, geothermal, and hydroelectric power only constituted 6 percent of the consumption of energy in 2017.

Do we need more renewable energy? Absolutely, yes.

Is it realistic that we will keep our homes, businesses, schools, powered reliably without coal and natural gas? Absolutely not.

We need to be focused on innovation, like real carbon capture, that can make a real difference in protecting our government—our environment. Excuse me.

Ms. Hamilton, I appreciated your reference to Appalachian roots and the term "thoughtful," because thoughtful is very, very important. So is supply and demand.

We need to consider the economic consequences of what this committee is considering. I want my colleagues to understand that a few years ago my constituents were left with the results of bad policy, of mandates which picked winners and losers without letting the market decide.

There is a place for all forms of energy, but it cannot come at the expense of jobs and livelihoods and entire communities being wiped out.

Electricity bills skyrocketed, which left many people with fixed incomes choosing between food, and medicine, and keeping their heat and lights on.

My State and Mr. Palmer's State of Alabama are amongst the top five energy exporters in the United States and have to backfill all of the grids in States like California, which is the number one energy importer, at nearly 90 million megawatt hours per year. My State's total export of energy could power every household and business in Orange and San Diego County for the entire year.

Ms. Tezak, we have 50 States in this country with different needs and different weather patterns. What is needed in Hawaii won't necessarily be needed in Florida or New Hampshire. Can you discuss the pitfalls of a top-down approach of applying aggressive renewable schemes and mandates across all the 50 States?

Ms. CASTOR. I am sorry. The gentlewoman's time has expired, but we are going to encourage you to answer that for the record.

And at this time I will recognize Mr. Casten for 5 minutes.

Mr. CASTEN. Thank you, Chair Castor. Thank you so much to the witnesses.

I want to respond a little bit to the last comment before I start.

Our job here is to write the laws of the United States. That is a pretty awesome job. We are at our best when we respect the laws of economics and thermodynamics, because those laws you can't really change.

Coal is dying because it is uneconomic, coal is dying because it is not thermodynamic, and coal is dying in spite of the fact that we do not charge coal for the full social cost of carbon that it imposes on society. The health costs of coal vastly exceed the revenue of any coal plant in this country, and they are getting that for free right now.

If you don't believe me, all you have got to do is look at—we have fantastic good news. Over the last two decades, we have seen coal steadily lose market share to cleaner and cheaper alternatives, not because of the laws of this country, because of the laws of economics.

Combined cycle, renewable energy, every one of those plants comes on and competes on the margin and is a better investment as it comes on. And so we are making that transition. Now, that is really good news.

There is a cost. Over the last—from 2005 to 2018, energy related CO2 emissions dropped by 14 percent. The price of energy has fallen by about 6 percent. As my friend Mr. Levin pointed out, that

is an opportunity we should embrace and double down on, not run away from.

But it started going up last year. Last year the emissions rose by 1.9 percent. And there was a—there was a February 2019 report from the EIA that suggests that a big part of the reason for that is that we are now increasingly deploying much less efficient natural gas power cycles to balance—to balance load and deal with the swings, because we have to do something when the wind isn't blowing and the sun isn't shining, and we don't have the transmission that Mr. Kiernan pointed out about or the storage capacity that was out there. Now, the only way, and I would submit the best way, to deal with that intermittency is not inefficient natural gas.

And so I would like to start with Ms. Hamilton. Can you talk about how technologies like storage can change the story and ensure that we continue to see the economic and environmental gains of clean energy but also have the kind of reliability we have come to expect?

Ms. HAMILTON. Yeah, absolutely. And I will just say that coal that is inefficient and uneconomic in operating out of market is costing consumers a billion dollars a year. So it is indeed a price.

In California, four peaker plants, natural gas peaker plants, that were not clean have been replaced with energy storage. And it wasn't more expensive. It was cheaper, quicker, and cleaner to install energy storage than it was to continue operating plants that were not economic. So I think that is one of the big solutions.

Mr. CASTEN. So are there additional Federal policy support so they can accelerate the deployment of energy storage?

Ms. HAMILTON. Yeah. Certainly a tax credit would be really helpful, because those were standalone projects that were not coupled with any sort of other renewable resource.

Allowing for flexibility—if you do a Federal clean energy standard of some sort, allowing for some credit for resources that are flexible like that, that can both serve as load or generation.

And load is important in California. To suck up the belly of the duck, you need both load and generation at different times. And so I think those two policies would be really important.

Mr. CASTEN. I love that you and I and maybe a couple of people in the room understand the belly of the duck joke. But thank you.

So—so I agree obviously. And I was proud to introduce H.R. 2909, the Promoting Grid Storage Act of 2019, among other things, that would authorize about a billion dollars for new cost-cutting energy storage, R&D at DOE, provide technical assistance. The effort is bipartisan, bicameral, would encourage all of my colleagues to sign on.

I want to turn to the grid itself, because—and again, Ms. Hamilton, in your comment to Mr. Levin, you mentioned allowing load-sided resources to participate in FERC markets. You had me at load-sided market participation.

However, one of the things that I think—I think we don't talk about it enough, but I would welcome your thoughts on, is that there are some ISOs, independent system operators, who allow that; there are some that don't.

Can you just speak to the—the kind of market rules and market access in different FERC markets in the country that—whether for

load-sided participation or other ancillary services, where are the best practices that we should look to that we can point around the country and rule out?

Ms. HAMILTON. Well, everybody has a little work to do. I would say New England ISO has finally allowed solar and storage to start participating as a distributed energy resource.

PJM has been traditionally pretty forward-thinking. A lot of the middle-of-the-country utilities and States opted out—with Order 719, opted out of aggregation of demand response. And what that did was it really—MISO is a tough market anyway, because the prices are pretty low. But what it did was it just did not enable aggregation of resources of all types.

But I have found working within States as diverse as Indiana, Missouri, Louisiana, that working with utilities to say let us—let innovators bring resources—all of these customer-sided resources to you and then you be able to bid those into the market, that that has been a really good solution and that utilities are starting to see that because they need solutions.

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

I would love to continue the conversation, because I think a lot of those market access and how—we get what we reward. Markets are really powerful. But if we don't send signals to people to build the kind of generation we want in the right place, we are not going to do it.

Thank you and I yield back.

Ms. CASTOR. Mr. Palmer, you are recognized for 5 minutes.

Mr. PALMER. Thank you, Madam Chairman.

Ms. Ross Hopper and Mr. Kiernan, how long have you all been in the solar/wind power generation business? How long has that——

Ms. ROSS HOPPER. I have been generally in the energy work since 2000—my son was born in 2007—2008.

Mr. PALMER. Okay. So 11 years.

Ms. ROSS HOPPER. Yes, sir.

Mr. KIERNAN. I have been with AWEA particularly the last six years, but involved in energy and environmental policy for 30.

Mr. PALMER. For 30. Why is it——

Mr. KIERNAN. Plus or minus.

Mr. PALMER. Why is it that wind and solar only represent about 5 percent of our energy production if we have had that industry around so long?

It is a simple answer.

Mr. KIERNAN. Because of the dramatic, relatively recent costs in the last 10 years—dramatic decline in the last 10 years, we are deploying more wind energy than ever, it is that recent cost decline that is a leading to a dramatic increase in wind deployment in the U.S.

Mr. PALMER. But even with the cost decline, the cost is still extremely high.

You mentioned that you need natural gas. What do you need—I mean, if you didn't have the subsidies, the market wouldn't bear the cost. Why do you need natural gas?

Mr. KIERNAN. If I can address the first, per Lazard, we are the cheapest source of electricity unsubsidized.

We do need and appreciate natural gas. It is a very important partner for wind energy. I would point out that the cost to back up wind energy is less expensive than the cost to back up conventional power plants, say coal or nuclear, because they can trip off.

Mr. PALMER. But why do you need it?

Mr. KIERNAN. Because wind is variable. But a traditional power plant can trip off in an instant, and you need spinning reserves, which are more expensive——

Mr. PALMER. No, the reason you need it is because our grid is designed for a baseload, and it is not designed for variations in that baseload.

And if you don't have the ability to maintain a baseload, you are going to have disruptions in your—your output. That is why you need a backup system.

Mr. KIERNAN. The demand for electricity varies throughout the day, increases and decreases. And grid operators have learned how to manage that.

Actually the variability for wind energy is less than the variability of demand of electricity. So grid operators talk about actually wind energy as the new baseload, because our variability is less than——

Mr. PALMER. If you—but, again, you get into the engineering part of this, that—and this is from a report from the Institute of Electrical and Electronic Engineers. If a large enough share of the power grid flows through invertors, which you have to have when you are using wind and solar, the grid itself could collapse. Existing converter technologies have faced serious software problems and prompted outages where they have been deployed.

You know, when you talk about going to zero carbon output, which, by the way, we had a hearing a couple of months ago, and if we completely eliminated our carbon emissions, it wouldn't stop climate change. We have got climate change that is occurring—it is going to occur no matter what we do on the carbon side.

But when we talk about, you know, completely going to a renewable power grid, you are talking trillions and trillions of dollars.

Mr. KIERNAN. I will just mention, for wind energy, we are currently 6-and-a-half percent of generation throughout the entire United States, and we look forward to 10, 20, 30 percent or more. There is all kinds of headroom with wind energy currently.

Mr. PALMER. Are you aware of the problems they are having in Spain and Germany right now with their renewables?

Mr. KIERNAN. I am not an expert on international energy issues.

Mr. PALMER. Well, I think you ought to take a look at it if you want to have that as the primary source of power for the United States.

Here is a New York Times article: Renewable Energy in Spain is Taking a Beating. It is exorbitantly expensive.

There was a hearing before the—the House Select Committee on Energy Independence and Global Warming back in September of 2009 where two professors from Spain testified that for every one green job financed by the Spanish taxpayer, 2.2 jobs were lost as an opportunity cost.

Here is another from a publication called Blue and Green: Has Spain Learned its Renewable Lesson? Der Spiegel had an article

about the problems in Germany. And the thing is, I am all for renewable power. I am fine with that. But there are certain engineering realities that—that we are going to have to face. And to tell the American public that we are going to have a Green New Deal that makes us—puts us at all renewables in 10 years, frankly I think is doing the public a great disservice.

I yield back.

Ms. CASTOR. Thank you.

Ms. Brownley, you are recognized for 5 minutes.

Ms. BROWNLEY. Thank you, Madam Chair.

And I want to thank you also for traveling to my district over the Memorial Day recess. And I think we saw a lot in the district in terms of impacts of the climate change and also innovative ways to address it.

One of the places that we visited was Houwelings Tomatoes, which is an innovator in sustainable agriculture. And they grow tomatoes year-round in a greenhouse, which uses about a sixth of the water, compared to field-grown tomato. They run their whole facility from a 5-acre solar photovoltaic field. It is quite innovative.

The CEO of Houwelings certainly pointed out to us in our visit that unlike Europe, you know, one of the barriers that he saw is there are not enough financial tools available to provide capital for low carbon or no carbon projects.

And I think, Ms. Hamilton, you mentioned a green bank concept. We have talked a lot about tax credits today, and I think—I believe in tax credits and the incentives to move the markets along.

What about, you know, this concept of a green bank?

Ms. HAMILTON. Yeah, thank you very much for asking that question.

Because there are a lot of projects that traditional financing just won't cover and traditional banks won't come to the table for, and a lot of those are energy efficiency projects that are commercial, and they are projects that make sense for customer savings, and yet no one is going to finance them.

So having some kind of institution, whether it is quasi Federal or a full Federal institution that really brings that capital and does a lot of public/private partnerships—they have done this in New York. They have one in Hawaii, Rhode Island. There are several—Connecticut was another green bank—Montgomery County, Maryland, has a green bank. This brings capital and puts it toward projects that would not normally be financed but that are still really viable commercially.

So I think it is a great thing—a concept to think about and to think about how we can do something that consumers could actually benefit from and also participate in.

Ms. BROWNLEY. And so some of the green banks that you mentioned have—are they—have they gone through full lifecycles of investments of sorts?

Ms. HAMILTON. Yes. Yes. So there are definite success stories——

Ms. BROWNLEY. And the returns have been stable?

Ms. HAMILTON. Yeah, been great, absolutely.

Ms. BROWNLEY. Thank you. Thank you for that.

Ms. Hopper, you talked—you know, in your testimony, you talked about an aggressive goal of 20 percent of solar by 2030. The break-

down on that is do you see it mainly coming from rooftop—you know, residential rooftop solar, or is it, you know—what is the breakdown between that and large utility-scale deployments?

Ms. ROSS HOPPER. Thank you for the question. It is always nice when people recognize that there is all different ways to deploy solar.

So we think it—roughly track what the market is now. So now it is about 60 percent utility-scale, so big solar farms; about 20 percent commercial and industrial. So tops of—tops of companies, tops of Walmarts, you know, community solar, and then about 20 percent residential.

Ms. BROWNLEY. And that—and as you said in your testimony, in the first 10 years, it was—the growth was slow and then very fast.

Ms. ROSS HOPPER. Right. It definitely hit an inflexion point.

Ms. BROWNLEY. And then once you hit that inflection point, was there a shift in the breakdown of that, or was it because of more residential solar?

Ms. ROSS HOPPER. That is a good question. I don't know historically. I am happy to look back and get that to you.

Ms. BROWNLEY. Okay. Okay.

And, Mr. Kiernan, Ms. Hopper talked about an aggressive goal of 20 percent by 2030. In terms of wind energy, you talked a lot about wind production. Just—if you could, can you put what you said in your testimony and make it comparable to what it would look like in a 2030 scenario?

Mr. KIERNAN. Yes, I can. And I will harken back to a document, a process called wind vision that DOE did under President George W. Bush and then updated by Barack Obama. They laid out a goal, so both Presidents—10 percent by 2020 and 20 percent of all electric generation in the U.S. is wind energy by 2030, and then onto 35 percent by 2050, I believe, as wind energy.

And I will just observe the head—the manager of operations in SPP—a quick quote—he talks about 10 years ago we thought hitting even 25 percent wind penetration would be extremely challenging. Now we have the ability to reliably manage greater than 50 percent penetration. It is not even our ceiling. That is the gentleman that manages SPP. Sorry.

Ms. BROWNLEY. And the technology for wind, how quickly is that——

Ms. CASTOR. I am sorry. The gentlewoman's time has expired. We have a vote call, so I am going to recognize the——

Ms. BROWNLEY. Oh. I apologize.

Ms. CASTOR [continuing]. Ranking member for 5 minutes.

Mr. GRAVES. I am going to try and go very quickly here so we can squeeze a bunch in.

Ms. Hopper and Mr. Kiernan—and I don't want to put words in your mouth, Ms. Hamilton—but I believe there was a lot of talk about kind of reimagining the grid or redesigning the grid and transmission systems based upon this renewable technology evolution that we are going through.

Is that fair somewhat?

Ms. HAMILTON. Well, and we can use technologies that we have today. We don't necessarily have to redesign, but reimagine.

Mr. GRAVES. Okay. Reimagine.

The challenges that we are seeing right now in deploying the transmission lines, it is—we are running into challenges with the Endangered Species Act and 404 and National Environmental Policy Act and all of these things. And we are running into similar challenges with transmitting or transporting natural gas, which is needed for some of the balancing of your—of your resources.

What does this streamlined regulatory process look like that helps to facilitate or deploy renewables in your mind?

What does that look like?

Mr. KIERNAN. I think it is doable and manageable. We were talking with Chairman Chatterjee at FERC this week—last week. It is better planning, and it is giving FERC some backstop authority so that decisions on transmission lines can get made. We just need to move it more rapidly, but we have the tools and technology with us today.

Ms. ROSS HOPPER. I will just add one additional piece of that is once we have the transmission lines built—and I concur with Tom—then we have to get the projects interconnected. And so that is the other half that has to happen. And we have to have sort of clear standards and expectations from utilities about how quickly they have to plug in these systems.

Mr. GRAVES. Thank you.

Quickly, Ms. Tezak, there was a lot of discussion about cost competitiveness of renewables. But I also heard in the same breath, production tax credit, investment tax credit, carbon tax, renewable portfolio standards, procurement preferences, and other things that somewhat distort price.

You also referenced perhaps approaching a trillion-dollar investment in order to achieve this objective of Mayor Bloomberg.

Can you talk a little bit just about cost competitiveness and what that looks like in terms of taxpayer investment quickly, please?

Ms. TEZAK. Sure. And I will describe the universe right after that.

I think the challenge is, is that because natural gas has been so modestly priced, it has been extremely competitive on the margin. And while, you know, we have seen great advances in, you know, for example, in SPP and, you know, wind is absolutely kicking proverbial tail there and in Texas, those are locational areas. That doesn't help Georgia. It certainly doesn't help Georgia in the absence of transmission. It doesn't help other parts of the country if it is trapped locally. It is a great resource for those who have it.

So I think when you are—when you are hearing calls for, you know, continued expansion of tax programs, there is two things to think about. One, that means that the marginal cost environment is still very competitive, in part because in many places we have oversupply.

Mr. GRAVES. Ms. Tezak, just because I am going to try and squeeze this in real quick, could I ask you to respond to that in writing?

Ms. TEZAK. Sure, absolutely.

Mr. GRAVES. Thank you. And I yield to Mr. Griffith.

Mr. GRIFFITH. Thank you very much. I am going to try to do this, because we have got votes going fairly quickly.

So let me start with coal, since we were just there. And my colleague on the other side of the aisle said that, you know, coal was hurt by financial circumstances, and that is true. But regs hit our area first, because I have the Virginia section of the coal fields that my colleague from West Virginia has on the other side of the line.

And regs came in first to hurt coal and then fracking. And what I found so fascinating is, most of the time people on my left don't like fracking either. But what has made coal not financially marketable for energy production or electric production has been the fracking and the gas fields of Marcellus and Utica. So you have got to have one or the other.

So that being said, I would also say that you can't make good quality steel without using some of our metallurgical coal from the coal fields.

Now, my friend Mr. Kelly has talked about rare-earth earlier. And one of the great breakthroughs is we can actually do two things, because apparently there is a greater amount of the rare-earths in the area in central Appalachia where the coal meets the rock. And if we can learn how to extract that, we can do better.

And as this committee has heard me say before, that is technology we can export, because what has—what has happened is—is that that technology, although it is not fully refined yet, is now being licensed to steel mills in India, because they can lower the carbon footprint of the Indian coal. And that is where I think we need to go, is with research.

Yesterday I had a meeting with—along with a number of others—with Paul Dabbar, the DOE Under Secretary for Science, and he was talking about that they have got a film that they believe is just about ready for primetime—not quite, but just about ready—that will take carbon dioxide out of our coal-fired power plants and our natural gas-fired power plants.

Technology is going to help us break through. I am all for research on renewables, but we need to do research on ways that we can make our carbon-based forms of energy more affordable, and we also have to make sure we look at hydro.

With that, I will yield back, because I know that we are running out of time.

Ms. CASTOR. Thank you, Mr. Griffith.

Recognize Mr. McEachin for 5 minutes.

Mr. MCEACHIN. Thank you, Madam Chair, and thank you for this hearing.

You know, there is a myth going around that renewable energy is bad for low-income communities and communities of color. I want to explore that myth for a moment.

And, Ms. Hopper, you have spoken about what I think you called community solar deployment as an option for folks. Can you elaborate beyond what you put in your written testimony about that?

Ms. ROSS HOPPER. Sure. So community solar projects are projects where folks sort of buy a share of the—of the output of the community solar. So it applies—you know, I live in a house that has a lot of trees around it, so I can't put solar on my house because there is no sunlight that comes. It is for folks that live in multifamily buildings; it is sometimes for folks of low and moderate income.

So it is a model that allows access to folks other than simply homeowners. I think that—it is clearly—lots of States have chosen to allow the regulatory construct to have that happen. I think at the Federal level, there are opportunities to help move community solar forward through sort of best practices and perhaps some funding opportunities.

Mr. MCEACHIN. You have also in your written testimony outlined the need to build a robust workforce for solar energy, and you note that solar installation, in terms of the number of jobs, is among the fastest growing industries in the country.

Could you tell us what Congress should do to make these solar jobs available to more people in diverse communities around the country?

Ms. ROSS HOPPER. Absolutely. Thank you for that question.

I forget—one of the folks who sat down there talked about this being one of the largest wealth-creating opportunities available. And I believe that to my core. I think as we think about how we are going to literally transform our energy system, there is going to be so much opportunity for wealth creation, ensuring that communities of all varieties have an opportunity at wealth creation and not simply getting a job is important.

What can the Federal Government to do so sort of help that? I think there are workforce development—we have heard consistently about the need for these workers, and at least in the solar industry. Tom can talk about wind.

It is everything from construction workers to electricians to financiers to sort of predict—you know, literally forecasting sunlight. And so making sure that our—everything from our high schools to our community colleges to our universities have clear links to our industry and—so students understand opportunities that are available to them is important.

I think having some transparency around sort of where we are getting our candidates from. So at SEIA we have developed an MLU with historically black colleges and universities to ensure that our pipelines are diverse as well for these jobs.

So I think there is lots of things—as I am sure you know, Congressman Rush has a bill on workforce diversity that we are fully supportive of.

Mr. MCEACHIN. Very good. I thank you. I thank the witnesses.

And, Madam Chair, I yield back.

Ms. CASTOR. Well, thank you, Mr. McEachin.

And thank you to our witnesses today for expert analysis and participating in the Climate Crisis Committee and how we ramp up renewables to solve the climate crisis.

Without objection, all members will have 10 business days within which to submit additional written questions for the witnesses. I ask our witnesses to please respond as promptly as you can.

And I encourage the public to follow the work of the committee at climatecrisis.house.gov and on Twitter@climatecrisis.

The hearing is adjourned. Thank you.

[Whereupon, at 11:35 a.m., the committee was adjourned.]

United States House of Representatives, Select Committee on the Climate Crisis
Hearing on June 13, 2019, "Solving the Climate Crisis: Ramping Up Renewables"
Questions for the Record

Christine Tezak, Managing Director, ClearView Energy Partners, LLC

THE HONORABLE GARRET GRAVES

1. There was a lot of discussion about cost competitiveness of renewables. But I also heard in the same breath, production tax credit, investment tax credit, carbon tax, renewable portfolio standards, procurement preferences, and other things that somewhat distort price.

Can you talk a little bit just about cost competitiveness and what that looks like in terms of taxpayer investment quickly, please?

Thank you for the question, Ranking Member Graves. First, electric generation assets (power plants) are dispatched (given orders to produce power) most economically when the grid operator or local balancing authority/utility can follow "security constrained economic dispatch." That technique relies on two inputs, operating characteristics and price. Power plants are "stacked" according to these two attributes and then are given orders to produce power by the grid operator based on the amount of demand that needs to be met. This is would be dispatch "in merit order." When grid operators deviate from this efficient approach customers can face higher and more opaque costs in the form of locally higher rates, uplift charges, and a higher tax burden that does not necessarily fund power supplies they use.[1]

Some emissions—such as sulfur dioxide (SO_2)[2] and nitrogen oxides (NO_X)[3]—have trading and credit markets with transparent prices that are readily incorporated into the power plant's price. We would argue that these emissions-oriented policies do not "distort" prices, but integrate those nationally applicable policies into generation asset price profiles.

However, state-level and regional policies that focus on increasing renewable energy deployments or non-price preferences for lower carbon resources can "distort" prices when they operate outside the electricity market algorithms that set dispatch merit order. This has led to several iterations of price formation and market reform proceedings at the Federal Energy Regulatory Commission to address "out of market" policies adopted by states who regulate the market participants, primarily in New England the PJM Interconnection regions.

Renewable portfolio standards/procurement practices and production/investment tax credits can make it more difficult for the market operator to follow security constrained economic dispatch because the costs of these policies isn't well reflected in market prices. For example, RPS programs and renewable energy tax credits have fostered the entry of power generation assets that do not follow dispatch.[4] Wind farms produce power when the wind blows and solar when the sun shines, not when the grid operator directs them. This means that the grid operator often must accommodate those resources first, even though they may not be the first to dispatch from an operational characteristics basis, and deploys other assets to complement them.

Depending on the time of day, this accommodation may require that the grid operator ask other generators to back down their production by charging them to produce power instead of paying them for it (negative pricing), or dispatching higher-priced, but more flexible capacity that can provide power in small increments until the full capacity of a larger (baseload) asset can be accommodated at its lower price. Wind's production tax credit, worth as much as $23/MWh for many existing facilities, means that these assets have $23/MWh of "headroom" relative to other generators, buffering them from the adverse impacts of lower prices. Even as the tax credit has declined ahead of expiration, deployments remain robust.[5] [6]

To be clear, tax-preferred resources with no fuel costs (such as wind/solar) can and do lead to lower wholesale prices in the hours when they are plentiful, something that does benefit consumers. However, these cost decreases can be offset by increases elsewhere on the system. Structurally lower wholesale market prices, in par-

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[1] https://www.sciencedirect.com/science/article/pii/S0960148115300343.
[2] https://www.epa.gov/airmarkets/acid-rain-program.
[3] https://www.epa.gov/airmarkets/phase-ii-acid-rain-program.
[4] https://blogs.ei.columbia.edu/2018/03/16/how-much-do-renewables-actually-depend-on-tax-breaks/.
[5] https://www.eia.gov/todayinenergy/detail.php?id=39472.
[6] https://fas.org/sgp/crs/misc/R43453.pdf.

ticular for baseload energy (often provided by coal and nuclear plants), can lead to power plant retirements, and in some areas, may have adverse impact on the ability to maintain system stability and power delivery at high demand (peak) or emergency periods. Some of those retirements do not adversely impact ratepayers financially, however some do. If an asset is retired before it is fully recovered in retail rates, customers may still be obligated to pay off most, if not all, of the remaining value of the asset, if the plant's construction had been approved by regulators. These costs could offset the savings from the lower prices of the newer market entrants.[7]

In addition, incremental transmission and distribution system investments may be required to handle retirements, shifts in power flows. These are occasioned when renewable assets must be located where nature provides the best opportunity, and that may not necessarily be the most optimal location.[8] Further, the power grid has been substantially constructed to flow power one direction—from generation resources to customers.[9] However, when customers produce more energy than they can use they become "pro-sumers" and power may flow the other direction on the distribution system.

Retooling the nation's grid to accommodate this new capability won't happen without investment (in other words, money from ratepayers). We would argue adoption of incrementally lower greenhouse gas emitting resources are not neutral to ratepayers, and in some cases may result in rate increases to cover investments ahead of potential savings realized over the longer term.

Incremental investment in both the transmission and distribution systems is generally socialized across all grid users, not paid for by the owner of the renewable generation resource. We'd agree that these investments in "grid modernization" do have benefits beyond renewables integration, but the cost impact of renewables deployment can be opaque to the consumer given that these investments are not reflected in the wholesale prices offered by renewable energy assets to the wholesale market.

This ratemaking reality can make the cost of new renewables assets more opaque. Further, pro-sumers seek to be paid for "excess" energy their systems may be able to produce relative to their load. Initial rate designs in this area have been so beneficial to these pro-sumers that many states have been making incremental reforms to their rate design to reduce and eventually eliminate cross-subsidization between customer classes.

In addition, the excess gross supply of power generation assets and low market prices have undermined the ability of flexible units to make reasonable returns to stay in the market (the experience of natural gas plants in California provides an extreme example). This leads to calls for incremental charges for reliability must run (RMR) contracts to be struck (and paid by customers) or very high, and volatile peak pricing schemes to prevent the closure of these power plants, too. These less transparent costs can eat into the notional "cost savings" of lower wholesale market prices, and potentially offset them altogether.

Therefore, at the end of the day, electricity customers pay for power generated and delivered to them over the nation's grid. They pay taxes, too. Customers can face higher electricity rates that support procurements to preserve reliability arising from local or regional needs—whether to retain coal-fired or nuclear baseload plants or natural gas mid-merit and peaking facilities—and increased investment in the grid to accommodate the renewables capability their taxes also support.

A quick word about carbon taxes or carbon prices. While this policy would not be without cost it has the potential to be more transparent (much like SO_2 and NO_X credits) and easier to integrate into restructured market algorithms.

Further, if adopted as part of a holistic, national policy decision, Congress would have the opportunity to direct some of the revenues raised from a greenhouse gas limitation program to the areas of the country facing the largest transition challenges if needed. This may be appropriate to reflect two important realities. First, some areas of the country have more renewables or low carbon generation resources available than others.[10]

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[7] https://www.economist.com/leaders/2017/02/25/wind-and-solar-power-are-disrupting-electricity-systems, https://www.forbes.com/sites/michaelshellenberger/2019/05/27/we-shouldnt-be-surprised-renewables-make-energy-expensive-since-thats-always-been-the-greens-goal/#45a506224e6d.

[8] https://blog.friendsofscience.org/2018/03/22/examining-the-claim-that-renewable-energy-will-soon-replace-fossil-fuels/.

[9] https://pages.bv.com/SDR-SmartUtilities-Download.html.

[10] http://archives.maproomblog.com/2008/03/us_atlas_of_renewable_resources.php.

Second, the nation's environmental, energy and industrial policies in place 40–50 years ago differ dramatically from those adopted over the last decade and under discussion today. Many regions that are still carbon-intensive in power generation are facing other economic challenges, including de-industrialization as well as economic reliance on the production of the natural resources a national policy that would limit GHG emissions could constrain or eliminate altogether over time.

Policy proposals that reflect these two realities would appear to be the most likely to be adopted nationally. Policy proposals that advantage one region of the country at the expense of others (particularly those that purport to "reward" areas that are deemed "first movers") and do not consider ameliorating the potential adverse consequences of a rapid transitions have not succeeded to date, and appear unlikely to in future.

Questions for the Record

Katherine Hamilton, Chair, 38 North Solutions

THE HONORABLE KATHY CASTOR

1. In some regions of the United States, it may be difficult to use renewable energy during extreme weather, such as during extremely cold weather in the northern part of the country. How could greater use of flexible energy resources help address this challenge?

Interestingly, based on the evidence, the issue of resources unable to operate in extreme weather situations is almost entirely limited to traditional generation, not renewables and flexible resources. Several examples of resilience provided by flexible resources were cited in my testimony. In addition, I would refer the Committee to Hurricane Florence news stories that discuss the nuclear and coal plants not only having to shut down in preparation for the storm, but also coal ash ponds being breached, causing collateral environmental damage to water systems in North Carolina. The resources most quickly brought back on line were solar farm, and, luckily, the state has many solar systems. Another story to point to is natural gas in the Midwest this past winter; in many parts of the country, there is a tension between natural gas being used for home heating and the supply for generation. Wind energy resources are hearty in hurricanes with self-managing systems to ensure blades are locked and feathered to prevent damage. As I mentioned in my testimony, demand response, microgrids, and distributed generation (as long as it is able to disconnect from the overarching grid) all prove to be the most resilient resources on the system.

2. Conventional fossil fuels are often more energy dense than newer technologies. How should Federal Research and Development (R&D) investments be targeted to address this challenge?

Rather than thinking about energy density as the attribute we need, I recommend instead focusing on end-states (parity of cost and performance at the system level). Taking electric vehicles as an example, rather than comparing the size of the battery to the size of the gasoline tank, one would look at the mileage achieved in a similar sized vehicle at a particular price—performance and service provided rather than one specific measurement that may not translate (or be relevant) between technologies. In recent testimony before House Science Committee, I discuss this issue of attribute as well. I use the example of energy storage to state that "rather than identifying this research as 'grid-scale' or prescribing time durations for storage technology operations, I recommend instead stating the problems that should be solved or the services delivered, and allow new chemistries and technologies—individually or as a system—be developed that can fit those needs." The same should be true for other flexible technologies: state the problem that needs solving and build the R&D around possible solutions. Comparing fossil fuel to renewable plus storage systems, the question might be whether we want leaded or unleaded paint; one resource exacerbates climate change while the other mitigates it.

3. Most decarbonization scenarios anticipate electrification of transportation and industry and greater use of battery storage. However, batteries require the use of precious metals that are mostly imported. How should the Federal government drive the development of battery recycling?

Precious metals (Rhodium, Platinum, Gold, Palladium, and Silver) are used in electronics and catalytic convertors, but are not used in lithium-ion batteries. Rather, metals such as Cobalt, Nickel, Lithium, Aluminum, Manganese, and Iron are used in manufacturing those batteries. The cathode of the battery is made from a Lithium-Cobalt-Nickel oxide mixture on an Aluminum foil while the anode of the battery is made from graphite on Copper foil. Recycling end of life lithium-ion bat-

teries in the U.S. should encourage processes that return those elements to be reused in battery materials. Reuse of the recovered elements only makes sense, of course, if there is a robust lithium-ion battery manufacturing industry, accompanied by collection, dismantling and pre-processing, and refining capability. While the U.S. has established collectors and pre-processors, there is no lithium-ion refining capacity in the U.S. By establishing federal policies—establishing best practices for collection, requiring labeling and responsibility from manufacturers, and ensuring the federal government leads by example, as just a few ideas—we could create the certainty and market scale for refiners to build recycling plants here in the U.S.

4. What should Congress do to ensure that flexible demand-side resources are integrated into wholesale power markets?

With jurisdiction over the Federal Energy Regulatory Commission, Congress is able to exert pressure on that agency to make a final rule on the Distributed Energy Resource rulemaking. Senators and Members of the House (on both sides of the issue) have sent letters urging FERC to act on the rulemaking. A more durable solution, of course, would be legislation that clarifies flexible demand-side (consumer) resources in the Federal Power Act as being able to serve as resources—just as generators serve as resources—and have access to a participation model in the wholesale market.

5. During the hearing, the challenges that European countries, especially Spain and Germany, faced in the last decade as they have increased their use of renewable energy were raised. Overall have Spain and Germany succeeded in increasing their use of renewable energy in a way that has benefited their economy? Are there any overarching lessons that the United States can learn to inform the development of national polices from these countries?

European countries have indeed experimented with renewable energy policy and technology and felt some growing pains, although the result has been that renewable energy is now the cheapest source of electricity in those regions. Spain and Germany, in particular, each put into place a Feed-In-Tariff (FIT), which set higher payments for renewable energy, thus drawing investment from those industries. Over time, this policy kept prices higher as the cost of renewables dropped. Subsequently, adjustments have been made to ensure that consumers are not paying more than market price for renewable energy. Today, Spain and Germany have adjusted down or removed their FIT altogether and have seen some of the highest penetration of renewable energy, while also enjoying economic and environmental benefits. In fact, a quarter of the start-up companies in Germany contribute to the green economy. A FIT was also instituted in Ontario, Canada, setting high prices to incentivize renewable energy deployment. While this policy worked to scale renewables, over time it also kept prices higher than the market. The U.S. has not instituted a FIT policy on the federal or state level, but instead has used tax incentives, Renewable Portfolio Standards, emissions trading schemes, and other procurement policies to scale renewable deployment and lower prices for consumers. Today, thanks to experimentation by countries in Europe as well as the U.S., solar and wind are in many cases the cheapest sources of energy.

REFERENCES

Question #1 references

Hurricane Florence and nuclear:

https://www.washingtonpost.com/news/powerpost/paloma/the-energy -202/2018/09/18/the-energy-202-hurricane -florence-blows-hole-in-trump-team-s-case-for-helping-coal-and-nuclear -power-critics-say/5ba022621b326b 47ec9596b9/?utm_term=.a25d19c1e4f5.

Hurricane Florence and coal:

https://www.nytimes.com/2018/09/21/climate/florences-floodwaters-breach-defenses-at-power-plant-prompting-shutdown.html

Hurricane Florence and solar:

https://insideclimatenews.org/news/20092018/hurricane-florence-solar-panel-energy-resilience-extreme-weather-damage-wind-flooding

Nuclear and cold temperatures:

https://www.pressofatlanticcity.com/news/below-freezing-temps-shut-down-salem-nuclear-reactor/article _X2fb9b5c7-931f-57be-b4a1-0db516b7e439.html

Midwest natural gas story:

https://www.nepr.net/post/deep-freeze-puts-strain-midwest-gas-and-electricity-grids#stream/0

DOE study on wind energy and natural disaster:

https://www.energy.gov/eere/articles/wind-turbines-extreme-weather-solutions-hurricane-resiliency

Advanced Energy Management Comments to California Wildfire Strike Force: https://aem-alliance.org/aema-urges-consideration-of-der-in-wildfire-mitigation/

Question #2 references

Link to Science Committee Testimony can be found here: https://science.house.gov/hearings/the-future-of-electricity-delivery -modernizing-and-securing-our-nations-electricity-grid

Question #3 references

See new DOE program on battery recycling: https://americanmadechallenges.org/batteryrecycling/

Umicore, Inc. chart shows where facilities are located: https://csm.umicore.com/en/recycling/battery-recycling/e-mobility/

Recycling in the EU is driven by the WEEE directive, which creates certainty for industry: https://ec.europa.eu/environment/waste/weee/legis _en.htm https://www.pv-magazine.com /2019/03/25/innovation-boosts-lithium -ion-battery-recycling-rate-to-over-80/

Question #4 references

Letter to FERC on DER NOPR from House Members in support of DER rulemaking: https://mikelevin.house.gov/sites/mikelevin.house.gov /files/Letter%20to%20FERC%20re%20DER%20Rulemaking%20021119.pdf

Letter to FERC on DER NOPR from Senators in support of participation model: https://www.whitehouse.senate.gov/imo/media/doc/2019-02 -11%20FERC%20Letter.pdf

Letter to FERC on DER NOPR from Senators opposed to DER in wholesale market: https://www.hoeven.senate.gov/imo/media/doc/2019.05.07%20Hoeven%20Letter%20to%20FERC%20on%20DER%20Aggregation%20by%20Third%20 Parties.pdf

Question #5 references

See analysis on current solar boom in Spain: https://www.greentechmedia.com/articles/read/spanish-gold-rush-fuels-new-european -solar-boom#gs.tz3kf7

Solar as engine for economic boom in Spain: https://www.renewableenergymagazine.com/pv _solar/solar-power-is-engine-of-spain-s-20190410

Germany has also seen a rise in solar installations as a result of cutting back their FIT: https://www.pv-magazine.com/2019/08/01/germany-installed-2-gw-of-solar-in-six-months/

Report on start-ups in Germany: https://www.cleanenergywire.org/news/quarter-german-start-ups-contribute-green-economy-report

Blog from NRDC on economic benefit of climate policy to state of California: https://www.nrdc.org/experts/ralph-cavanagh/new-report-shows-how-climate-action-and-healthy-economy-wo

New York is taking much of its offshore wind strategy from what Europe has learned: https://www.nypa.gov/news/press-releases/ 2019/20190807-key-learnings-offshore-wind-transmission-models

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