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RPTR JOHNSON

EDTR HUMKE

BUILDING A 100 PERCENT CLEAN ECONOMY: SOLUTIONS FOR THE U.S. POWER SECTOR

WEDNESDAY, OCTOBER 30, 2019

House of Representatives,

Subcommittee on Energy,

Committee on Energy and Commerce,

Washington, D.C.

The subcommittee met, pursuant to call, at 10:30 a.m., in Room 2322, Rayburn House Office Building, Hon. Bobby L. Rush [chairman of the subcommittee] presiding.

Present: Representatives Rush, Peters, Doyle, Sarbanes, McNerney, Tonko, Loebsack, Butterfield, Welch, Schrader, Kennedy, Veasey, Kuster, Barragan, O'Halleran, Blunt Rochester, Pallone (ex officio), Upton, Latta, Rodgers, McKinley, Kinzinger, Griffith, Johnson, Bucshon, Flores, Hudson, Walberg, Duncan, and Walden (ex officio).

Staff Present: Adam Fischer, Policy Analyst; Jean Fruci, Energy and Environment

Policy Advisor; Catherine Giljohann, FERC Detailee; Waverly Gordon, Deputy Chief Counsel; Omar Guzman-Toro, Policy Analyst; Caitlin Haberman, Professional Staff Member; Rick Kessler, Senior Advisor and Staff Director, Energy and Environment; Brendan Larkin, Policy Coordinator; Jourdan Lewis, Policy Coordinator; Elysa Montfort, Press Secretary; Alivia Roberts, Press Assistant; Tim Robinson, Chief Counsel; Nikki Roy, Policy Coordinator; Tuley Wright, Energy and Environment Policy Advisor; Rebecca Tomilchik, Staff Assistant; Mike Bloomquist, Minority Staff Director; Peter Kielty, Minority General Counsel; Mary Martin, Minority Chief Counsel, Energy and Environment and Climate Change; Brandon Mooney, Minority Deputy Chief Counsel, Energy; Brannon Rains, Minority Legislative Clerk; and Peter Spencer, Minority Senior Professional Staff Member, Environment and Climate Change.

Mr. Rush. The Subcommittee on Energy will now come to order.

And the chair now recognizes himself for 5 minutes for the purposes of an opening statement.

Good morning to each of you and good morning to all of the panelists.

I want to thank you all for attending today's hearing entitled Building a 100 Percent Clean Economy: Solutions for the U.S. Power Sector.

Today's hearing is an extension of the subcommittee's series focused on expanding our Nation's clean energy economy. Further, it is a continuation of the committee's broader objective to identify pathways to a 100 percent clean energy future by the year 2050, as proposed by Chairman Pallone, Chairman Tonko, and myself.

As we approach the year 2050, our Nation faces unique challenges in its efforts to address more energy production demands as well as the obligation to limit our contribution to climate change. In the United States, the greatest sources of greenhouse gas emissions, that are directly linked to human activity, are attributed to the burning of fuels for electricity, transportation, and the production of goods.

The power sector, whose electricity generation is historically dependent on fossil fuels, accounts for nearly 30 percent of all U.S. emissions. In view of this, it is important that the subcommittee evaluates what can be done to reduce that impact. Therefore, discussions concerning necessary steps to both meet rising energy demands, while at the same time, considering critical technology to reduce the impact of the power sector's immense carbon footprint are to say at least essential.

Already diversification within the power generation sector has contributed to a

25 percent decrease in carbon dioxide intensity, and the opportunity exists to create further reductions by incorporating additional low or zero carbon sources of energy production. Further reductions in carbon dioxide emissions are continued upon, and made possible by, varying among -- variances among our energy sources.

According to the National Renewable Energy Laboratory, renewables -- like wind, nuclear, and solar -- can help reduce carbon emissions and produce up to 80 percent of all U.S. electricity generation by the year 2050. However, in our haste to address the real threat proposed by climate change, we must make sure to effectively transition our workforce without leaving minorities and other vulnerable communities behind.

My bill, the Blue and Green Collar Jobs Acts, would accomplish that, but this subcommittee can still gain much needed insight from our witnesses today on how Congress can make this transition more equitable and more just.

So I welcome each and all of our witnesses, which includes our distinguished former Member, Mr. Jim Matheson, who was a former Member of this committee and someone whom we all had found a lot of favor in working with during his tenure here in Congress.

And now I recognize my friend and my colleague, the Representative from the Great State of -- the Wolverine State -- Michigan, my friend, chairman -- Ranking Member Upton for an opening statement.

[The prepared statement of Mr. Rush follows:]

******** INSERT 1-1 ********

Mr. Upton. Well, thank you, my friend, Mr. Chairman.

Today's hearing does examine an issue that this committee has spent a considerable amount of time on in the last couple of Congresses through our bipartisan "Powering America" hearing series.

Now, while this hearing appears to be part of the majority's legislative effort to decarbonize the entire American economy by 2050, I would urge the chairman not to politicize the issue. We certainly owe it to our constituents to take this work seriously and work together.

And, yes, over the last decade, the U.S. has become the world's leading processor of oil and natural gas. I am real proud of that. We import less and we are more energy secure today than ever before because of it. And thanks to hydraulic fracturing and the shale revolution, we are all reaping those benefits in the form of affordable and reliable supplies of energy from gasoline to electricity.

We are also leading the world in carbon emission reductions, and we didn't need a top-down Federal mandate or a Waxman-Markey cap and trade bill. We owe it to the free market and competition for our tremendous progress to reduce emissions. And these are the facts that we should keep in mind as we hear proposals for new Federal mandates, carbon taxes, or complicated emission trading schemes.

Our power sector has been at the forefront of significant changes as natural gas has overtaken coal as the primary fuel used to generate electricity for our homes, factories, and businesses across the country. And with the rise of natural gas, we are seeing early retirements of baseload coal and nuclear plants and increases in generation

from intermittent renewables led by wind and solar.

We are also seeing shifts in consumer preferences, in new technologies, having been developed to monitor, store, and distribute energy across the grid. And at the same time increasing energy efficiency has kept electricity consumption relatively flat, even as our economy continues to grow.

In its Annual Energy Outlook, the Department of Energy's Energy Information Administration, EIA, predicts a continued decline of electricity generation from both coal and nuclear power plants, with a significant shift toward natural gas and an increase in renewables. And by 2050, EIA predicts that 31 percent of electricity will be produced from renewables across the country, 39 percent from natural gas, 12 percent from nuclear, and 17 percent from coal.

Of course, as you would expect, these trends are not uniform across the country. They vary significantly by region, depending on available resources and market prices. What works in Michigan may not work in other parts of the country due to the climate or the amount of sunshine and wind that we receive. But we also must recognize that States, rather than the Federal Government, are the primary drivers of the trends that we see today, because many of the~~n~~m, certainly Michigan, has developed legally binding portfolio standards that require electricity suppliers to source their electricity from designated renewable sources or eligible technologies.

We also have independent regional entities, authorized by FERC, that have developed complex market rules governing the operation of the electric grid.

Thanks to the rise of affordable natural gas, improvements in efficiency, and the leadership of the States, carbon dioxide emissions are down about a third from the 2005

levels. Tremendous accomplishment. But I am confident that with a balanced market-driven policy, we will continue to make progress.

As this committee examines the challenges and opportunities associated with reducing emissions from the power sector, I will be particularly focused on the issues that matter most to my constituents, the cost of electricity, the reliability of our electric grid, and the diversity of options for all consumers.

We also need to have reality-based discussions on energy infrastructure, specifically how can we get it built within the reasonable timeframes and cost. The permitting process for energy generation, distribution, and transmission infrastructure, whether it be from a solar farm, a natural gas pipeline, offshore wind, or a transmission line, has got to be improved.

While I don't agree with the proposals like the Green New Deal, if the majority is pursuing these kinds of radical transformations of our country's energy system, shouldn't getting infrastructure built as quickly and safely as possible be at the very top of their to do list.

I encourage all of us to talk to utilities, engineers, union workers, about the realities of infrastructure permitting and sit down with all of us to discuss how can we solve the problem.

With that, I look forward to hearing from our witnesses today, and I yield back the balance of my time.

[The prepared statement of Mr. Upton follows:]

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

Mr. Rush. The chair thanks the gentleman for that brazenly nonpolitical opening statement.

And now the chair recognizes the chairman of the full committee, Mr. Pallone, for 5 minutes.

The Chairman. Thank you, Chairman Rush.

Today's hearing is the fifth in the committee's series on "Building a 100 Percent Clean Economy by 2050." Each of these hearings has focused on a separate sector of our economy. And today we look at pathways to developing a 100 percent clean power sector.

The power sector has made noticeable progress over the last 15 years in reducing emissions from the facilities that deliver electricity to American homes and businesses. Its carbon emissions have fallen steadily since 2005 thanks to a gradual move away from coal to natural gas and renewable energy like wind and solar. In some respects, decarbonizing the power sector presents fewer challenges than other parts of the economy, but that does not mean it will happen overnight, especially if we electrify more aspects of the economy.

And as we have heard in the previous hearings, the pathway to net zero greenhouse gas pollution by 2050 relies on aggressively improving energy efficiency across all sectors, quickly electrifying as much of the economy as possible, developing and deploying low and zero carbon fuels where electrification is not possible, and switching to clean sources of generation for that electricity.

Electrifying a wide range of services, processes, and end uses will be crucial to

achieving our climate goals, but only if that electricity comes from clean sources. And electrifying more segments of the economy through the increased use of electric vehicles, heat pumps, and other technologies will be necessary to achieve a 100 percent clean economy.

But this creates challenges even broader than the simple question of how we can incentivize more consumers to use these products. For example, a comprehensive transition to electric heat pumps over gas-fired furnaces would shift peak electricity load to the winter in many parts of the country, which presents several new challenges that would have to be addressed by power generators, and we will likely need more transmission to transport power across the country or in from the offshore.

In the power sector, there are clear, achievable ways to get to 80 percent decarbonization, but it is the last 20 percent that will by far the biggest challenge. We must use all available tools. Getting to 100 percent will require a balanced portfolio of low and zero carbon technologies, including solar, wind, and nuclear power, as well as energy storage and carbon capture technologies. Without this balanced portfolio, deep decarbonization will happen at a slower pace and at a higher cost to homeowners and businesses.

A solution that is unaffordable or technological infeasible isn't really a solution at all. As we transition to a 100 percent clean economy, we must ensure that it does not harm people already struggling to afford their electricity bills.

We have to also look to break down market barriers to clean electricity development. For example, in some parts of the country, monopoly utilities effectively prevent customers from installing and using rooftop solar. Over 70 percent of corporate

renewable energy purchases occur in areas with competitive electricity markets, which illustrates the challenges that exist to renewable deployment in markets where one utility has a monopoly.

And while the power sector has made progress reducing its emissions, we need Federal action to expand and accelerate the transition to a 100 percent clean economy.

There are several different policy options available to put us on a pathway to achieve this goal. Many States have implemented either a renewable portfolio standard or a clean energy standard to increase their proportion of clean and renewable power. And several States, including my own, New Jersey, have banded together to develop a mandatory market-based program to reduce greenhouse gas pollution.

So I would like to welcome Ralph Izzo, chairman and CEO of New Jersey's PSEG. Ralph has been a great partner in helping New Jersey address climate change and to modernize our energy systems.

And I am also pleased to welcome back to the committee our friend and former colleague Jim Matheson. It is great to have you here, Jim, as well.

So our goal today is to examine which policies have been most effective in reducing power sector emissions and to learn how we can build upon those successes on a national scale to successfully develop a 100 percent clean net power -- or net zero power sector by 2050.

And again, I thank you, Chairman Rush, for having this and other hearings in this effort to try to come up with a climate bill that is meaningful.

Thank you.

[The prepared statement of The Chairman follows:]

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******** INSERT 1-2 ********

Mr. Rush. The chair thanks the chairman.

The chair now recognizes Mr. Walden, the ranking member of the full committee -- he is on his way?

All right. In that event, we will move forward to the witnesses, and when the ranking member comes in, then we will --

Mr. Upton. He likes the term chairman, but that is okay.

Mr. Rush. Well, I am sure he does, but he won't have it for a while.

I would like to now welcome all of our witnesses to today's hearing. And I will introduce our witnesses.

From my left, as I mentioned previously, we are really delighted to have our former Member, the Honorable Jim Matheson, who serves as the CEO of the National Rural Electric Cooperative Association present with us.

Next to Mr. Matheson is Mr. Ralph Izzo. I think that is how you pronounce it, Izzo. He is the chairman and president and CEO of the Public Service Enterprise Group, Incorporated, PSEG.

Next to him is Mr. Lee Anderson. Mr. Anderson is the governmental affairs for the Utility Workers Unions of America, AFL-CIO.

And next to Mr. Anderson is Ms. Palmer -- Ms. Karen Palmer. She is a senior fellow and director of the Future of Power Initiative at Resources for the Future.

And then lastly, but not least, we have next to Ms. Palmer, Mr. John Bear. He is the CEO of the Midcontinent Independent System Operator, Incorporated.

And last, but not least, Mr. Jim Dennis. Mr. Dennis serves as the general counsel

and managing director for the Advanced Energy Economy.

Thank you for joining us here today, and we look forward to each of your testimony.

Before we begin, I would like to explain the lighting system that is before you. In front of you is a series of lights. The light will initially be green at the start of your opening remarks. The light will turn yellow when you have 1 minute remaining. And please at the yellow light, begin to wrap up your testimony. And then the light will turn red when your turn expires.

And I will begin by asking our friend and former colleague, Mr. Matheson -- Mr. Matheson to begin. You are recognized for 5 minutes.

STATEMENTS OF JIM MATHESON, CHIEF EXECUTIVE OFFICER, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION; RALPH IZZO, PRESIDENT, CHAIRMAN, AND CEO, PUBLIC SERVICE ENTERPRISE GROUP (PSEG); LEE ANDERSON, GOVERNMENT AFFAIRS DIRECTOR, UTILITY WORKERS UNION OF AMERICA, AFL-CIO; KAREN PALMER, SENIOR FELLOW AND DIRECTOR, FUTURE OF POWER INITIATIVE, RESOURCES FOR THE FUTURE; JOHN BEAR, CHIEF EXECUTIVE OFFICER, MIDCONTINENT INDEPENDENT SYSTEM OPERATOR, INC.; AND JEFFREY S. DENNIS, GENERAL COUNSEL AND MANAGING DIRECTOR, ADVANCED ENERGY ECONOMY

STATEMENT OF JIM MATHESON

Mr. Matheson. Well, thank you. Thank you, Chairman Rush and Ranking Member Upton. I really appreciate the opportunity to return before this committee that I proudly served for eight years.

Simply put, America's electric cooperatives are focused on responsibly delivering reliable and affordable electricity. And as you know, when you are a cooperative, you are built by and you belong to each community that you serve. So each cooperative is different, based on their community's specific needs.

Historically, electric co-ops proudly shouldered the responsibility of bringing electricity to rural communities, and this obligation is not without its challenges today.

Sparsely populated communities are more expensive to serve and provide less revenue compared to those areas served by investor-owned or municipal utilities. On average, for every one mile of distribution line that a electric co-op serves, it is only eight

consumers, and we collect about $19,000 of revenue a year.

For the rest of the utility sector combined, it is four times that, 32 customers per line, roughly $79,000 in annual revenue. And yet, one in eight Americans are served by an electric cooperative.

Importantly, electric cooperatives serve 92 percent of the Nation's persistent poverty counties.

So these factors make it especially important for co-ops to keep electric rates affordable, maintain reliability, and improve sustainability as they explore all ideas to meet the evolving energy needs of their local communities.

Diversity of electric generation, including baseload resources, is essential to meeting co-op members' expectations. Co-ops have and will continue to diversify their energy portfolios, with the majority of their power now coming from low and no emissions resources.

For example, electric co-op solar capacity has more than quadrupled since 2016. This is due to in large part to a partnership between DOE, NRECA, and 17 co-ops, reduced the cost of solar installations, addressed deployment barriers, and developed financing models and other resources.

Just last week, DOE selected NRECA, in partnership with the Pacific Northwest National Laboratory, to research small-scale, community-based wind energy that can similarly be deployed by electric co-ops. Interest among electric co-ops in deploying energy storage is also growing and should accelerate as more experience is gained, costs decline, and battery performance improves.

Hydropower and nuclear energy also remain an essential source of zero emission

generation for electric cooperatives in certain regions.

Knowing that both natural gas and coal will continue to play an important role in providing affordable and reliable electricity in a carbon-strained future, electric co-ops are actively engaged in carbon capture research and development.

As not-for-profit utilities, all costs incurred by a co-op are ultimately passed on to our consumer members, and that is why co-ops are committed to generating power as efficiently and cost effectively as possible. It is also why we are particularly attuned to the potential for stranded assets. We have no shareholders to help shoulder that type of burden.

Actions taken by co-ops continue to meet the resource needs of their communities and have also resulted in significant reductions in carbon dioxide emissions. CO2 emissions in 2017 from co-op-owned generating facilities were 12 percent below 2005 levels, even as co-op electric generation increased during that time. And, of course, the whole U.S. electric sector has decreased its CO2 emissions to around 1988 levels and it is well positioned to contribute to CO2 reductions in other sectors through beneficial electrification.

There are meaningful opportunities for further electrification of commercial, industrial, and agricultural applications, which would significantly reduce carbon emissions economy-wide.

Responsibly providing reliable affordable electricity remains the shared commitment of all NRECA members, but a technology program or policy that works for one co-op might not work for another.

Ultimately, and most importantly, every co-op's resource mix is unique to the

needs of that co-op and will continue to vary greatly depending on existing resources and assets, the impact on electricity costs for its member-consumers, reliability implications, the availability of alternative electric generation, and other local circumstances.

So having the flexibility to implement energy solutions across the many regions where cooperatives serve is a critical factor for today and for the future of our members.

So policymakers should be mindful of this and ensure that any proposals that this committee considers provide long-term certainty and that flexibility that maintains energy diversity for electric co-ops, that protects reliability of the electric grid, and minimizes undue economic impact for consumers.

Again, I appreciate this opportunity. I look forward to taking your questions.

[The prepared statement of Mr. Matheson follows:]

******** INSERT 1-3 ********

Mr. Rush. Next, we will have Mr. Izzo.

Mr. Izzo, you are recognized for 5 minutes for opening statement.

STATEMENT OF RALPH IZZO

Mr. Izzo. Good morning, Subcommittee Chair Rush, Ranking Member Upton, and good morning and thank you to full committee Chairman Pallone for his greeting.

As was mentioned, my name is Ralph Izzo, and I am the CEO and chairman of New Jersey-based Public Service Enterprise Group. We are the parent company of the State's largest electric and gas utility, serving millions of customers in most of the State's major urban areas.

Our subsidiary, PSEG Power, owns 12,000 megawatts of generation across the northeast and Midatlantic. Power's fleet ranks third lowest in carbon intensity among the country's major generators, at about half the national average.

Thank you for holding this hearing and for the bigger task you are undertaking to steer us toward a 100 percent clean economy by 2050.

In the 10 years since Congress last considered the topic of climate change, my company has continued to make progress. We have worked with our State to preserve at-risk nuclear generation, which supplies over 90 percent of New Jersey's carbon-free electricity. We have invested over $1.7 billion in solar energy. We have closed our New Jersey coal plants and will close our only remaining coal unit, which is located in Connecticut, by the middle of 2021.

We have proposed bringing energy efficiency and other elements of a clean energy future to our New Jersey customers at a historic scale.

Last summer, we committed to reducing our power plant emissions 80 percent below 2005 levels by 2046. And with advances in technology, customer behavior, and public policy, we believe we can achieve our vision of net zero carbon emissions from our fleet by 2050.

As to why Federal action is needed, I frequently ask this riddle: Is the current cost of emitting carbon dioxide in New Jersey $0 a ton, $5 a ton, $17 a ton, $100 a ton, or $400 a ton?

Sadly, the answer is all of the above. Here is how. Our regional energy market, PJM, does not include carbon in its electricity price, so the cost of emission is zero. But under the regional greenhouse gas initiative, the carbon cost is around $5 per ton for an emissions credit.

In New Jersey, the zero emission credit for existing nuclear translates to a carbon cost of $17 per ton.

At the highest end, renewable energy credits needed to meet a renewable portfolio standard for offshore wind and solar produce carbon costs closer to $400 and $100 per ton.

In the absence of a national price on carbon, we are left with economic inefficiency that translates to customers as a cost. It is time for Congress to bring the consistency that only a national program can provide.

In addition to a price on carbon, there are other near-term actions to consider. We must ensure Federal policy does not undo State efforts to preserve clean energy,

including existing nuclear. Nuclear energy provides over half the Nation's carbon-free electricity. But low natural gas prices have put many plants on the brink of closure.

Much is at stake as FERC weighs fundamental change to the PJM capacity market, and some options would worsen the economic for at-risk plants, to the detriment of the environment and the resilience of our regional power supply.

Secondly, I can think of no more urgent priority than doing all we can to reduce carbon emissions through energy efficiency. When these efforts are led by the regulated utility, the savings can more than offset the cost of the investment, thus carbon reductions can be achieved this way at $0 per ton.

Congress can leverage the power of utilities as a transformative investor by providing Federal dollars through a LIEAP like program to States that aggressively move in this direction. These funds could help ease the burden on low-income customers of other, more expensive strategies. A model program already in the LIFT Act for methane could be expanded for this purpose.

But make no mistake, the shortest path to a net zero economy requires setting a national price on carbon. This is what will drive the innovation needed to achieve our goals. This is what allows us to end technology-specific subsidies that layer on additional costs. And this is what will help drive emissions reductions through market mechanisms, not just from the power sector, but economy-wide, with the utmost obvious opportunity coming from the electrification of the transportation sector.

A national price on carbon could take many forms. Cap and trade concept is market-based and proven and deserves another look. In the alternative, an upstream emissions fee could generate as much as $250 billion per year for consumer dividends,

debt reduction, or R&D.

I am pleased to continue this discussion during the Q&A. Thank you for your time.

[The prepared statement of Mr. Izzo follows:]

******** INSERT 1-4 ********

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

STATEMENT OF LEE ANDERSON

Mr. Anderson. Thank you, Chairman Rush, Ranking Member Upton, and distinguished members of the committee.

My name is Lee Anderson, and I am the government affairs director for the Utility Workers Union of America.

The Utility Workers Union represents more than 50,000 workers in the electric, gas, nuclear, and water utility sectors. In the power sector specifically, our members maintain electric generation assets including nuclear, coal, natural gas, and liquid fuel power plants, as well as utility-scale wind farms, solar arrays, and energy storage facilities. We also have substation operations, above and below ground line crews, and even tree trimming crews.

It is a truism at this point that the manner in which the world generates electricity is evolving rapidly. In America, ever-more coal and nuclear assets are being taken offline every year, with natural gas and renewable generation expanding.

Abroad, other countries are expanding coal and nuclear power, alongside gas and renewables, as their rapidly growing economies demand ever-more energy to make them function.

The Utility Workers Union recognizes that change is being driven by economics, by the recognition that global climate change is happening, and that it is the result of

manmade carbon emissions.

Our union is made up of highly skilled people whose everyday work involves thinking like an engineer, a mechanic, a scientist.

We ask not -- we ask how do we engineer our way through this challenge, not how do we argue or vote our way out of this. In answering this question, there are both opportunities and challenges in the power sector.

For our union, the polestar in understanding the science of climate change and the appropriate response to it is the Intergovernmental Panel on Climate Change. Bringing together the world's leading climate scientists to understand the problem and the necessary responses seems the obviously starting point.

One such response that, according to the IPCC, is indispensable to our ability to combat a changing climate is carbon capture. In their reporting, the IPCC has stated that less than 50 percent of their climate models can achieve a 450-parts-per-million CO2 target by the year 2100 without the widespread use of carbon removal technologies and power generation and industrial processes. For those models that do achieve the goal without its use, the price increases by 138 percent.

In the nuclear fleet, there are still over 90 nuclear power plants in operation across the U.S. And taken together, this fleet already provides over half of America's carbon-free electricity. Unfortunately, our union's experience is increasingly informed by the closure of nuclear facilities.

To date, UWUA members have lost some of the best jobs in the power sector due to nuclear closures in California, Massachusetts, and Michigan, with additional closures slated to occur at an additional facility in Michigan, as well as in New York.

We are losing already-built zero carbon facilities that could be kept online to obviate the need to build whole new systems from scratch.

In renewable energy, America's demand is, of course, growing. Our only Power for American Training Trust, or P4A as we call it, has developed the country's first Department of Labor certified apprenticeship program in renewable energy that includes training for apprentices across three technologies: Wind, solar, and battery storage systems.

So today we see a consensus growing that a net zero emissions philosophy is needed. Even civilization is deeply complex, and it will always have a carbon --

However, although we must decarbonize our economy, we must do so in a manner that does not crash the economy. The closure of a power plant means the loss of many hundreds or even thousands of jobs for people directly employed in these large facilities and their supply chains.

Increasingly, entire regions and ways of life are changing too rapidly for individuals and small communities to adapt on their own. We must recognize the contribution made by these workers to build this Nation and aid them in making this change.

So in summary, we see reason for optimism but also reasons to be cautious. The technology already exists to retain and build out low or zero carbon power generation. There is nothing which needs to be invented from scratch, only systems which need to be scaled, improved, or in some cases, simply retained.

I thank you for the opportunity today to be a part of these proceedings, and I look forward to answering your questions.

[The prepared statement of Mr. Anderson follows:]

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******** INSERT 1-5 ********

Mr. Rush. The chair now recognizes Ms. Palmer for 5 minutes.

STATEMENT OF KAREN PALMER

Ms. Palmer. Thank you.

Chairman Rush, Ranking Member Upton, and distinguished members of the subcommittee, my name is Karen Palmer, and I am a senior fellow and director of the Future of Power Initiative at Resources for the Future.

RFF is an independent, nonprofit research institution in Washington, D.C. our mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. The views I express here today are my own and may differ from those of others at RFF. RFF does not take positions on specific legislative proposals.

This hearing is timely and takes place against the backdrop of a rapidly evolving power sector shaped by policy and economics. Emissions from the power sector are down 27 percent from 2005 levels, due to a combination of falling costs for lower emitting natural gas and renewables, and State and Federal policies.

However, without further policy intervention, the power sector will fall far short of the 100 percent net zero emission goal put forward by the committee leadership. In this testimony, I am going to offer a discussion of relevant policy options and some potential challenges that needed to be addressed along the way.

Economic theory and experience indicate that the most cost-efficient policy

solutions are those that introduce a price or carbon emissions, either through a carbon tax or cap and trade program. An economy-wide price on carbon makes carbon-intensive fuels more expensive than those with lower carbon content, sending an economic signal to reduce emission through the entire economy.

When carbon pricing is applied to the electricity sector, all emissions are priced consistently, enabling a wide range of reduction strategies.

In comparing climate policy options, the greater the number of available options to reduce emissions, the lower the overall cost of the policy.

Carbon pricing policies can raise substantial revenue, and how such revenue is used affects the outcomes driven by the policy. Decisions about the use of revenues involve tradeoffs among efficiency, emissions reductions, and distributional outcomes.

Another option would be to build on the success of renewable portfolio standards that have been implemented at the State level to require a fully renewable sector by 2050. However, renewables-only policy would reduce emissions at relatively higher costs than a more technology-inclusive policy, such as a clean energy standard, which would credit additional zero or low carbon generation, such as nuclear, or coal or natural gas fitted with carbon capture.

RFF bottling of proposed CES policies, has shown that a CES would put the power sector well on its way to full decarbonization with modest effects on electricity rates, approach the cost efficiency of a carbon price, and increase retail electricity rates by less than an equivalent carbon pricing policy that does not use its revenue for electricity rate reduction.

An alternative approach would be to clarify EPA's existing authority to regulate

greenhouse gas emissions from stationary and mobile sources under the Clean Air Act. Congress could specify emission reduction targets, reaffirm the Clean Air Act as mechanism that can be used, and clarify both the relevant sections of the statute and that carbon pricing and other market mechanisms would constitute valid approaches.

Transitioning to a decarbonized electricity sector raises some important challenges to traditional approaches to electricity system operations and wholesale electricity markets. But these challenges are not insurmountable.

First, a high penetration of renewables can be expected to drive wholesale energy prices to zero in many hours of the day. Markets may need to be altered in order to promote new investment while delivering power reliably and at low cost.

Second, maintaining a reliable grid with high penetration of intermittent renewables will likely require a build-out of bulk energy storage and more flexible electricity demand activated by greater time-varying prices.

Newly electrified loads, such as electric vehicles, may be an important source of flexible demand to aid renewables integration.

Third, targeting electricity sector emissions in isolation from the rest of the economy, could discourage electrification of our sectors, such as transportation and buildings. Ideally, simultaneous efforts to address carbon emissions from these sectors would be put in place.

In closing, I note that climate policy outcomes are certain to involve a portfolio of these measures at Federal, State, and local levels. This policy mix may be desirable for various reasons, such as to promote innovation, achieve local air quality improvements, or achieve better distributional outcomes. Policies should be designed in anticipation of

overlapping influence to maximize the effectiveness of the entire portfolio.

Notably, meeting the environmental challenge before us is not totally unprecedented. Though these emission targets are ambitious, so too were targets under the Clean Air Act in 1970, which addressed multiple pollutants across the economy and for which technologies to achieve emission reductions did not exist at that time. The dramatic declines in air pollution achieved under the act happened at the same time the U.S. economy grew 16-fold and as the population grew by roughly 150 percent.

I look forward to addressing your questions today.

[The prepared statement of Ms. Palmer follows:]

******** INSERT 1-6 ********

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

STATEMENT OF JOHN BEAR

Mr. Bear. Good morning.

Chairman Rush, Ranking Member Upton, and members of the subcommittee, I am John Bear. I am the chief executive offer of the Midcontinent Independent System Operator, or MISO. It is a pleasure to be with you today as you consider the future of renewable energy and its impact on our Nation. I hope you will find MISO's insights useful in your work in shaping U.S. energy policy.

MISO is a regional transmission organization, commonly referred to in the industry as an RTO. In fact, we were the first RTO approved by FERC in 2001. RTOs were established to independent entities, and we put a priority on maintaining that independence. We are fuel source neutral and policy neutral, meaning we don't favor, prefer, or advocate for any fuel or policy outcome.

That doesn't mean, however, that we are disinterested observers. MISO is a 501(c)(4) not-for-profit social welfare organization with responsibility for ensuring the reliability of the high-voltage electric transmission system to deliver low-cost energy to consumers.

The topic of this hearing, the role of renewable energy, can have a direct impact on both the reliability of the system and the value created for consumers.

The system that MISO operators, including 72,000 miles of transmission lines,

175,000 megawatts of generation, is the largest in North America in terms of geographical scope. We serve 42 million people across all or part all of 15 states, a Canadian province, and border from Canada to the Gulf of Mexico. This vast footprint provides for tremendous diversity in terms of the types of resources, State policies, weather patterns, and, notably, perspectives and viewpoints across our stakeholder committees that are crucial to us solving today's complex challenges.

On this topic, we have stakeholder sectors that include utilities that are having to respond to customer demands for 100 percent renewable energy, others are responsible for approving the State and resource plans that ensure the utility has those type of resources in its fleet, and yet others that represent end-use customers and that interest and appropriately remind us that customers are still paying to have reliable power and the resources that are contemplated being replaced by new green resources whose cost will be borne by those same customers.

Our fleet is evolving, and it is evolving significantly. MISO has experienced significant fleet evolution over the last 15 years, going from 80 percent coal to 50 percent coal, 7 percent gas to 30 percent gas, zero percent wind to 8 percent wind, and is increasing.

The required innovative changes to our planning, our markets, our operations to maintain reliability along the way -- and we continue to learn and adapt in response to the associated impacts of low reserve margins, degrading unit performance, increased reliance on variable generation, and what that means to us.

We see several macro trends, and we expect the transition to more renewable energy to continue to be driven by those three macro trends. We call them the three

Ds: Demarginalization, decentralization, and digitization.

Our work to understand the implication of these trends has identified the future needs to reliably meet these challenges: Improved availability, improved flexibility, and improved visibility.

We have conducted a Renewable Integration Impact Assessment, we call it RIIA, and it really has been informed by our future planning scenario and the requests that we have received for new resources to connect to our grid.

Three years ago, we started a study with our stakeholders to identify the inflection points of these increasing levels of renewable penetration, what were the implications on our policies, our procedures, and the attributes that we needed our assets to demonstrate.

Thus far, our findings reveal that it is very manageable, to a 30 percent renewable level. However, at 40 percent, the integration complexity goes up significantly, and we have got a lot of things to think about in terms of how to accomplish that in a reliable and cost-effective manner. New processes and market products are required, new pricing regimes are required, and the potential role of new technologies that can help mitigate these system risks, system stability attributes, and transfer capability.

Our industry engagement has been very strong, not just here in the United States, but also across the globe. As a member of a group called the Geo 15, which is the largest market and grid operators across the planet, we are all dealing with very similar problems as we see significant increase in renewable portfolios.

In terms of how we think about things in the past and how we are going to think about things in the future, significant changes are taking place. In the past, we planned

for the peak hour of a peak day, and we assumed that the resources would be there all year long when we needed them.

With renewable and intermittent portfolio increases, that is not true anymore. Now it is about availability, how much assets -- where are the assets and are they available. Pricing mechanisms are critical, as Ms. Palmer noted. We are seeing demarginalization take place to the point where we need to think about how to price these attributes so that the assets are incented to provide what we need them to provide at that time that we need them to provide that.

Again, our steady work and our information gathering experience have helped to identify these changes in these attributes that we need, and they show a further paradigm shift going forward.

With that, I look forward to your questions.

[The prepared statement of Mr. Bear follows:]

******** INSERT 1-7 ********

Mr. Rush. The chair now recognizes our final witness for opening statement.

Mr. Dennis, you are recognized for 5 minutes.

STATEMENT OF JEFFERY S. DENNIS

Mr. Dennis. Thank you.

Chairman Rush, Ranking Member Upton, and members of the subcommittee.

Mr. Rush. Will you please turn your microphone on?

Mr. Dennis. It is an honor to testify today on the opportunity to utilize clean, advanced energy technologies to decarbonize the power sector in the U.S. economy.

My name is Jeff Dennis, and I am general counsel and managing director at Advanced Energy Economy.

AEE is a national organization of businesses making the energy we use secure, clean, and affordable. Advanced energy technologies include energy efficiency, demand response, solar, wind, energy storage, and electric vehicles, to name just a few.

AEE also manages the Advanced Energy Buyers Group, a coalition of large electricity consumers interested in increasing their purchases of advanced energy.

AEE strongly supports this committee's efforts to undertake a broad review of policy options for decarbonizing the power sector and reaching net zero carbon emissions by 2050. We welcome the opportunity to work with the committee as it explores these policy options.

This conversation comes at a time when advanced energy technologies have

become the most cost-effective resources on the grid. This innovation success story means that we can transition to 100 percent clean power sector and save consumers money rather than driving up their costs.

Advanced energy technology costs have fallen so sharply that investing in new wind and solar resources can be more cost effective than continuing to pay the operating costs of some traditional generating technologies.

For example, recent research shows that retiring the vast majority of the existing coal fleet by 2025 and replacing it with local wind and solar would lower electric bills across the United States while reducing carbon emissions substantially.

Advanced energy technologies are also reliable and private enhanced resilience in the face of extreme weather and other threats to the grid and fuel supplies.

For example, earlier this month, over 700 megawatts of flexible demand response resources were deployed to maintain reliability in the Midatlantic States during an unusual hot weather event which occurred during a period when many traditional technology -- resources are shut down for maintenance.

Advanced energy is already $238 billion industry in the United States, supporting 3.5 million American jobs, spread across all 50 states, in both rural and urban communities and in communities that previously relied on fossil fuel based industries.

States, utilities, and large electricity consumers are acting to capture the economic and reliability advantages of switching to advanced energy. State policy changes and large corporate customer commitments, in fact, are the primary drivers of growth in the advanced energy market and resulting reductions in carbon emissions.

While each State is unique, some of the common policy approaches States are

pursuing today include expanded renewable and clean energy standards, improved utility resource planning, and allowing for customer choice and competition in retail service.

In addition, since 2008, commercial and industrial customers have signed contracts to procure 22 gigawatts of renewable energy, including a record 7.15 gigawatts so far this year.

In addition to renewables, these large corporate customers are also increasing their investments in energy efficiency, demand response, distributed energy, and energy storage.

Federal leadership can build on these trends. In addition to the longer term policy options we will discuss today, improving competition in the Federally regulated wholesale electricity markets is an important near-term opportunity. When wholesale markets allow all technologies to compete based solely on price and performance, least cost advanced energy technologies win and displace high-emitting power plants, driving down power sector emissions and lowering prices for consumers.

Too often, however, the rules and regulations in wholesale markets either implicitly or explicitly preclude advanced energy technologies from fully participating.

Progress has been made in removing barriers to advanced energy in wholesale electricity markets, including important actions to open markets to energy storage and ensure that resources like energy efficiency aren't excluded.

But continued by FERC and Congress is necessary to ensure that wholesale markets are technology neutral and capture the benefits of advanced energy.

Doing so would unleash significant market-based investment in clean energy, more energy innovation, reduced emissions, and lower consumer costs.

Thank you for the opportunity to be here today, and I look forward to the discussion.

[The prepared statement of Mr. Dennis follows:]

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Mr. Rush. I want to thank all of the witnesses.

And I will now recognize the ranking member, whose recent announcement sent the stock markets reeling -- Mr. Walden is recognized for 5 minutes.

Mr. Walden. Wow. Yeah, I didn't know that happened. Maybe I should reconsider. No. No, I am not. Actually, it is only down 13 points.

So, thank you, Mr. Chairman. Appreciate that. And I really appreciate you holding this hearing today. I think it is an important one as we examine the opportunities and challenges associated with modernizing our electric grid.

And I want to thank our witnesses for being here.

We had another hearing going on downstairs in the health sub that I had to stay for a little longer the health sub, I guess it is.

Today's hearing is obviously a part of a series the majority scheduled to look at all of these opportunities and challenges and the transformations that some policies propose. And I have a great belief in American ingenuity and get-it-done attitude and all of that. But I also want to make sure that as policies move forward, we put the consumer first as we work on reducing emissions. I think we have to do that. Cost matters.

We have seen different strategies play out in both different States and different countries. And some of them are working better than others. And there are actually wonderful laboratories you can go look at and go, ahh, we don't want to do that necessarily, or maybe we want to do this. But we have to make sure that the grid is safe and secure and adequate. We did a lot of work on that in last Congress and the one

before, as you integrate new energy sources in.

And as I have said before, Mr. Chairman, Republicans are more than willing to sit down with you and work on some of these issues, and I know there is a lot to be done.

But the stakes are high. Our grid is facing many new and emerging challenges, and the potential to significantly impact grid reliability and increase prices for consumers could result if we make the wrong choices.

Baseload coal fire and nuclear power plants are closing around the country at a record pace. I know in Europe, they have put a lot of renewables on, but they have taken nuclear off. So, in some cases, it is a sort of net zero, in effect, in terms of what they are trying to do there.

We are relying more and more on natural gas for electricity than ever before, and yet we are facing all kinds of pipeline, siting bottlenecks and permitting challenges that affect reliability of natural gas supply, both for heating and for electricity generation. And then we have some politicians that then attack the companies who are trying to build the pipelines to get gas to their areas who are not getting gas to their areas in adequate amounts. And it is like, you know, you can't have it both ways.

Electricity generation from intermittent renewable resources is also on the rise. And I know in the northwest, for a long time we had a little more flexibility, with the dams and the river system as a battery, but most of that is gone out of the system now for all kinds of reasons. And so, we have to make sure that we can -- we can deal with that.

As these trends continue, we will need a tremendous amount of new solar panels, new wind farms, more electricity storage, more high-voltage transmission lines. We will also need more natural gas pipelines, and the industry must develop commercially viable

grid-scale storage and advanced technologies for distributed energy resources and demand response.

I think we also have to deal with serious physical threats. We have all been in briefings and hearings about the cyber threats, about the severe weather threats, and tragically watching what is happening in California and the threats and the loss of life there year after year. Over the past several weeks, we have seen millions of people without power and affected and moved out of their homes because of the fires.

And while some say California's policies are partially to blame to forcing utilities to redirect resources away from basic maintenance and for making it difficult to manage vegetable on rights-of-way, the facts of the matter is that people are suffering, and a one-size-fits-all policy is not going to solve that.

So, there is a lot of work to do. And I think nuclear has to play a key role in this. The committee has worked in the past and under Chairman's Upton's leadership and, in the last Congress mine, to try and figure out what can we do to advance new technology for nuclear power. You want zero emissions; it is right there. And we can have baseload power, but we know that it is a bit in the distance.

I am told, for example, in South Korea, I think they can site a new nuclear facility in just a few years for a couple billion dollars, and here it is a few lifetimes and 10 or 15 times that. And so other countries are kind of figuring this out, and I think we have got to take a look at what they do.

So, Mr. Chairman, thank you for indulging my tardiness in getting here. Thanks for your leadership on this issue and your friendship, and I look forward to the discussion continuing.

And I yield back.

Mr. Rush. The gentleman yields back.

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

And now the opening statements have been concluded, and now we will move on to the questioning of the witnesses.

And the chair recognizes himself for 5 minutes for the purpose of questioning the witnesses.

The committee has set its sight for reaching a 100 percent clean energy economy by the year 2050 and demonstrating that we are ready to move boldly to aggressively tackle issues linked to climate change.

And my first question is to Ms. Palmer.

Ms. Palmer, in your testimony, you were highlighting that environmental equity and environmental justice considerations should be a central focus in both climate policy and transforming energy systems discussion.

I am interested in mentioned how this corresponds with renewable energy workforce transition.

Ms. Palmer. Yes. Thank you, Chairman Rush.

So I think an important opportunity that presents itself with policies that impose a price on emission allowances is it generates some revenue that can be used for job training or transition assistance to -- to make opportunities available for people who are losing their jobs potentially in the fossil fuel sector to transition to jobs in other sectors, maybe -- and in particular, in the clean energy sectors, to the extent that those

geographies correspond.

I know that sense of place is really important to people. But there are places, for example, in West Virginia, where you could exploit wind resources and create a clean, more -- more of a clean energy economy as you move out of fossil fuels.

And I think in order to do those types of activities, though, you do need resources. And one of the opportunities created by putting a price on carbon is it does create revenues that would be available to fund such an effort.

Mr. Rush. Uh-huh. Also associate the statement that you made in your written testimony where you stated that disadvantaged communities are most vulnerable to the potential cost of policy and to the effects of a changing climate. I appreciate this sentiment.

And I wanted to just ask you, none of the committee frown upon those sentiments?

Ms. Palmer. Right. So I think as we look to address and mitigate that emissions that are contributing to climate change, it is also important to take actions to adapt to it. Because there is -- the climate is already changing. And some adaptation is going to be necessary.

And particularly folks who don't have access to a lot of resources, they may be prone to vulnerabilities associated with changes in agriculture or changes in floods being -- in flood zones and also being proximate to areas where pollution has been an issue in the past.

So while policies to address emissions in the electricity sector are really important, it is also important at the same time that we focus on adaptation issues, and the most

vulnerable are going to be the folks that we should target in those efforts.

RPTR WARREN

EDTR HUMKE

[11:30 a.m.]

Mr. Rush. Thank you.

Mr. Matheson, with these communities in mind, what additional incentives should the Government consider to support the transition of electric utilities to create a cleaner economy?

Mr. Matheson. I think it is important, first of all, to look at the fact that, as I mentioned in my opening testimony, different communities have different circumstances. So, a simplistic one-size-fits-all is not necessarily going to target these communities.

And as I mentioned, electric co-ops are 92 percent of the persistent poverty counties in America. So, this is an issue for a lot of our membership in terms of making sure we make sound decisions that do not have significant economic harm to these vulnerable communities.

One aspect of Federal policy that would be meaningful for electric co-ops is we are non-for-profit entities. So When it comes to the tax credits for renewables, for example, we offer having a contract with a third party to do it because we don't have a tax appetite ourselves. So, one policy option that could be considered at the Federal level is making it a more elegant or simple way for nonprofit entities to monetize the value of tax credits that are part of Federal policy.

Mr. Rush. How do we issue a policy that we pursue will not result in higher rates for customers who live in disadvantaged areas?

Mr. Matheson. Great question without an easy answer. I think that you want

to make sure you understand the cost implications, but I would also say also the reliability implications as well when you look at these policies. And I think for folks in the most vulnerable areas -- like I say, we can't push these things on shareholders. It all goes to the bottom line to our ratepayers for any impact we face.

So I think electric co-ops provide an interesting perspective on any of these policy considerations or how it affects someone's rates.

Mr. Rush. The chairman's time is up.

The chair now recognizes Mr. Upton for five minutes.

Mr. Upton. Well, again, thank you, Mr. Chairman.

And I will indulge my colleagues a little bit. The Michigan example, in Michigan, we are making great progress in reducing emissions from the power sector. Electricity is affordable. In fact, we are ranked No. 11 for electricity prices. We haven't had any issues with reliability other than a few storms every now and then.

In fact, we export some of our electricity as well; and we have a pretty diverse fuel mix. In fact, as of July of this year, natural gas was 33 percent. Coal was 34 percent, and it is going down because our utilities have announced that they are going to be closing the remaining coal plants in the next 5 to 7 years.

Nuclear is about a little bit less than 25 percent, and renewables then are about somewhere between 6 and 8 percent. In fact, when you take down the coal percentage, that will probably be split between natural gas and renewables.

And I guess the first question I have for Mr. Bear, who knows Michigan maybe better than anybody else, perhaps, likelihood, what has happened with emissions? Do you-all track emissions within the region that you represent by State?

Mr. Bear. We don't track it by State. We track it sort of overall as far as what is happening.

Mr. Upton. Is Michigan about the representative sample of the other States within MISO?

Mr. Bear. I think it is fair, yes. It is probably a representative State, although things are changing. We have moved from, you know, having all the States look fairly homogeneous to different policy choices being made, some moving a lot more towards renewables, some stepping into renewables lightly and some not stepping in at all. So now things are changing pretty significantly.

Mr. Upton. Michigan has been a leader actually in terms of increase in its percentage of renewables from where we were 15, 20 years ago and to where we are headed. Our major utilities have announced that they are going to be dramatically increasing that percentage over the next number of years on their own, which is a good thing.

Mr. Bear. That is correct. Michigan, Minnesota, and Iowa.

Mr. Upton. And what has that done to prices as it relates? Again, I mentioned Michigan was No. 11. Where do you think Michigan is headed in the region in terms of competitiveness as relates to prices for consumers?

Mr. Bear. Very competitive. Michigan has done a very good job of keeping their prices low.

Mr. Upton. Mr. Matheson, you mentioned in your opening statement about carbon capture. Of course, you were on the committee when we began to pursue that. I think many of us here, regardless, both sides of the aisle think that this is an approach

we could take. Where exactly is your side of things on carbon capture?

Mr. Matheson. Well, certainly we think it is an important technology to pursue. You are right. This has been discussed in the public domain for quite a while. Not a lot of action has happened in terms of significant commitment and research. From our perspective of the electric co-ops, we have been active in pursuing it. We funded something called the Wyoming Integrated Test Center which is a co-op facility in Wyoming where they are testing different technology for carbon capture.

Another one of our members, Minnkota Power in North Dakota, has got a project called Project Tundra. They are moving ahead now. That is going be a carbon capture effort at their coal-fired facility.

So we are trying to act on this and demonstrate how it can work in the real world but I would suggest that the technology is not as mature as it would like to be in terms of being readily economically available across the country.

But I think it is an important tool for us to take a hard look at and pursue because I think having reliable baseload power is an important part of maintaining grid reliability.

Mr. Upton. I think we all would agree.

With that, Mr. Chairman, I yield back.

The birthday boy, as I understand it.

Mr. Rush. The chair now recognizes the chairman of the full committee, Mr. Pallone, for five minutes.

Mr. Pallone. Thank you.

I wanted to start with Mr. Izzo. In your testimony you highlighted the impressive progress that PSEG has made in reducing carbon emissions and I appreciate that you also

acknowledge that Federal climate change legislation is crucial to achieving decarbonization in all sectors of the economy and we heard testimony at previous hearings about the need to electrify other sectors of the economy that are reliant on fossil fuels including the transportation sector.

So my question is PSEG has installed hundreds of electric vehicles charging stations in New Jersey to date while plans to install thousands more. What are some of the barriers to the build-out of the EV infrastructure?

Mr. Matheson. So the primary barriers for the build-out are market barriers. There is a chicken and egg issue that folks don't want to develop the infrastructure, absent penetration of electric vehicles; and folks don't want to buy electric vehicles, absent the development of the infrastructure.

So States that have successfully primed the market by having utilities build out the infrastructure as an way to eliminate the range phobia that limits the penetration of the electric vehicle itself.

Mr. Pallone. We have been reading these news reports about, you know, cities across the country that proposed a large EV charging network; but then they run into roadblocks. Seattle in particular comes to mind. What policies can we implement at the Federal level to broaden adoption of EV charging technology?

Mr. Izzo. Well, as is always the case, a little bit of encouragement of grant programs to States that do allow this to be part of a utilities rate base would encourage utility investment in that infrastructure.

Mr. Pallone. All right. I wanted to just -- I wanted to -- is this working? This is not working? I will just talk louder.

You wanted to -- Mr. Dennis -- and should the issue of market barriers to the deployment of renewable energy.

Increasingly electricity customers are becoming more sophisticated with their electricity needs; and whether the goals are simply to save money or supply reliable power and demonstrate leadership and sustainability in the UC, customers are looking for more options. But multiple barriers again remain, such as dependence on different countries that may not be allowed to put solar powers on your roof.

So, if I could ask Mr. Dennis, you spoke about this issue in your testimony. In your opinion what are the highest priorities that Congress can take in a potential climate build to remove these market barriers?

Mr. Dennis. We see a number of market barriers in the vein you talked about in terms of customers being able to better access renewable energy supplies or manage their own -- their own energy needs and there is a number of steps you can take. Certainly laying the policy groundwork for removing those barriers in wholesale markets but there is much more that needs to be done in terms of those wholesale market rules in terms of they take advantage of and recognize the technical and operational characteristics of those technologies.

We also see our corporate purchasing customers really prefer operating in a regional wholesale market where they see clear price signals that can really guide their investment in energy technology.

So certainly considering ways to continue to improve those constructs and continuing to expand them is something that would be of interest to our industry.

Mr. Pallone. Let me ask you one more thing. Are there forms of the

transactions in consumer-driven innovations that can't be undertaken, steps that have a vertically integrated market; and if so, could you give us some examples?

Mr. Dennis. We see a number of examples today, particular in the realm of distributed energy resources. So customers are adopting distributed energy resources at the Cox fall and as they want to manage their own energy use better and a number of companies are offering innovative services to those customers where they can maintain operation of that resource at the retail level, provide a service to those customers, and then also offer more services from that resource into the wholesale market.

So, offering services across retail and wholesale markets is a challenge. Many States, States and local utilities put up both implicit and explicit barriers to doing that; and there is much that can be done at both the Federal and the State level to remove those barriers and allow these technologies to provide a broader range of services.

Mr. Pallone. Thank you, Mr. Chairman.

Mr. Rush. Thank you.

We are having some technical difficulties. This hearing has global infrastructure. So, we have some technical difficulties, and so bear with us.

The chair will now recognize Mr. Latta for five minutes for questions.

Mr. Latta. Thank you, Mr. Chairman.

And I will speak louder and welcome to the Energy and Commerce Committee where we also have the committee I am a ranking member on. The communications, we can't make the microphones work. So, welcome. Thanks to our witnesses for being here.

Thanks, Mr. Chairman, for having the committee hearing today and if I could

welcome our former colleague. If I could, I would like to direct my questioning to you because I think it is important because I have the largest number of electric co-ops in a congressional district in the State of Ohio. I am proud of that fact. They do a tremendous job. I am now with them all the time. I know when they are doing out there.

They know more than I do, good or whether bad. The taxes they face today, that they are talking about that economic impact they might have but, you know, they are out there, dealing with things like security. They work, and they want to make sure that they are also reliable. So, they are trying to do the upgrades.

So, you know, many of those consumers are on fixed incomes that live out there, you know, a lot of them mainly rural areas and then you look at anything that is increasing energy costs have a significant impact on their daily lives.

And a couple of things that if I could just ask quickly you can follow up on. One, would you define baseload capacity, what you are talking about? Because I think that is a term that people have got to understand. I have 60.000 manufacturing jobs in my district from steel. I have. I have a central foundry that make engine blocks at General Motors.

Mr. Matheson. Baseload means that, absent some failure, it is available all the time. That is the simple definition. Others are intermittent.

Mr. Latta. So, I know that you just can't shut that on and off.

So, and the other term I would really like you to get into is when you are talking about that undue economic impact out there. Could you go into that?

Because, again, for my small, medium, and large companies out there -- I think the

mike is back on -- but we want to make sure that small companies company thrive out in our rural areas. But could you just talk a little bit about that undue economic impact?

Mr. Matheson. Yeah, and I offered partially on the previous question as well. Not only baseload is helpful; but when you mention those manufacturing entities, they need reliable power. They can't -- power bumps for certain manufacturing processes can be extremely costly.

So, having a reliable grid is also -- I am going to sound like a broken record: Reliability, affordable, reliability, affordability. So I wanted to mention that as well, particularly for many in the manufacturing sector that means a lot.

I think we want to be cautious as we look at, as all Federal legislation and policy, we always make decisions and then there are consequences that fall out from then that weren't thought through at the front end and that just is a creature of the business but I think we ought to be really careful here when we talk about energy policy because, again, this is a for my members' perspective we have a very disbursed, sparsely populated area. So the revenue per mile is limited, and any additional costs we have disproportionately hits every one of our ratepayers.

That is what I mean by those undue costs. It could be far more impactful for the rural areas than it is going to be fore a more densely populated urban area in terms of cost impact because we just can't spread the cost over as many people and so we are really in the most vulnerable spot in that regard and that is what I was trying to communicate to the community.

Mr. Latta. Well, thank you.

And many of the co-ops in my district have supported an all-of-above energy

policy. I know that we really started talking about that back in 2008, especially on our side, that we want to make sure we have both things running parallel together. When we are talking about that, we always talk about reliability.

Would you give your thoughts on this and why it is important to foster choice in selecting energy sources and not picking winners and losers out there?

Mr. Matheson. In my case I represent association. We have over 900 cooperatives. They are in 48 States. There is a lot of diversity of circumstance. It is dangerous to paint rural America with a broad brush in a lot of ways including their electricity profile, and so it is really important to meet the needs that are in a local area based on geographic considerations.

You know, solar in Arizona and solar in Michigan and solar in Maine are three different things; and it is really important that we have policy that allows that flexibility for the whole portfolio of energy choices to do what makes the most sense for those community.

And since we are consumer owned and we are owned by the people in the community we serve, that drives all of our decision-making in the cooperative movement. So, that is why we think the all-of-the-above or having full complement of choices makes sense for my membership.

Mr. Latta. That is really important because, again, I am in my district all the time when I am back home and I know that we have got to keep that power on and, you know, we have issues like we did back in 2014 with the polar vortex that hit that we didn't have any blackouts, brownouts in the State of Ohio and it was important because everybody, everybody was out there, doing when they had to do to keeps the lights on and keep

everything running. So I appreciate you coming back, and it is good seeing you again.

Mr. Chairman, I am going to yield back the balance of my time.

Mr. Rush. The gentleman yields back.

The chair now recognizes Mr. Peters for five minutes.

Mr. Peters. Thank you, Mr. Chairman. I also echo that it is nice to see Mr. Matheson. He was always our coach when I was a freshman about how to behave out here and not to take dumb votes but I appreciate seeing you again, Jim.

I want to ask a question for Ms. Palmer. In September, 2008, Governor Brown of -- then the governor of California signed SB-100 in my home State which managed the State to achieve a hundred percent carbon neutrality by 2045 and we are advancing toward that goal as far as I understand.

Why is that approach not the right approach, or is it the right approach at the Federal level?

Ms. Palmer. So thank you, Congressman, for your question.

So one of the features of SB-100 is, while there is specificity about the renewables goal in the interim years, there is a declared goal for 2045 but the mechanism by which you are going to get to that goal and the technologies that are going to count is sort of unfolding and I think the types of bills that we are talking about here today are examples of things that could be used to reach that goal.

For example, a clean energy standard would be kind of in the spirit of SB-100 because it is open to allowing variation technologies and getting the full fleet of options out there through a crediting mechanism. So there is a lot of similarities between policies that might emerge under that type of policy and the policies that we have been

talking about here.

Mr. Peters. I assume that a pricing strategy for carbon would be one of the tools you would use to reach that goal as well.

Ms. Palmer. Yes. So one could directly price carbon, as I mentioned in my testimony, or use a crediting program that credits clean energy relative to some emission rate standard; and depending upon how those policies are designed, they can be very similar in outcomes and levels of efficiency as work at Resources For the Future has shown.

Mr. Peters. Right. We appreciate your work.

I would ask the question to Mr. Izzo or Mr. Dennis about other baseload clean technologies. We are creating energy resources using technologies like battery storage and smart grids. But what percentage of a carbon-free portfolio do you think we can create across the Nation with new carbon-free baseload technologies including hydro, smart modular reactors and what would Congress be most useful -- what would be the most useful thing for us to be doing in terms of affecting that?

Mr. Izzo?

Mr. Izzo. So we have pledged we believe we can get to a hundred percent carbon free by 2050 through some combination of public policy changes in technology developments. The technology developments that we would anticipate would be needed, you mentioned two of them. They would be improvement in battery storage technology and advanced nuclear fuel cycles.

Mr. Peters. Okay. Mr. Dennis.

Mr. Dennis. Like others on this panel, we support a technology-neutral approach

that allows all toxinologies to compete in the market and so what percentages within the baseload definition that Mr. Matheson gave you or in some other definition is really it is how do all of these toxinologies work together. The technologies you mentioned, modular nuclear reactors, battery storage in particular, how do they work together to maintain moment-to-moment balance and reliability on the system? It would be a variety and a portfolio of technologies, all operating within that goal that this committee has of a net zero carbon emissions by 2050.

Mr. Peters. So one of the carbon -- one of the technology-neutral strategies we have heard about to push these developments, to incentivize development is carbon pricing. Other than either cap and trade or carbon fee, do you see something that the Federal Government should be doing to generate that innovation?

Mr. Dennis?

Mr. Dennis. I think I agree with the thrust of Ms. Palmer's testimony in the sense that there are a number of options that this committee should consider. It should really take a holistic approach. As I mentioned in my testimony, we support the policy objective of net zero carbon emissions by 2015 and carbon pricing and clean energy standards. Those are all potential options that should be studied. There is probably no one silver bullet here. They are all going to work in different ways and so considering all of those options together. Take a look at what the States are doing as well. The States have pursued a number of different objectives, your States and others, that can all be looked at and considered by this committee.

Mr. Peters. Since you are here and I will push you a little bit more because we are the ones that are supposed to study it. I think this is the classroom here a little bit.

Are there particular States you think are doing a better job than others?

Mr. Dennis. That is a hard question to answer because we have a number of States we are working in, and I don't want to choose among our children that have done well in moving toward a hundred percent clean energy grid.

But certainly, you know, some of the examples are obviously your State of California in setting the objectives and, as Ms. Palmer talked about, working through those policy objectives. We have recently seen Colorado move toward 100 percent clean energy as well in its legislation. So, there are a variety of approaches.

Mr. Peters. My time has expired.

Thank you, Mr. Chairman.

Mr. Rush. The gentleman yields back.

The chair now recognizes Ms. McMorris Rodgers for five minutes.

Mr. Rodgers. Thank you, Mr. Chairman.

And I wanted to say thank you to the entire panel for being here today. I appreciate hearing your perspectives.

Reducing emissions, carbon emissions, is a shared goal. However, I believe that we must be realistic; and we must be honest about the challenges that we face. We need a strategy that provides consumer choice, ensures affordability, and maintains grid reliability and capacity.

Clearly the United States is a large country. It is diverse; and coming from different regions, different States, you find that there is different strengths and needs. A topdown Government-mandated approach is not going to be workable. For some States, nuclear is the best option. For others it is wind, solar, or natural gas. Others it

is hydropower.

I am excited about the technological innovation and the American ingenuity that enables us to develop a variety of new cutting-edge ways of clean energy production. I am proud that America is leading the world in reducing carbon emissions.

Eastern Washington is a leader in clean energy solutions. Hydropower built the Pacific Northwest. It built our economy; and it continues to provide clean, renewable, reliable electricity. In fact, we are No. One. We have the lowest electricity cost in the country. It accounts for 70 percent of the energy in Washington State; and as we all know, it is the largest source of renewable energy in the country. We could double hydropower in America without building a new dam simply by investing in technology.

However, right now in America it takes 10 years to license a new hydropower project. You compare that to 18 months for a natural gas facility. We can and we should do better. Washington State is known as being a leader in wanting to bring down and reduce carbon emissions. Just in January, though, there was an article in The Seattle Times that was highlighting that carbon emissions are actually up.

In Washington State over a decade ago, we wrote a plan into law to reduce carbon gas emissions to 1990 levels by 2020; but the latest tally of States emissions show that we are trending in the wrong direction to meet that target and that more emission goals are ahead of us. In fact, the legislature has continued to increase those carbon emission goals. The fact though is from 2012 to 2015 our carbon emissions spiked 6.1 percent due in part to increasing fossil fuel-generated electricity.

So at a time when we have this shared goal, we should be embracing what makes sense in each region of the country; and for us it is hydropower. We shouldn't be

putting more costs and more mandates on hydropower. We should be actually moving forward with licensing reform here at the Federal level, in Congress.

And you know that I have worked on this and I encourage the majority in their goal to move legislation to -- I urge you to take action to address the licensing of hydropower projects in this country. Without it, I am not sure there is a realistic path to success.

So I wanted to ask Mr. Matheson -- and I, too want to welcome you back to the committee and appreciate your service and your continued leadership. I want you to expand on the role of hydropower in terms of grid reliability, capacity. How does it compare to other forms of renewable electricity?

Mr. Matheson. Well, you stated the case well; and it matters a lot. Pacific Northwest, of course, is where it is so important; but I have to got tell you. We have got over 600 electric co-opers in the country to get hydro from Federal power marketing agencies in 34 States. So this issue translates across a lot of country, maybe not quite to the proportion it is in the Pacific Northwest; but by members in that part of the country it is a significant part of their power supply. The low rates are an important part of how they provide affordable power, and it is extremely reliable.

It is interesting. You mentioned the history that it built Washington and it is such a significant part of the history of the northwest and yet here we are today, talking about moving to a more of a carbon-constrained future. It is just another value adder for the hydro assets, quite candidly.

And it seems to me that I would concur with your statement that any discussion about moving ahead for Federal policy to enact a more carbon-restrained future, that the

consideration of how we can best enhance our hydroelectric generating capacity ought to be right at the top of the list because it is there.

Ms. Rodgers. Thank you. I appreciate you making that point because, hydropower, we have new technology; and it isn't just Washington State. It is all over the country, 34 States; and there is potential to double it.

Thank you, Mr. Chairman.

I yield back.

Mr. Rush. The gentlelady yields back.

The chair now recognizes Mr. Doyle for five minutes.

Mr. Doyle. Thank you, Mr. Chairman, for holding this hearing today.

Jim, it is good to see you back here and appreciate all the work that we were able to do together when you served on the committee here.

We know climate change is real. It is affecting our communities today. It is going to get worse if we do nothing to reduce our greenhouse gas emissions. I believe we must get to a 100 percent net zero emission economy by 2050, and we have to take aggressive action to do so. Since the power sector is responsible for almost one third of the country's greenhouse gas emissions, finding ways to decarbonize a sector is going to be vital as we attack climate change.

Ms. Palmer, we know that in order to get to net zero emissions there will be a large expansion of renewable energy resources such as solar and wind. We also know there is challenges to rapidly incorporating a large amount of intermittent renewables onto the grid. This is why I believe it will be important to deploy energy storage so that grid operators can better manage the fluctuating power supply of renewables.

For this reason I have introduced H.R. 2096, the Energy Storage Tax Incentive and Deployment Act, which aims to expand the deployment of energy storage by extending a 30 percent tax credit to qualifying energy storage products.

Ms. Palmer, as we add large amounts of intromittent energy, how critical is energy storage going to be to ensuring grid reliability and resiliency; and if an incentive like my bill is successful in getting more energy storage deployed, would that significantly alter the modeling for the amount of renewables we could deploy as we move towards net zero by 2050?

Ms. Palmer. Thank you, Congressman, for that question.

Energy storage is indeed going to be crucial as we move forward with a renewable grid. I think energy storage could take a variety of forms including grid scale batteries but there also could be storage opportunities on the customer side of the meter associated with charging vehicles and perhaps preheating water, for example, as happens in some locations today but could happen more if we move to electrify our water heating stock out there.

And, in addition, longer term types of storage are going to be necessary as well. I have to confess I am not familiar with all the details of your bill but I do think we need to attack storage from a sort of shorter-term perspective of carrying renewable energy through the day but also dealing with seasonal fluctuations in the supply of renewables which is probably a bigger challenge, particularly as they become an increasing share. So storage is going to be really important in that realm as well.

Mr. Doyle. Thank you.

Mr. Izzo, New Jersey is a member of the Regional Greenhouse Gas Initiative, a

regional cap and trade system; but as you testified, the State also created a clean energy credit for nuclear power. Our governor in Pennsylvania has recently announced that we are going join RGGI; and while our long-term goal is to reach net zero carbon emissions in the short-term, I don't want to see a situation where nuclear power plants are closing now and being replaced by fossil fuels. That would only lead to increased emissions and the loss of hundreds of good paying jobs.

What lessons about incentivizing and retaining clean energy sources have you learned from your experience as part of RGGI, and what do you believe are the best strategies for retaining our current nuclear power fleet so that we can more quickly meet our clean energy goals?

Mr. Izzo. Thank you for the question, sir.

So the biggest challenge between RGGI and electric power markets, Pennsylvania and New Jersey alike, is that the RGGI States do not coincide with the PGM power market States. So, therefore, the regional power market does not see the price signal that RGGI is intended to deliver. So, the RGGI costs don't get reflected in other generators that are not part of RGGI; and, therefore, nuclear does not benefit the way it should from being carbon free, thus the need currently for direct State action to rescue the nuclear plants. Otherwise, as you said, we would lose an important carbon free source of electricity.

If there were Federal action, then nuclear in Pennsylvania, New Jersey, Maryland and every other State would see the benefits of being carbon free.

Mr. Doyle. Mr. Anderson, first of all, I want to thank you for being here. I think it is important that we get labor's perspective in this hearing also, and we have talked a

lot about how the grid will change as we decarbonize. We have also seen firsthand in Pennsylvania how devastating it is for a community when a nuclear manufacturing plant closes.

What can we do at the Federal level to ensure that workers are at the table for these discussions, and how can climate legislation reflect the needs of workers in these energy-intensive industries?

Mr. Anderson. Think you very much for that question, sir. This is a topic we take more seriously than almost any other on energy policy. We used to have considerable coal assets in Pennsylvania. Today we have none, zero; and the effects when those plants in Pennsylvania closed were the same as they were when they closed anywhere. They were devastating. You cannot overstate the impact that it has on workforces and communities.

What we can do as nation is begin to design robust policy response to that, and it is not impossible. It is just a choice to do it. Other countries have undertaken this. A particularly good example is Germany that is powering billions of Euros into transforming their coal sector and at the microlevel they go all the way down to assigning individual case workers to workers to take what are their situation, what are their skills, how do we move them over here and they have a very high success rate in doing that. Canada similarly has undertaken a national effort and a provincial effort in Alberta to design robust policy to do this.

In all of those cases -- in those cases and others, there are other countries. They have fully integrated labor into those discussions and to into designing those and asking people, What do you need? What are your communities going to need? If you don't

ask, you don't know. I will humbly submit that labor is indispensable to designing that.

Mr. Doyle. Thank you Mr. Chairman. Thank you.

I yield back.

Mr. Rush. The gentleman yields back.

The chair recognizes the gentleman from West Virginia, Mr. McKinley.

Mr. McKinley. Thank you, Mr. Chairman.

For the foreseeable future, the world is going to continue to have this voracious appetite for fossil fuels. We just have to understand that.

And according to the IER -- I guess we have been screwed over.

Mr. Rush. Waiting for the popcorn.

Mr. McKinley. The quote that we wanted to put up there that they didn't want to show says that global carbonization, that we are going to increase by 16 percent by the year 2040 around the world and China, India, other Asian countries, we have got a chart that they have chosen not to put up that shows the rest of the world is going to continue to build fossil fuel plants all over the world.

The next chart that they didn't show shows that in China the C02 emissions are going to be up 290 percent in the last 10 years. India is up 235 percent in the same time the United States --

Mr. Rush. Mr. McKinley, excuse me. We are having a -- some more technical difficulties. Are you prepared --

Mr. McKinley. We tried to work it out, and they said they would be fine when they did it. So obviously they weren't. They weren't straight up with us.

Voice. I think they are trying to get it done.

Mr. McKinley. The next is we see China out there funding carbon plants all across the world at 102 gigawatts. That is like the equivalent of maybe a hundred power plants or 150 coal-fired power plants. China is still going to use coal.

So, if we ignore this body of evidence, let's look for just a moment then, just ignoring this, let's look at the body of evidence about this commitment that we are trying to make to go a hundred percent renewables. It would halt fossil fuel research and we would be abdicating our role of global leadership in developing technologies on carbon capture but we would be pivoting to renewables.

Look at Moniz's quote that we have; and, again, his quote earlier this year in February said that the idea that by 2050 we are going to have 100 percent renewable system is not realistic. This is the Secretary of Energy saying this.

So, let's deal with how we are going to concentrate on battery storage that everybody likes to talk about. Let's look at the complications with that because the Wood Mackenzie report has already said if we are going rely on batteries, we they'd to have 900 gigawatts of power capacity but around the whole world today there is only 5.5 gigawatts of power.

We have got a real challenge. We have got to get away from the political jargon of saying we need the battery. How are we going to do it? And so if we are going go battery storage, let's talk about the ecological impact of extracting Lithium for batteries, 500,000 gallons of water to get 1 ton of Lithium. What about the social cost of acquiring cobalt, the new blood diamond in Africa?

So and then we have to disregard the 2017 study that Moniz's group did, The Energy Futures Initiative, that declared that found out that in California one in four days,

25 percent of the time there was not sufficient wind to have wind energy in California.

So, despite all of this science and the evidence to the contrary, let's assume America can decarbonize. What would be the metrics of the progress? Think tanks have already concluded that because of the continued international consumption that we have already talked about, the fossil fuels, the fact that they are going continue to increase their use within five years of us totalling decarbonizing, we will be back to neutral again because they are going to continue to use it and we won't have -- there will just simply be offset by what the other countries are doing.

And we are still going to have -- we are still going have all those threats: Temperature, sea levels, wildfires, droughts, tornadoes. The MIT quote that we tried to put up said -- MIT has come out and said that, regardless of anything the United States does to decrease its emissions, until China and India reduce their emissions, the results will be climate catastrophe.

So, I want to get to this as quickly as I can. I am sorry that we lost the time in not being able to get our quotes up. So if we totally do transform our economy -- and for initially the air will be cleaner but, having abandoned our research on fossil fuels, America will be at the mercy of harmful emissions of other nations that are not following our lead.

So it has come down to a choice. What are we going to do? Are we going to abandon what built America great, powerful, and switch over; or why don't we fix it? Why don't we do it? We stay in the game to do research and innovation. Do any rational scientists really expect that China and India are going to cut their coal fire emissions? No.

So, if I could go back to you, Matheson, I begin. Am I wrong than?

You cost me the time up there.

Mr. Rush. Mr. McKinley, I know and I understand and the chair will give you an additional one minute. However, I really do want to apologize.

Mr. McKinley. Thank you.

Am I wrong? Are we going to have wildfires?

Mr. Matheson. I do think it is important, your statement that we should continue with fossil fuel research, because, as I said in my opening statement, I believe that coal and natural gas are going to continue to be part of our portfolio and we should be looking at carbon capture technologies that allow us to do that. I think it is going to be an important step.

If the United States leads in that opportunity and develops that technology here, I think that that may have the impact globally over time where that technology; but we should be the leader on that technology.

Mr. McKinley. We have got to have it. What about the use it Act? Would you support the USE IT Act?

Mr. Matheson. Yeah, yeah, the -- we do.

Mr. McKinley. Mr. Anderson, how about you? Would you support the USE IT Act?

Mr. Anderson. We already do, sir.

Mr. McKinley. Okay. Thank you.

I yield back whatever time you gave me.

Mr. Rush. Mr. McKinley, I want to reiterate most staff are working on this technical issue; and I do want to reiterate.

The chair now recognizes the gentleman from Maryland, Mr. Sarbanes, for five minutes.

Mr. Sarbanes. Thank you, Mr. Chair.

We are having trouble again. I am just going to -- we are cut out again. I will use my outside voice. I want to welcome our former colleague, Jim Matheson. Thanks for coming and testifying and the rest of the panel as well.

And thank you, Mr. Chairman, for holding the hearing today. The hearing is an important issue. Obviously we all appreciate that climate change, the existential crisis of our time; and we have to take all measures to address that.

Decarbonizing our economy is at the top of that list in trying to achieve zero emissions by 2050 if we can in order to avoid most disaster impact.

You all have been emphasizing, we certainly appreciate it, that addressing the climate crisis will take a multilayered approach and a component of that will certainly be the infrastructure that we are building and in this committee you probably know we introduced an infrastructure package to address, among other things, the energy infrastructure needs. As we move towards decarbonizing energy sectors and where it is more renewable energy, we need to invest in our electric bill. Not only is that grid aging but we need to modernize it for the 21st century.

Now I am going to come clean. I have a bill. We have been hawking our wares up here today. It is call the 21st Century Power Grid Act which is designed to do just that. It would empower the Department of Energy to support projects that improve grid performance, security, resiliency through grant-making and cooperative agreements. It is designed to kind of leverage investment and put attention on when it comes to building

that smart grid.

So, Mr. Dennis, can you explain in your view, do you agree why our Nation must invest in modernizing electric grids to accommodate these renewable energy and innovative technologies?

In other words, we are talking a lot about the innovation of energy, but talk a lot about the grid that receives those new kind of components of portfolio and how to make sure that we are maximizing that in a way that decarbonizes the environment.

So, if you could, just speak to that and what reliable service to customers looks like.

Mr. Dennis. Absolutely. It is again you are going to hear from me a lot. It is range of toxinologies working together. You mentioned the grid and both the transmission and the distribution grid. There is a number of investments we can make to make those grids more flexible, to make them more efficient, to get more out of the infrastructure than we already have.

And then we have got a real job do to build infrastructure in key places to access low cost, renewable resources that aren't near the grid we have today. That takes a lot of planning and then obviously the will to get it done.

But certainly all of those technologies working together is what is going to provide us a reliable and resilient grid and we have to think about it both at the transmission level and at the distribution level as well.

You know, obviously transmission is key to accessing renewables; but we also need a strong and flexible distribution grid to allow customers to take advantage of new technologies like energy storage and distributed energy toxinologies.

Mr. Sarbanes. Thank you very much.

Lucy with the football here.

Mr. Izzo, I would like to get your perspective on grid resiliency, particularly with the impacts of Hurricane Sandy, my district like, you know, yours and others has been impacted and continue to feel the effects of climate change, rising sea levels, et cetera.

So, could you talk about how PSEG has worked to build resiliency; and do you have any additional recommendations on how we can help empower sectors to build out that resiliency?

Mr. Izzo. Yes. So, we have invested north of $3 billion over the past 12 years since Superstorm Sandy and the range of activities, some as simple as literally lifting equipment off the ground in areas that are now more subject to floods.

In other cases what we have done is we have changed the geometry, the electrical geometry, of the grid so that we can feed customers from multiple directions in the event of power being lost.

Clearly whenever one undertakes actions like that, it is a cost impact on customers. So, the No. 1 thing Congress could do is assistance programs, particularly for lower-income populations as they experience these elevated costs due to the physical improvements to the grid.

Mr. Sarbanes. Thank you very much.

Mr. Rush. The chair now recognizes Mr. Kinzinger for five minutes.

Mr. Kinzinger. Thank you, Mr. Chairman.

Thank you all for being here.

I think the best way to address climate change is by reducing not only our Nation's

carbon emissions but that of the rest of the world. The changes pose both short and long term challenges that I believe can be addressed in two major ways.

First, we need diversity in our energy resources. Energy diversity is energy security. This is comparative to one's own personal investment strategies. When you are looking to invest, you don't put all of savings in one stock and let it ride. You diversify your investments into various funds. Similarly this nation cannot afford to put all its eggs in one basic.

Second, we need to support market-driven innovations to develop new clean energy technologies that will put the U.S. at the forefront of environmental technology. My district, the 16th District in Illinois, is a great example of what it can look like. My district and really the whole State of Illinois is home to a broad array of energy sources.

Nuclear generators provide the most abundant, clean, and stable source on the plant; and my district's home to four nuclear generating stations, in addition to hundreds of wind turbines, solar powers, geothermal sources, and others. These diverse sources not only provide yearend reliable clean energy but have produced high paying jobs for my constituency.

While some may say that the U.S. needs to be a leader on reducing emission and combatting climate change, I would say we actually already are.

Since 2005, global emissions have increased by 20 percent, while the growth rate of United States emissions has decreased by more than the next twelve emission-reducing countries combined. It is going take a major innovation and breakthroughs to not only reduce our emissions here at home but also convey this ability to others around the world.

All Americans want to be good stewards of their environment, and this desire drives markets. Tesla doesn't sell cars because of the sound system or you want to put solar panels on their roof because they look good. It is just smart.

So if there is one thing I noticed in each of the witness' testimonies, it is that everyone either strongly supports nuclear energy or at least recognizes that it is not reasonably possible to achieve emissions reductions goals in the near term without it.

So, Mr. Matheson, let me ask you. As you know, nuclear is an important source of baseload emission power for many co-ops. Would it be possible to continue making sustained emissions reductions if we don't maintain a strong nuclear fleet?

Mr. Matheson. I think you can't do that, and I also think you have a reliability concern if you don't maintain that fleet as well.

Mr. Kinzinger. Yeah, I think you are right.

Mr. Bear, your testimony shows that you are resource planning for upwards of 40 percent renewable energy. Can you talk about how much wind would you have to bring online that replace the premature closure of a nuclear plant?

Mr. Bear. We haven't looked at it that way because they are not equivalent.

Mr. Kinzinger. But it does produce X amount of power. In theory, if you bring a plant offline, you have to bring, if you are going to --

Mr. Bear. Depending on where it is, maybe 1.5 to 2.

Mr. Kinzinger. 1.57 to 2.

Mr. Bear. Two megawatts for every one you retire.

Mr. Kinzinger. Okay. And as you may be aware, Vistra Energy is slated to close four coal plants in Illinois by the end of the year. This include the Hennepin Power Plant

which is in my district, as well as plants in Coffeen, Havana, and Canton. It is my understanding your organization, the Midcontinent Independent System Operator, and PJM must approve these closures based on an analysis of whether they are needed for grid reliability.

Is that accurate, and can you explain further your role in this process?

Mr. Bear. So that is true. They submit a study to us or a request for us to study the retirement. We take a look at what impact is from a liability standpoint on the grid and render them a decision. If it has reliability consequences, we ask them to wait until we can build a transmission line to solve the problem.

Mr. Kinzinger. And is that review currently underway, and how would closures like these affect reliability?

Mr. Bear. I can't answer your second question because we are studying it, and that review is underway.

Mr. Kinzinger. Do you have a timeframe on that by chance?

Mr. Bear. Probably 12 months.

Mr. Kinzinger. Not only am I concerned about reliability, I am concerned about two more things, job loss and stranded assets or really wasted assets. This closure means scores of my constituents without jobs. It also means we have a usable facility linked into the grid with no power being fed into it.

So, Mr. Matheson, given the reliability concerns, job loss, and wasted asset factors, shouldn't there be some sort of arrangement to convert these facilities to solar storage or some type of facility before forcing them offline?

Mr. Matheson. I think you have got to think about all potential possibilities to

mitigate the impact of stranded assets and the ones you -- those items you suggested shouldn't be on the list.

Mr. Kinzinger. And do you see any needs for policy changes on that front?

Mr. Matheson. Look, I think we haven't had Federal policy that is for stranded assets to this day. I am not sure there is a Federal role in that, but I do think the consideration of workforce impacts and community impacts on plant closures is something that we should all care about.

Mr. Kinzinger. Excellent. I will yield back, Mr. Chairman. Thank you.

Mr. Rush. The gentleman yields back.

The chair now recognizes Mr. McNerney for five minutes.

Mr. McNerney. I thank the chairman, and I thank the witnesses this morning. I appreciate your testimony.

I am sure you all watched in horror and dread the California wildfire situation. The challenge is how do we balance reliability with safety, given an aging infrastructure.

Mr. Izzo, you have had to confront the challenges associated with extreme weather events. What lessons can we learn as we expand electrification while also adapting to climate change?

Mr. Izzo. Yes. So there is an element of adaptation that is important. We are all paying the price for under-investing in an aging infrastructure. PSEG, for example, has transmission towers that are approaching a hundred years old.

We have gas pipes that are in excess of 100 years old. These are expensive improvements, but they must be made. We seek to balance them with high investments in energy efficiency and direct those investments in energy efficiency at

those populations that are most vulnerable to the increase in builds associated with the more resilient infrastructure that we seek to build.

Mr. McNerney. Do you see there is a role for the Federal Government in assisting in this transition?

Mr. Izzo. As I mentioned earlier, it would be in a LIFT Act or in the form of a LIHEAP type of program.

Mr. McNerney. Right. I couldn't agree more.

Mr. Dennis, you noted the importance of developing new tools to assist utilities in containing isolated outages within the grid, as well as keeping critical infrastructure functioning while the rest of the grid can go down.

Can you expand on some of the new planning tools and operational changes you would like to see?

Mr. Dennis. Certainly. I think we need to be planning for a more distributed grid certainly that can isolate these kinds of unique challenges. We also need tools and training to help market operators and system operators understand how new technologies, a more distributed system, a system that is more categorized by variable renewable energy, is operated and how it can be operated most efficiently and effectively.

Mr. McNerney. Thank you.

Ms. Palmer, you noted that a long-term need to consider wholesale electricity markets and the bulk electric system will be designed, planned, and operated in a future reliant on low and zero carbon energy technologies. Can you expand on the necessary modeling practices and market rules that must be developed in order to capture the

value of advanced energy and grid services?

Ms. Palmer. Yes. So I think there are a number of options out there that various groups are exploring with respect to wholesale market design reforms and I think that this is going to be a subject of some ongoing discussion but basically when you are in a situation where a lot of generators have zero marginal cost, that may limit the number of hours in which there are opportunities to earn revenues and those hours would occur when demand is really high and supply is scarce and that would create scarcity pricing that would be a potential source of revenue. And the questions remain about whether those scarcity events are going to overlap with the availability of renewables and investment occurring. So, some more exploration of those opportunities is important.

Alternatively, people think greater reliance -- another group of people think greater reliance on sort of a centralized planning procurement approach would provide more assurance and that approach could overlap potentially with approaches like a technology-neutral clean energy standard that would create important value for those resources and lead to more investment. So I think it is an ongoing discussion and something people are paying attention to and will be advancing.

Mr. McNerney. So, it sounds like you think the Federal Government's role could be some sort of renewable energy standard and research money.

Ms. Palmer. Yeah, definitely, yeah.

Mr. McNerney. Thank you.

Mr. Izzo, again, according to NREL, today's commercially renewable technologies are more than adequate to provide 80 percent of electricity generation in the United States by 2050.

Can you speak to the important role that the federal investment in climate-related research will play in helping utilities decarbonize?

Mr. Izzo. Yes. So research and development will be an instrumental part of any attempt to decarbonize our future. Material science research in particular to help improve the efficiency of solar conversion, material science research to help improve the size of turban blades that can then capture greater degrees of wind and higher capacity factors would all be useful in future decarbonization, and, of course, advanced fuel cycles in nuclear.

Mr. McNerney. Thanks. I spent a career developing wind energy technology. I am pretty excited about offshore development. What about the challenges that a project of that magnitude gives in terms of the Federal Government's role in helping?

Mr. Izzo. So, as you know, the challenges on offshore wind are both technical as well as public policy. Something as simple as the requirements to meet The Jones Act and the limitations that puts on vessels that can be used to transport these very large structures is going to increase the cost of offshore wind in the Nation.

The depth of our waters is different from some of the regions around the world where this has been done successfully. So, there will be some technology modifications that will need to be utilized as well.

Mr. McNerney. We will have to have floaters in California. It's too deep out there.

Thank you, Mr. Chairman. I yield back.

Mr. Rush. The gentleman yields back.

The chair now recognizes the gentleman from Ohio, Mr. Johnson, for five minutes.

Mr. Johnson. Thank you, Mr. Chairman.

And thanks to our panel of witnesses here today, testifying.

You know, many of my colleagues on this committee have repeatedly and rightfully expressed concerns about topdown Federal proposals such as the likes of the Green New Deal. Now it is important to discuss how we can achieve emission reductions and that is a big debate but I worry that these types of approaches will cause electric rates to rise astronomically, while our domestic economy stagnates in the process to say the very least.

Instead of a one-size-fits-all approach to these issues, we need to ensure our laws and regulations foster competitive markets that allow our innovators to innovate and to compete.

So, Mr. Bear, what role has MISO played and what role can MISO play in the future in ensuring well-functioning markets, competition, and the most cost-effective option for consumers?

Mr. Bear. Well, what we try to do is conduct a series of studies to understand as the portfolio evolves and changes and we bring more intermittent resources on the portfolio, what do we need to make that portfolio reliable? What attributes need to be there? Is it flexibility?

Is it frequency response, you know, those kinds of things, and then understanding what those attributes are and as Ms. Palmer noted, pricing them appropriately using different regimes so that they can be compensated appropriately and they are there when we need them.

Mr. Johnson. So can you comment on how a proposal like the Green New Deal

might inhibit these possibilities?

Mr. Bear. I can't comment on that. We haven't studied how that would inhibit what is going forward and what we are doing.

Mr. Johnson. Okay. All right.

Mr. Matheson, electric cooperatives cover some of the most sparsely populated and costly-to-serve areas of our country. Many parts of eastern and southeastern Ohio are good examples of where rural, hilly terrain can prevent some very unique or present some very unique challenges for co-ops to deliver reliable electricity.

But they do and in many ways these challenges are similar to those inhibiting the rollout of successful, reliable, rural broadband deployment as well. The economies are very, very similar.

Mr. Matheson. Right.

Mr. Johnson. Can you speak to some of the challenges co-ops have faced and have overcome in order to provide reliable cost-effective electricity to rural America?

Mr. Matheson. Sure. And I know you visited co-ops in your district. You know them well.

Look, I think that you laid the predicate really well. At one level it is pretty simple. You have got these sparsely populated areas. So, the economics are very challenging just on the revenue per mile. That was the case in the 1930s.

That is still the case today in terms of electrification; and now it is the case in terms of broadband, as you suggested, as well.

What do we do? What I think is interesting about the cooperative movement is these are smaller utilities. Sometime you may think they are little slow to the action.

Actually they are really innovative; and the embracing of technology like automatic meter infrastructure, the penetration of that across all co-ops this in this country is far higher than the utility sector in general, which gives you greater telecommunication capability to monitor how electric use is taking place at the source.

And so I am impressed with how we have tried to within the co-op family embrace this innovation in a way to make it work; but every decision we make, as I said in my opening comment, we have no shareholders. It all goes to the consumer, the impact, for good or bad. It all goes to the consumers.

We are very careful about making good decisions but that doesn't mean we don't embrace innovation and that is how we try to take on that challenge in economic circumstance.

Mr. Johnson. I think you make a very valid point. Those co-ops are very, very innovative. There is a lot of innovation in rural America. You know, I am often reminded in the late 1800s, early 1900s, Dayton, Ohio, was a rural area. Two bicycle tinkers with no college education figured out how to master the power of flight, and they did it out in the middle of a field. It is unbelievable, and we are missing a lot of that.

And so what one final question. Why do you think co-ops have been able to overcome these challenges? Is it their ability to share experience amongst cooperatives, the obligation to serve all their customers? Why have they been so successful, do you think?

Mr. Matheson. I think those are two important factors but I will give you the most important I think is that we are consumer owned and so and the consumers are the owners of the co-op.

So the consumers driving the decisions and they live with those decisions and that consumer bottom-up approach has created a very localized approach across the co-op network in this country in terms of how we make these decisions. I think that has been a real success factor for us.

Mr. Johnson. A lot can happen when you have a need-to motivation versus a want-to motivation.

Mr. Matheson. Right.

Mr. Johnson. I thank you.

And I yield back.

Mr. Rush. The gentleman yields back.

The chair now recognizes Mr. Tonko, my friend from New York, for five minutes.

Mr. Tonko. Thank you, Mr. Chairman.

And thank you to our panel of witnesses including my former colleague, Congressman Matheson. Good to see you all and thank you for your input.

Mr. Izzo, many utilities are making commitments to 80 percent or more emissions reductions; but they all caution that achieving that last 20 percent will be difficulty and will require technology developments and breakthroughs. Earlier you shared the carbon pricing riddle with this subcommittee and very cleverly stated.

How important is setting a clear and rising price on carbon today in order to achieve commercialization of new innovative technologies, some of which might be appearing 20 to 30 years into the future?

Mr. Izzo. I think -- thank you for the question.

I think it is vitally important. Most of these investments, whether it is offshore

wind, battery storage, or solar farms are multi-decade capital intensive investments; and one pretends to understand the economics for literally 20 to 40 years out into the future.

And when you do that kind of a discounted cash flow analysis, having some predictable price on carbon will just give tremendous clarity and, therefore. Motivation for people to make those investments and, where there are investments, creativity and entrepreneurship will follow.

Mr. Tonko. Thank you.

And, Ms. Palmer, same type of question. What do you think the role of carbon pricing, a sound carbon price, plays in terms of spurring innovation and investment the technologies will require?

Ms. Palmer. I think it is extremely important, Congressman. The prior examples that we have of pricing pollution include the Title IV program to price SO2 emissions in this economy and I think we see several examples there of innovative approaches that were developed when power generators were faced with a price associated with emitting SO2 and they found creative ways to reduce those emissions.

So, I think similarly here, when we provide that incentive, there will be all aspects of the sector will be looking for ways to reduce. So it is really important.

Mr. Tonko. I would imagine just engaging in the economy-wide outcome with carbon pricing.

Ms. Palmer. Yes.

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[12:32 p.m.]

Ms. Palmer. Yes. That is -- yeah, that is --

Mr. Tonko. Takes some of the -- provides the flexibility so that we don't have to really project which sector is going to produce the results we require, I would think.

Ms. Palmer. Exactly. And, you know, the innovations that are happening related to electric vehicles are spilling over into the power sector, and the climate challenges touches on all of our uses of energy. So I think it is important to try to get an economy-wide price to see those.

Mr. Tonko. Thank you.

Mr. Bear, MISO includes some renewable rich geographies. Many of them are also far from major load centers. My understanding is within MISO, several transmission projects have been planned and completed to integrate more renewable resources.

Would ambitious State or Federal clean energy targets require additional interregional and regional transmission development and, if so, to what degree?

Ms. Palmer. Sure. And thanks for your question.

So to the first part of your question, we did put a $3 billion portfolio in place. It has been incredibly successful, about a three-to-one benefit-to-cost ratio. We were able to lower prices for consumers, and it is almost complete at this point.

We do need another portfolio that is regional to move forward and balance out

what we have got. As we sort of decentralize the resources that are on the grid, we are going to have to change the way the grid is configured and how it works and make sure that we can move all of attributes where we can move them to keep reliability high.

Mr. Tonko. And what sort of timespan would you imagine will be required in order to meet the goals?

Mr. Bear. It will probably take 8 to 10 years to get something like that done.

Mr. Tonko. Okay. And, Mr. Izzo, again, to the infrastructure issue. And I heard you speak to it with my -- with earlier questions from my colleagues.

But the new grid infrastructure that is needed in order to meet the utilities goals to reduce emissions, what order of investment are you anticipating, and again, what sort of timespan?

Mr. Izzo. And, again, that will vary by region in the country. In some of the more urban areas, it can be as expensive as in some of the rural areas, not because of the distance between the customers but because of the undergrounding of the resource.

And the investments that we are making are more from an adaptation point of view as opposed to enabling the introduction of renewables, and the comment I made earlier is that we have spent over $3 billion since Superstorm Sandy, and we anticipate that could be an additional two in years to come.

Mr. Tonko. Thank you very much.

With that, Mr. Chair, I will yield back.

Mr. Rush. The gentleman yields back.

The chair now recognizes Mr. Bucshon for 5 minutes.

Mr. Bucshon. Thank you, Mr. Chairman. And thank you all. Witnesses, sorry I

had another hearing that was important -- as important as this, but I looked through your testimony.

Carbon capture utilization and storage, in my view, is essential for the energy sector to provide customers with affordable and reliable electricity. And, however, as a developing technology, increased research and development is continually going to be essential, which is why I was pleased to see the Department of Energy select Prairie State Generating Company for a $15 million project supporting the design of a carbon capture system.

While located in Illinois, it provides electricity to Hoosiers across my district, through the Wabash Valley Power Alliance and the Indiana Municipal Power Agency.

Congressman, can you maybe talk about why you think that -- how investment in carbon capture can help ensure both grid reliability and affordability?

Mr. Matheson. Well, it maintains a real reliable source, if you will. These baseload facilities are an important part of our grid functions today. I get that the grid is changing, but I think that -- and I think I heard in testimony from other witnesses, as you -- as you go higher and higher in percentage of intermittent resources, it creates greater challenges to the grid.

And I think having a baseload supply is important. I think if we are going to move to a carbon constrained world, then we have got to figure out a way to do carbon capture so that coal and natural gas can be an important part of our resource mix.

Mr. Buschon. Right. I mean, from my perspective, practically, to try to get to a carbon-neutral environment, that has to be part of the mix. That is why I support ongoing research and development, not only in renewables and across the energy sector,

but I think sometimes right now, at least, we are -- we are a little shortsighted maybe in trying to say that we don't need to continue to innovate in the fossil fuel space.

For example, which I support innovating and developing technology across all of the -- all of the -- the inputs, potentially in the future to a carbon-neutral environment. I wanted to get that there.

I have every coal mine in the State of Indiana, by the way, just so people know where my district is. And I am from the Midwest. My dad was a coal miner. But I do understand the challenges to all of these industries. But let's not be shortsighted and not continue to innovate.

Mr. Bear, I appreciate your work to ensure that we have a reliable grid 8,760 hours of the year. This is incredibly important, especially require Hoosiers and other Americans in the Midwest who have experienced the intensity of a polar vortex. However, I am concerned that the wholesale power market does not adequately price the resiliency attributes of baseload power. Would you agree? And if so, how do you suggest addressing that issue? Does that make sense?

Mr. Bear. It makes perfect sense.

Mr. Bucshon. We don't really address the value of having that consistency and reliability that baseload provides.

Mr. Bear. That is a fair comment. One of things that we are trying to do is understand how much of that we need and where we need it and then how to price it based on value.

As was noted by several panelists, marginal cost pricing, which we have used for a long time now, is not going to get us where we need to go.

Mr. Bucshon. Yeah. I appreciate that. Because that is the other thing that I -- I am concerned about, about reliability and stability of the electrical grid. We have seen in the European experience where they have had some issues there and the cost.

I am in rural America. I have a lot of rural areas that have -- we will just say low-income individuals or -- and also seniors on fixed incomes across all of our districts and across the United States. And so I think if we get too far ahead of ourselves here, the cost can inhibit the ability to -- of these citizens, particularly the low-income citizens and seniors on fixed incomes, to be able to afford their electricity and their power.

I am going to ask Ms. Palmer this last question, because I heard a comment that she just made about electric cars. And this is an interesting subject for me, because one of the things I think we fail to realize sometimes is what the environmental impact of the entire lifecycle of a technology is.

And so in my district, for example, if you have an electric car, which I support, it doesn't put out any emissions, but when you plug it into the wall, about 80 percent of the electricity generated comes from a coal-fire power plant.

So can you explain to why you think -- you know, I realize you decrease emissions, but I just am not convinced that that particularly will change much, the overall lifecycle of carbon emissions with the battery -- the development of the batteries and what it costs to do that, when you plug it in, how the power is generated. Just quickly, because I am out of time.

Ms. Palmer. Yeah, I think it is important to move towards a largely substantially decarbonized grid, either through adoption of clean technologies, more carbon capture and storage. And in that situation, the -- the power that you are using to charge the

battery would be clean. So I think the two kind of have to happen in tandem.

Mr. Bucshon. Okay. I guess -- I am out of time, but I guess my point is that electrical cars -- going to electric cars alone is not going to solve our problem.

I yield back.

Ms. Palmer. No, but they are more efficient, yeah.

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

Mr. Veasey. Thank you, Chairman Rush, for holding this hearing, and I would like to thank the witnesses also for being here. I think this has been a really fascinating discussion, as we talk about ways we can reduce emissions in the power sector.

As you know, the power sector is responsible for about 20 percent of our Nation's energy use and greenhouse gas emissions. And if we are going to make meaningful progress on tackling climate change, we must, of course, work to reduce these emissions through cleaner energy, and we should also look at barriers to clean energy deployment.

As part of the deregulation in my home State of Texas, many consumers, since the early two thousands, have had the ability to decide who they buy electricity from. Allowing consumer choice has not only has created some of the lowest retail prices in the Nation of 11.5 cents, compared to the Nation average of about 12.5 percent, it has also allowed for consumers to seek out cleaner sources of energy.

Of course, this change alone -- this change, along with other market improvements in Texas, has allowed renewable energy to also rapidly grow and has seen the State decarbonize faster than any other State in the union.

According to recently released data from the U.S. Energy Information Administration, Texas is the leader in electric sector decarbonization. In 2013, we

closed about a third of our coal plants in the State of Texas. At the same time, Texas led the Nation in adding renewable power capacity. Specifically, Texas leads the Nation in wind generation capacity with nearly 25 gigawatts, which is more than a quarter of the Nation's total.

Texas still added more wind and renewable generation than any other State last year. In fact, Texas has enough wind capacity to rank number five globally if we were a country. And some people do think that we are a country. And the other thing, too, that I think is always fascinating, that I like to brag about up here, is that if we compare the energy mix of the grid in Texas to that of the European Union, that Texas actually produces more renewable energy on our grid than they do in the E.U. so, furthermore, the State indicates another 21 gigawatts of solar projects and 30 gigawatts of wind projects are in the pipeline.

And so my question today is for Ms. Palmer of Resources for the Future. Can you speak to the benefits of a competitive market like ERCOT provides, in terms of reducing barriers for renewable energies to compete on the grid.

Ms. Palmer. Certainly, Congressman.

So I think you identified some of them in your opening remarks, about the ability for people to select their energy supplier not solely based on price but also based on these other attributes.

And I believe a lot of the clean energy development that is happening, as Mr. Dennis referred to, is actually coming from those sorts of opportunities. Particularly large companies are interested in doing this, and their ability to do so in a sort of integrated way where they are pointing to the actual sources in their local area, is

enhanced and actually made possible by having more competitive markets.

So I think it is not going to answer the problems that we have, but it is certainly going to provide another avenue by which clean energy development can be encouraged.

Mr. Veasey. Thank you very much.

I would like to now turn to Jeff Dennis of Advanced Energy Economy.

In your testimony, you mentioned that Federal leadership in wholesale electricity markets provide a near and long-term opportunity to lower consumer costs, expand consumer access to advanced energy, and reduce emissions.

Specifically, what role does Congress have to make sure consumers in any State have a choice and access to cleaner sources of energy?

Mr. Dennis. Well, Congress's role certainly in overseeing the regulation of the wholesale markets is critically important, to make sure that all resources that are technically capable of providing services are allowed to do so and that those market barriers are reduced.

I think Congress certainly has a role in looking at how competition in those markets gives consumers across the board the opportunity to make the choices we just talked about, to choose advanced energy, particularly now that advanced energy is not only a great choice for folks who have sustainability goals and other things, but is also the least cost resource on the grid.

Mr. Veasey. Thank you very much. Appreciate the panel for being here today.

Mr. Chairman, I yield back.

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

Mr. Flores. Thank you, Mr. Chair.

I want to echo the comments that Mr. Veasey had regarding Texas. I do consider it its own country.

Anyway, we are the country -- as you heard before, we are the country's largest producer and consumer of electricity, and our State has a robust market that is open to both buyers and sellers of electrons. And since the establishment of a competitive electricity market in 2002, Texas now leads the U.S. in wind production and Texas also leads in adding renewable capacity and clean burning natural gas.

Today, residential consumers in Texas pay some of the lowest electricity costs in the country at 11.8 cents per kilowatt hour. On the other hand, California residential consumers, by comparison, pay nearly twice as much, at almost 20 cents per hour.

At this time I would like to ask unanimous consent to insert for the record a Dallas Morning News editorial entitled "California's energy nightmare shows us why Texas must trust the free market."

Mr. Rush. With no objection, so ordered.

Mr. Flores. This editorial clearly lays out the absolute failure of a government-sanctioned monopoly. California does mandates through its monopoly; Texas does markets. And where is the consumer being better served?

I am sympathetic to those that are currently impacted by the weather changes in California, but it should be noted that the root of the problem results from a monopoly utilities mismanagement of their infrastructure and the adjacent vegetation, under the watch of State regulators.

Now we see the consequences that our friends in California are facing today. PG&E's announcement late yesterday that up to 1.8 million will face a power shutoff

because the bankrupt utility cannot manage the fire danger posed by its outdated equipment and infrastructure.

The carbon emissions from the California fires last year were equal to the emissions from the California power sector last year. So as the committee's majority continues to compliment -- contemplate a chaotic decarbonization of our economy, I hope that they seriously consider flexible market solutions over mandates so that the mistakes of the past are not repeated.

Texas is a great example of the superiority of market-based solutions to increase the use of renewable power sources. This committee would be well served to consider expansion of market-based solutions versus ineffective and costly mandates.

For Mr. Dennis, there are some places in the country with significant market barriers limiting deployment of more efficient generation. I am the largest residential solar power producer in Brazos County, Texas, and I have also implemented demand-side restrictions to peal another 42 percent off my usage of grid power. But some States still ban homeowners from putting solar on their roof. Some other areas also ban manufactures and large businesses from generating their own renewable electricity, or access to new technologies is limited because many consumers in America are limited to a monopoly to purchase their electricity.

So, Mr. Dennis, should we accept the status quo where certain consumers of electricity are worse off simply because of their geographic location?

Mr. Dennis. We certainly shouldn't accept a status quo of consumers not being able to access the energy that they desire, certainly. And we see instances where innovative new services are not -- are more difficult to provide or are barred by State

policies or utility policies that limit their access to the grid.

So certainly there are a range of policy approaches that both Congress and the States can take to address those issues. But certainly we have seen and the example of -- the great example of Texas that you mentioned, in terms of the ability of consumers to choose more advanced energy, is a powerful one.

And there are other tools as well. Certainly improving utility planning and ensuring that the low cost benefits of advanced energy are recognized.

Mr. Flores. When we look at the fact that electrons flow freely across State borders, they are not identified as State 1 electrons or State 2 electrons, is interstate commerce inhibited by prohibitions of new entrants, new products, and services and new forms of transactions from one State to another?

Mr. Dennis. I think they can be, certainly. In instances where new technologies are able to provide a range of services across that sort of wholesale and retail divide that we have traditionally thought about the electricity grid, there can certainly be barriers that inhibit those kinds of services.

Obviously all of these things depend on the particular physics of a local area.

Mr. Flores. Sure.

Mr. Dennis. But in general that could happen.

Mr. Flores. Should this committee consider legislation to improve access to more innovative technologies and lower cost advanced energy across all regions of the country?

Mr. Dennis. I think this committee should consider a range of options to continue to empower consumers to choose clean and advanced energy.

As I mentioned in my testimony, 71 percent of the Fortune 100 and 43 percent of the Fortune 500 companies have clean, stainable energy goals and want to purchase more advanced energy.

There are a range of options that -- that States and utilities can give those -- those entities, as well as residential consumers and others. And those should all be considered as we think about decarbonizing the electricity grid.

Mr. Flores. And I appreciate your answers today. And I have a couple of other questions to submit for the record. I will ask you to follow up separately. Thank you.

Mr. Dennis. Thank you, Congressman.

Mr. Rush. The gentleman yields back.

The chair now recognizes Mr. Schrader for 5 minutes.

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

Ms. Palmer, we have got a lot of talking points these days about the best way to get to zero carbon emissions at the end of the day. And one side of the aisle is always about innovation, innovation, innovation; the other is about regulatory approaches, carbon pricing, et cetera.

Are they mutually exclusive, or could we work together to come up with something, with a little bit of the regulatory framework that enhances, hopefully, getting there and at the same time making sure that the innovation, so that the different industries can actually all contribute to reducing our carbon emissions?

Ms. Palmer. So, Congressman, I think it is important to do both actually. I think putting a flexible approach in, such as a price on carbon, will provide incentives to folks to innovate, both folks who are in the energy supply business and also folks who produce

supplies for them and other -- energy storage people.

But we as -- as has been mentioned previously at this hearing, we are pretty certain that we can get to the 80 percent decarbonized goal now. But the technologies that we really need to get to the 100 percent goal, which is an important goal, are probably largely yet to be created. And so we need to put resources into doing that. And so I think it is important to do both.

Mr. Schrader. So question for -- maybe a followup question to you and maybe Mr. Izzo, too, frankly.

You know, the idea of just pricing carbon would seem to tacitly admit that we are going to still have a lot of carbon production as a result of different energy sources in this country.

What about putting a lot of money into research and innovation, to go far an all-of-the-above carbon capture, carbon reduction, renewable approach and allow the market to do its innovation? In other words, instead of putting money on one side of equation, we put it on the other side of equation, too, and then set a zero emission standard for some point in the future that is, you know, reasonable, given your comments?

Ms. Palmer. Right. So I think that you can kind of do all of those things together. So one of the virtues of the price on carbon is it does encourage reducing carbon emissions and moving towards the goals that the committee is talking about would ideally probably happen through a price that goes up over time. And so that is going to increasingly discourage the carbon emissions, but it also creates in the interim a source of revenue, some of which could be devoted to doing the types of research that

is -- that will be required to get to our goals.

Mr. Schrader. Mr. Izzo, comment?

Mr. Izzo. Yes. I would invest on both sides of the equation. I was benefitted by being up at MIT yesterday where there is some exciting work going on a technology they call SPARC. There is $120 million worth of private capital being placed into fusion technology because of belief that Congress will do something about carbon. But that research was predicated on some DOE funding for basic material science in magnetic technology.

So I think it is both the allure of the market and the investment potential associated with being the least cost supplier of carbon-free energy, combined with the R&D in some fundamental science areas.

Mr. Schrader. Inherent in all of this, I think, is having Congress set some standards. Right now we are at the mercy of one executive order versus another executive order. And I don't care if you are in the transportation sector or the power plant sector, or whatever, there is no certainty in the marketplace. And that prohibits businesses more than anything else, in my experience as a businessperson, from making those leaps into various investment areas.

So if we can get, you know, my opinion, Congress behind some regulatory framework that is market based and encourages an all-of-the-above strategy to get to zero, that would actually maybe give everyone that certainty of going forward, and you guys can make the investments you need. MISO can do what it needs to do. I mean, it just, to me, makes a lot more sense. And so hopefully we will have opportunity to do some of that going forward.

I yield back. Thank you very much.

Mr. Rush. The chair thanks the gentleman.

The chair now recognizes the gentleman from Virginia -- West Virginia, Mr. Griffith, for 5 minutes.

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

I am so excited by the conversation that was started by my friend, Mr. Schrader, because -- and I tell my constituents this all the time. We may disagree on how to get there, but most folks are coming here trying to solve problems. And I have to agree -- I am a big believer that we need to have parity in our research dollars coming out of DOE and other places, because we are going to continue to use the carbon-based fuels, and we have got to figure out ways to do that. And doing research on all of this so that we can get to this number, not just by saying we are going to eliminate the carbon-based fuels, -- oil, natural gas, coal -- but by figuring out how we can do it cleaner.

Another colleague brought up carbon capture and sequestration. I will tell you, there is some great research going on out there. And just in my district, we have MOVA company that is now going to a prototype at Virginia Tech with panel bed filtration, which separates out through different filter processes individual pollutants. I am looking here at the screen, because there is a video -- soon come to a theater near you -- that shows how they can take out -- can take out with different filters NOx, SOx, flash and carbon dioxide.

And what they are planning on doing with it is, by having these separate panels, they can then take that product, because they are not getting it all filtered into one big box that then has to be separated. Each one of the filters would have a specific item

that it filtered out, so you could then sell the CO2, you could sell the NOx, the SOx, and the flash, or do what you want to do. Arsenic is another one that they have mentioned in the past. That is a fantastic way to go, but we have got to have the research to do it.

And it is a way that we can get to zero, perhaps by 2050, but not just by saying we are going to eliminate the use of our carbon-based fuels.

We also have one that is having surprising effects that is already going into use. And they started off looking for ways that they could separate rare-earth from the coal in central Appalachia. And so what they have done is they have got these different things -- and DOE has funded a lot of this and continues to fund some research in that area. But what they are doing is, is that they are going to, by figuring out how to separate it, they have now licensed that technology some steel mills -- I have to watch my accent, because it comes out still meals -- but steel mills in India. Because India has coal. They have dirty coal. They don't have much else to use in the way of fuels. And if we think they are going to eliminate the use of coal and bankrupt their industries, not going to happen.

But this technology that we have developed here, they have figured out can be used -- they don't have rare-earth, but they can separate the dirty coal from the higher -- utilization of the higher -- the better carbon and lower the carbon footprint at steel mills in India.

This is where research can have a dramatic impact on moving our country forward and helping the rest of the world. Because if we don't move it forward with affordable research and affordable technology, we can do everything we want to; it is not going to affect the climate or the atmosphere if we don't take care of making sure that it is

affordable for the rest of the world to use as well. And if we can make a little profit along the way, that is even better.

All right. Sorry about that diatribe, but I just got so excited listening to my colleague, and there are a lot of things we can do in a bipartisan fashion.

All right. Another former colleague, Mr. Matheson, let me just say thank you, first off. -- I guess that was originally going to be first off, but I got all wound up -- for supporting my New Source Review Permitting Improvement Act. This is an important issue, and if adopted, would help provide much-needed certainty from any -- including your members.

Now, if you could briefly tell us what the -- what differentiates -- and I know, but let's tell the public back home -- electric cooperatives in rural, oftentimes low-income areas, from the investor-owned utilities.

Mr. Matheson. Well, it is a different business model, first of all. We are owned by the consumers we serve. We are not owned by shareholders. And so we are also governed by our consumers. They elect the board of directors of each co-op. And so it is a different business structure. And we also have a different footprint in terms of the communities we serve. It is much lower revenue per mile.

I made some of these statements in my opening comments, where it is -- the utility average for revenue per mile or people per mile is four times as much for the other utilities than it is for us.

So we -- we have a sparsely populated group that we serve, and that was challenging back in the 1930's. That is why rural America -- the for-profit utilities wouldn't go to rural America. Even with Federal subsidies they wouldn't. And that is

why cooperatives formed back then. And those challenges continue today.

And so that is really -- those are some of the key distinctions, I would say, between the -- and it doesn't mean we don't get along with our brethren across the electric sector, both the municipals and the investor-owned. We actually have an excellent working relationship. But those are some of the distinctions for electric cooperatives.

Mr. Griffith. And you-all don't have the ability to go out and research things like the MOVA technology or the separation of the coal; you just want what is affordable, and it is up to us in the Federal Government to come up with a way that we can have research parity that gets you a cheap product so that you can provide it to your customer. Isn't that correct?

Mr. Matheson. I agree. But I will say, we have had success as a national association receiving grants from DOE. We do participate in those research projects.

Mr. Griffith. Very good. Thank you so much.

I yield back, Mr. Chairman.

Mr. Rush. The gentleman yields back.

The chair now recognizes Ms. Barrigan for 5 minutes.

Ms. Barrigan. Thank you, Mr. Chairman.

I will speak up a little bit. I think it is working?

Okay. Mr. Bear, do think the Federal Energy Regulatory Commission, as it is currently constructed, is an ally or an obstacle to getting to 100 percent clean energy, and are there reforms you would suggest?

Mr. Bear. I would say there are a lot of reforms that we would suggest. I

touched on some of those in my testimony where we need to rethink how we think about the electric energy, how we think about reliability, in terms of using just basic capacity as a homogenous commodity. We need to move away from that and start thinking about the attributes, that we need to operate a system with a lot of intermittent resources on it because it is very different.

We need to look at availability metrics, as opposed to reserve margins and things like that, because it is every hour that matters now, not the peak hour or the peak day. So I think there are some pretty significant shifts that need to change on that front.

The other key area, I would say, is pricing. Location marginal pricing is something that has been very good for rationalizing excess. But in terms of rewarding and incentivizing the attributes we need, I don't think it works. And so we need to move over to more value-based pricing.

Ms. Barrigan. Ms. Palmer, do you want to add anything?

Ms. Palmer. Yeah. I think that flexibility will be very important. I also think that the role of the demand side, in terms of customers, is going to become increasingly important.

And so I think that the FERC is going to have to find ways to work with the States on this issue, because it is not really jurisdictional to them. But creating opportunities for resources on the customer side of the meter to play both in the ancillary services markets but also to face more -- excuse me -- time differentiated prices that will help accommodate the variable renewables will be important.

Ms. Barrigan. And, Ms. Palmer, there has been a lot of talk about electric vehicles, especially on the other side, about maybe they are not as great as other options.

You were starting to have an answer.

Did you want to maybe have a little more time to explain why electric vehicles are worth investing in?

Ms. Palmer. Oh, yes. Well, I think that there is sort of a simultaneous movement that is happening in the energy systems. And one is moving towards a largely decarbonized electricity sector, the goals that the committee has set forth in this discussion.

And part of that -- part of what is going to happen there is the introduction of more intermittent renewables.

And -- but also it is become increasingly important, as we have had substantial success in decarbonizing the electricity sector relative to past, is the transportation sector is becoming a larger share of carbon emissions.

And so there may be various alternative ways to get to a decarbonized transportation system, but a lot of modeling suggests that electrification of transport and buildings under current cost conditions and expected cost improvements is going to be the way to do that. And so making it possible to electrify vehicles -- (a), they are highly efficient, and, (b), you are getting rid of not only carbon emissions but also other emissions associated with vehicle operations that are important.

Ms. Barrigan. Thank you. When I served on a City Council, one of the popular policy options for power communities was to purchase clean energy solutions with something called CCAs, Community Choice Aggregation providers. This allows local governments to purchase cleaner electricity from alternative supplier on behalf of residents and businesses. Currently only a handful of States, including California, allow

for CCAs.

Mr. Dennis, in your testimony, you talked about the importance of reforming utility business models and consumer choice. Can you speak to the role that CCAs could have nationally in accelerating our country to 100 percent clean energy?

Mr. Dennis. Certainly. I think opportunities for -- for communities to increase their ability to choose clean energy can have an important role in -- in taking advantage of, you know, the cost reductions I talked about, that clean energy is really now the most affordable resource on the grid.

We see different kinds of models. I think, you know -- not to steal Mr. Matheson's thunder, but certainly we see cooperatives, places like Holy Cross Energy in Colorado, that are really taking advantage of technology in that way, to work one-on-one with their consumers that are asking them for this and make these kinds of changes.

So certainly CCAs is one option. I don't think it is the only option. But it certainly provides an interesting model that other States and even Congress can look at.

Ms. Barrigan. Right. And I know it has been mentioned before, the situation in California with the rolling blackouts and the fires. I would be remiss if I didn't mention that we -- you know, first of all, I think it is unacceptable that we are dealing with this by having these rolling blackouts. I talk to people every day who tell me about them telling having to move and the hardships it causes and obviously the risk and the concern. It is unacceptable.

And I am hoping that when we develop this plan of going 100 percent by 2050, we are taking a look at the energy grid, how can we avoid this, and making sure we are

holding those accountable who are not investing in proper maintenance and under investment.

So with that I yield back. Thank you.

Mr. Rush. The gentlelady yields back.

The chair now recognizes the gentlelady from Colorado, Ms. DeGette, for 5 minutes.

Ms. DeGette. Thank you so much, Mr. Chairman. Thanks so much for letting me waive onto the committee for this important hearing.

And if I would have known my friend and our former colleague on this committee, Jim Matheson, were here, I would have come over a lot earlier.

But I wanted to come over to talk about some legislation that I have been working on. As we all know, and I am sure you have been discussing this today, to avoid the worst effects of the climate crisis, we have to cut carbon emissions in half by 2030 and then to net zero by 2050.

And so while I have been talking to Xcel Energy and lots of other people about this, we know we need to eliminate the carbon emissions, but we don't yet have the full technology to do that, to a zero percent. Wind and solar are critical, and we need to increase their use dramatically. But without breakthroughs in technology, those two sources alone will not get us to the zero percent.

And so I think we all agree we need innovation and technology to provide the reliable electricity that we have come to expect.

So here's what the legislation I expect to be introducing in the next few weeks will do. And I am hoping -- I still hope we can do it on a bipartisan basis.

But what it does -- part of what it does is it encourages the development of the widest possible array of technologies to produce emission-free electricity. And it sets us on a course to having affordable, reliable, and 100 percent emission-free electricity by 2050.

So I want to ask this panel some general questions that I have been thinking about in working on the bill.

Mr. Dennis, I wanted to ask you, sense spurring innovation is the goal of this hearing and also of my bill, I wanted to ask you about some of the advances that we have had in energy technology that have helped bring down the cost of solar and wind energy. Were those technological advances driven by the private markets alone, or did Federal policy play a role in driving the development of the technologies we have today?

Mr. Dennis. Well, certainly a mixture. Federal policy certainly played a role in terms of we had long-term tax incentives for investments in these technologies. We had research and development. DOE had a lot -- had and has a long-time effort around wind and solar as well.

Ms. DeGette. Right.

Mr. Dennis. So it is a combination.

Ms. DeGette. It is a combination. So you need both private and Federal policy. So what I want to ask, as we try to develop these technologies in the next few decades, is it fair to expect that new clean energy technologies will be invented in time to bring us this affordable, reliable net zero electricity by 2050 without a change in Federal policy? Or do we need a Federal change?

Mr. Dennis. We need a Federal change. We need the Federal Government to

set the direction. And as you mentioned as well, and as many others have mentioned, R&D is going to be important, too.

Mr. DeGette. Thank you.

Dr. Palmer, the legislation I have been working on would in, among other things, establish a clean energy standard that gradually increases until we are generating 100 percent of our electricity using zero emitting technologies.

And so what it does is it is designed to reward investment in clean energy technologies without adding to the size of the government.

And I would like to ask you, it is my understanding that a clean energy standard by its design would help keep electricity prices low compared with other carbon pricing mechanisms.

Would you agree with that?

Ms. Palmer. Yes, Congresswoman.

So traditionally, approaches -- approaches that apply a direct price on carbon are going to create a source of revenue, and that will pass through in the effect that it has on consumer prices of electricity, as long as that revenue is not used to offset the increase in electricity rates.

So a clean energy standard, on the other hand, provides an incentive to produce electricity from clean sources by rewarding that and creating a demand for that attribute in a marketplace. And so that will have a lower impact on electricity prices.

And, you know, with the carbon pricing approach, often it has been proposed that the money be dividend back to households. And that could mitigate -- or would, actually, particularly for low-income groups -- largely mitigate the impact on residential

consumers. But a clean energy standard would make a more broad-based mitigation of that impact.

Ms. DeGette. Thank you.

Finally, what we are trying to do this with bill that I am doing is to drive innovation and accelerate the use of new technologies. Some people have -- some of my colleagues have worked on similar measures, but they are not addressing deployment of the new technology.

So I wanted to ask you, Mr. Izzo and Anderson, briefly, if we seek to foster clean energy innovation without giving power companies a reason to deploy technologies, do you think they will be adopted universally in time to bring the emissions to net zero by 2050?

Why don't we start with you, Mr. Izzo.

Mr. Izzo. Yeah. I do not. I think a hallmark of utility service has been universal access. And that would be true in a renewable world as well.

Ms. DeGette. Thank you.

Mr. Anderson, briefly.

Mr. Anderson. I agree with that statement. I would just say that as technologies are emerging, that we are developing programs to train people to -- to work on them, to maintain them. But I agree with the essential point that he just made.

Ms. DeGette. Thank you.

Thank you very much, Mr. Chairman. I yield back.

Mr. Rush. The gentlelady yields back.

And that concludes the witness questions.

And I want to thank -- the chair stands corrected.

The chair now recognizes Mr. Walberg for 5 minutes.

Mr. Walberg. Thank you, Mr. Chairman.

Just spoke to my Michigan bankers, and they said let's keep the energy on and any way we can power to our rural areas, that is great. Thanks to the -- to the panel for being here.

Let me cut to the chase here.

Mr. Anderson, in your testimony, you mention the UWUA's Power for America Training Trust, P4A, and its partnership that we have, I appreciate the fact that -- with Consumers Energy in my district in achieving the first Department of Labor certified apprenticeship program in renewable energy.

I had a chance to talk with some of the students and the excitement they have with realizing that they are on the ground floor of a future that is going to be very special.

You know, I personally support an all-of-the-above plan. I hope we do the research necessary to make sure that we keep all of that base energy there, but we have to expand and develop as well.

So that program is great. I applaud you for that.

The apprenticeship program is important. It supplies skills for the future, as well as the present -- wind, solar, better technologies, energy sectors as well as present sector.

So let me ask you, as technology changes, it is essential that jobs evolve with then.

Can you elaborate a bit more on the demand for skilled trade training to meet the needs of our ever-changing energy sector?

Mr. Anderson. Yes, absolutely. Thank you very much for the question,

Congressman, and for your appreciation of our program there. We train people to do everything from climb utility polls to work on gas appliances and now how to -- how to build and operate brand new technologies.

These are programs that we are developing and have developed literally from scratch. There have not been previously apprenticeship programs that broad over that many technologies, and we have had to invent it as we go along. And there will be more of that.

We are already in the process of thinking about how we can develop apprenticeship programs so that people can operate and maintain zero emission vehicle infrastructures as that gets built out. We are also looking to expand what we do in wind energy to not just be on -- onshore wind farms, but also as offshore towers are built, we want to train people, apprentices, to go out and work on those towers as well.

The technology will not shop changing. That is for sure. 10, 15 years ago, there will be things coming online we haven't even imagined yet. And our goal at that time, I am sure, will be to develop new programs to train people to work on those things as well.

So we are using that program and programs that we want to build like that, to evolve our workforce, evolve our training programs, and adapt to the changing energy systems.

Mr. Walberg. Of course, we have to be more resolved in encouraging students to think about those careers, whether it is climbing a pole or climbing one of those towers made in my district for the wind turbine, working on those tuning -- how you tune those big blades and all of the rest. This is something that we have to excite our young people with.

Mr. Anderson. Oh, absolutely.

Actually to the point about the blades, we are in the process of figuring out how we are going to build at least part of a wind tower right there on that facility. One of the main threshold questions you have to ask an apprentice is can you climb that? It is very high, right?

There are people who don't get over that threshold, right? But for many people, that is very exciting, right? It is a thing that they can hardly imagine doing previously.

And yes, it is having that gets overlooked. People rush off to do, you know, college tracks or whatever, and that is appropriate for some people. But I am proud to say that many of the members who work in these industries make more money than I do. Those are very good jobs, and they are definitely a pathway to the middle class for sure.

Mr. Walberg. And beyond.

Thank you.

Mr. Bear, and also Mr. Matheson as well and Mr. Izzo -- I won't ask a question of whether you are related to Tom Izzo, the great hockey coach at Michigan State. I wish you were; we could talk about that.

I think it is clear that our Nation's energy grid needs to be resilient, and there is a real concern that it won't be if we don't plan carefully.

Can the three of you give me your perspective on how the transmission grid needs to change to support these significant changes in the power system?

Mr. Bear, we will start with you first.

Mr. Bear. Sure. Thank you. Appreciate the question.

I think that in looking at the grid, we are doing a lot of studies now to understand

at different levels of renewable penetration, what the implications are. And it comes from a couple different dimensions. You know, one, what do we need from a resource standpoint on the grid to make sure that we can maintain reliability, in terms of attributes, flexibility, for example, frequency balancing, stability balancing, those kinds of things.

We are also trying to understand what we need to price those mechanisms so that they are rewarded appropriately. And we have sort of a pricing scheme that reflects the underlying system conditions at all times.

And then, third, we have got to look at the transmission system itself, because I think the grid needs to be much different to balance much more -- larger penetrations of renewables as we go forward.

Mr. Walberg. Okay. Mr. Matheson.

Mr. Matheson. I think Mr. Bear hit the high points. I think one thing we should keep in mind when -- to the extent there is a transition, we should also do no harm, you know.

Our electric grid, while it is aging, we haven't invested enough. It is actually functioning remarkably well. We have 99.99 percent reliability across this country. It is a substantial investment with a great history. So let's make sure as we look at transitioning, we don't mess up what has been a pretty reliable thing over a long period of time.

Mr. Walberg. I am going to let Mr. Izzo respond to that as well.

Mr. Rush. The final witness.

Mr. Izzo. So I would echo those comments. The regional transmission

organizations, whether it is MISO or PGM, do a fine job of modelling for 15-year periods in advance, the reliability of the grid. FERC does a good job of creating an efficient and effective regulatory system to encourage investment.

I would just point out that it should not be the burden of the utility consumer or the transmission owners to create the infrastructure that are needed to connect the renewables to load centers. That really should be a generator lead. That should be the responsibility to fully reflect the cost of the supply option being selected in the location where it is being selected.

Mr. Walberg. Thank you.

And thank you, Mr. Chairman.

Mr. Rush. That concludes the witness questioning.

I would like to thank our witnesses for their participation in today's hearing. And I will remind members that pursuant to committee rules, they have 10 business days to submit additional questions for the record to be answered by the witnesses who have appeared. I ask each witness to respond promptly to any such questions that you may receive.

The chair now asks for unanimous consent to enter into the record the charts and the submissions by my colleague from West Virginia, Mr. McKinley, that were omitted because of technical difficulties.

Without objections, so ordered.

[That concludes the subcommittee hearing, and at this time the subcommittee is adjourned.]