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POWERING AMERICA: TECHNOLOGY'S ROLE IN EMPOWERING CONSUMERS

HEARING

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SUBCOMMITTEE ON ENERGY

OF THE

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HOUSE OF REPRESENTATIVES

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POWERING AMERICA: TECHNOLOGY'S ROLE IN EMPOWERING CONSUMERS

TUESDAY, SEPTEMBER 26, 2017

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The subcommittee met, pursuant to call, at 10:03 a.m., in Room 2123, Rayburn House Office Building, Hon. Fred Upton (chairman of the subcommittee) presiding.

Members present: Representatives Upton, Olson, Barton, Shimkus, Murphy, Latta, McKinley, Kinzinger, Griffith, Johnson, Bucshon, Flores, Mullin, Hudson, Cramer, Walberg, Walden (ex officio), Rush, McNerney, Green, Doyle, Castor, Sarbanes, Welch, Tonko, Loebsack, Schrader, Kennedy, and Pallone (ex officio).

Staff present: Elena Brennan, Legislative Clerk, Energy/Environment; Wyatt Ellertson, Research Associate, Energy/Environment; Tom Hassenboehler, Chief Counsel, Energy/Environment; Jordan Haverly, Policy Coordinator, Environment; A.T. Johnston, Senior Policy Advisor, Energy; Mary Martin, Deputy Chief Counsel, Energy/Environment; Alex Miller, Video Production Aide and Press Assistant; Brandon Mooney, Deputy Chief Energy Advisor; Mark Ratner, Policy Coordinator; Annelise Rickert, Counsel, Energy; Dan Schneider, Press Secretary; Sam Spector, Policy Coordinator, Oversight and Investigations; Jason Stanek, Senior Counsel, Energy; Madeline Vey, Policy Coordinator, Digital Commerce and Consumer Protection; Hamlin Wade, Special Advisor for External Affairs; Priscilla Barbour, Minority Energy Fellow; Jeff Carroll, Minority Staff Director; Rick Kessler, Minority Senior Advisor and Staff Director, Energy and Environment; Alexander Ratner, Minority Policy Analyst; Andrew Souvall, Minority Director of Communications, Member Services, and Outreach; Tuley Wright, Minority Energy and Environment Policy Advisor; and C.J. Young, Minority Press Secretary.

Mr. UPTON. You may be seated. I don't usually have to say that.

OPENING STATEMENT OF HON. FRED UPTON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MICHIGAN

Welcome. So good morning, everybody. Today we are going to kick off our fifth hearing in the Energy Subcommittee's Powering America series. And these hearings as we know have provided valuable insight into the complexities of our Nation's electric grid and electricity markets.

And as many in this room are aware and are watching now, this week is National Clean Energy Week so that makes our hearing this morning even more timely. I look forward to the opportunity to hear how advanced energy technologies are giving consumers greater control, convenience, and choice when it comes to their electricity use.

And that is why we are all here. Our Nation's grid is an engineering marvel that has enabled our country to become the advanced and modern society that it is today. However, that grid is currently undergoing a significant transformation—changing fuel mixes, advances in energy technologies, evolving consumer demands to say the least—and these changes present opportunities for consumers to become active market participants and to have greater control over their energy usage.

Some within the electric industry are recognizing the need to address and integrate the electric industry, to integrate these new energy technologies to meet the consumers' demand and preferences. Consumers now expect a certain level of control, convenience, and choice. No longer dependent on one centralized generation source, consumers, or "prosumers," can generate their own energy and sell that surplus back to the grid and behind-the-meter energy storage lets consumers store electricity for later use.

Intelligent energy technologies enable consumers to monitor and manage that energy consumption. The ability to manage energy gives consumers the opportunity to utilize techniques such as peak shaving, which is reducing electric power consumption during periods of maximum demand. That allows the consumer to save money on their electric bills.

And we know that with technological innovation, that is moving us closer to integrating artificial intelligence into our electricity systems which will for sure ensure an efficient, reliable, and resilient electrical grid.

Now most of these energy technologies are located at the distribution level of the electric grid. State utility regulators have jurisdiction over distribution level or retail markets while FERC has jurisdiction over the wholesale markets. However, the traditional jurisdictional lines are becoming blurred, in part, by the development and deployment of energy technologies, State energy policies, and the valuation of new energy resources such as demand response.

The digitization of the electric grid coupled with more distributed generation, energy storage, energy management technologies, and other distributed energy resources does indeed open the door for market-based transactive exchanges between energy producers and consumers. This transactive energy would allow for a more dynamic balance of supply and demand across the entire electricity system using the value as a key operational parameter. At the same time, energy technologies could help ensure that reliability, security, and resiliency of the grid is not compromised.

Looking forward, the traditional utility model could operate more as a market platform where consumers can find exactly what they need to meet their energy needs. Ultimately, this platform could lead to a better optimized grid where a consumer demand is more responsive in real-time to price.

Today we are going to hear from a robust panel of witnesses representing a variety of energy technologies on the cutting edge of innovation. We have witnesses who represent different utilities, electric utilities, and companies that are leading the way in accommodating and integrating these new energy technologies. A more dynamic and flexible grid, it does empower consumers and allows for energy to be available in a reliable and affordable manner.

[The statement of Mr. Upton follows:]

PREPARED STATEMENT OF HON. FRED UPTON

Good morning. Today we kick off our fifth hearing in the energy subcommittee'sPowering Americahearing series. These hearings have provided valuable insightinto the complexities of our Nation's electric grid and electricity markets. As many in this room are aware, this week is National Clean Energy Week, which makes our hearing this morning all the more timely. I look forward to the opportunity to hear how advanced energy technologies are giving consumers greater control, convenience, and choice when it comes to their electricity use.

Our Nation's electric grid is an engineering marvel that has enabled our country to become the advanced and modern society that it is today. However, the electric grid is currently undergoing a significant transformation—changing fuel mixes, advances in energy technologies, and evolving consumer demands. These changes present opportunities for consumers to become active market participants and to have greater control over their energy usage. Some within the electric industry are recognizing the need to address and integrate these new energy technologies to meet consumers' demand and preferences.

Consumers now expect a certain level of control, convenience and choice. No longer dependent on one centralized generation source, consumers, or "prosumers"can generate their own energy and sell the surplus power back to the electric grid. Behind-the-meter energy storage lets consumers store electricity for later use. Intelligent energy technologies enable consumers to monitor and manage their energy consumption. The ability to manage energy gives consumers the opportunity to utilize techniques such as peak shaving—which is reducing electric power consumption during periods of maximum demand. This allows consumers to save money on their electric bills. Technological innovation is moving us closer to integrating artificial intelligence into our electricity systems—which can help ensure an efficient, reliable, and resilient electrical grid.

Most of these energy technologies are located at the distribution level of the electric grid. State utility regulators have jurisdiction over distribution level or retail markets, while the FERC has jurisdiction over the wholesale markets. However, the traditional jurisdictional lines are becoming blurred, in part, by thedevelopment and deployment of energy technologies, State energy policies, and the valuation of new energy resources such as demand response.

The digitization of the electric grid coupled with more distributed generation, energy storage, energy management technologies, and other distributed energy resources opens the door for market-based transactive exchanges between energy producers and consumers. This "transactive energy" would allow for a more dynamic balance of supply and demand across the entire electricity system using value as a key operational parameter. At the same time, energy technologies could help ensure that reliability, security, and resiliency of our electric grid is not compromised. Looking forward the traditional utility model could operate more as a market "platform" where consumers can find what they need to meet their energy needs. Ultimately, this platform could lead to a better optimized electric grid, where consumer demand is more responsive in real-time to price.

Today we will hear from a robust panel of witnesses representing a variety of energy technologies on the cutting edge of innovation. We also have several witnesses who represent different electric utilities and companies that are leading the way in accommodating and integrating these new energy technologies.

A more dynamic and flexible electric grid empowers consumers and allows for energy to be available in reliable and affordable manner. These energy technologies will enhance the reliability, security, and resiliency of our Nation's electric grid—particularly in the event of extreme weather events. The key to ensuring the continued growth of technological innovation is competitive and wellfunctioning energy markets, which is an issue the committee will continue toexplore going forward.

Mr. UPTON. So we look forward to your testimony moving forward, and I would yield for an opening statement, my friend and colleague from the good State of Illinois, Mr. Rush, the ranking member of the subcommittee, 5 minutes.

OPENING STATEMENT OF HON. BOBBY L. RUSH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. RUSH. Good morning, Mr. Chairman. I want to thank you for holding this important hearing today, Examining Technology's Role in Empowering Consumers.

Mr. Chairman, as we convene here today, our thoughts and our prayers are with the three million American citizens on the island of Puerto Rico who still have no power and very little communication, as well as the people of Houston and Florida and all of those who have been uprooted by this historic and deadly season of hurricanes.

Mr. Chairman, it is my sincere hope and my expectation that these profound indicators that scientists have been warning us about for years now will finally spur serious consideration, compensation, and action by this subcommittee to finally address one of the greatest threats facing this Nation and our world, and that is the issue of global warming.

I must also note, Mr. Chairman, that we are holding this hearing in the midst of National Clean Energy Week, which is fitting, Mr. Chairman, considering that today we will hear about a variety of new and innovative technological advancements in the clean energy arena that would help move our Nation forward.

Mr. Chairman, the fact that as consumers we have become more aware of our carbon footprint and how their behavior impacts the environment, consumers are also demanding more information and the American consumers are demanding more control over how their energy is produced and consumed. Meanwhile, many changes in our electric grid are spurred by State and Federal policy and market forces.

It is important to understand that consumers are also driving many of the trends we see taking place in the electricity market. From an increase in smarter appliances with real-time access to data to local solar and wind gardens supplying an entire community, consumers are pushing many of these changes as they demand new tools to more responsibly use energy both as a way to save money and as a way to save our environment.

In addition to greater access to data and more control over their energy use, other consumer-driven trends we see emerging include a greater demanding for cleaner, renewable sources of energy to compete with traditional fossil fuels and increase a more discriminative generation in demand response resources, more energy efficiency initiatives as well as a demand for lower energy costs.

Mr. Chairman, I look forward to this hearing, and I want to thank you. And with that I yield back the balance of my time.

Mr. UPTON. The gentleman yields back. The Chair would recognize the chair of the full committee, the gentleman from Oregon, Mr. Walden.

OPENING STATEMENT OF HON. GREG WALDEN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OREGON

Mr. WALDEN. Thank you, Mr. Chairman. As you know, today we continue our Empowering America hearing series and we appreciate the witnesses who are here today to share with us as we look at new energy technologies and how they benefit and empower electricity consumers.

While the committee continues its review of wholesale power markets in ensuring reliability and affordability, this hearing is intended to examine the ways in which the traditional model of delivering electricity through a centralized system and one-way power flows is being disrupted by an increasingly de-centralized system with power being generated and managed by a growing number of new distributed technologies located at the edge of the grid.

You don't have to look far to see examples of how innovation is transforming the way electricity is being generated, delivered, and consumed and how consumers are interacting with the grid. For example, in my district in Oregon, Oregon Tech uses geothermal power to operate its entire campus. They also have a big solar array as well. They sell the excess energy back to the grid.

And I visited Oregon Tech's one-of-a-kind geothermal plant in August and saw firsthand how they are taking advantage of great renewable resources in the Klamath Basin. It is pretty cool to see. I think they may be the only university in America that is fully self-contained with renewable energy.

Today's hearing also allows us to examine how advanced electricity technologies are not only transforming the way the grid operates, but also how these technologies are empowering consumers. Today's consumers both large and small increasingly expect more from the energy infrastructure systems and the rigid regulatory structures of the past. Modern consumers want an electricity that is nimble enough to accommodate new technologies and provide consumers with greater control over how they purchase and manage their electricity usage and needs.

Advanced technologies are allowing consumers to express their preferences in electric generation and consumption to make purchasing decisions based on affordability, control, time of use, and the generation source or location of their electricity. And this consumer behavior is having an effect on electricity prices, choice, the environment, the grid resiliency, and reliability.

So in many instances, advanced energy technologies are being deployed behind the meter at consumers' homes or businesses. However, even though these technologies are physically located on the distribution system, we are seeing more and more instances where distributed energy technologies are beginning to have impacts on the bulk power system and the wholesale electricity markets. These technologies raise questions on what role, if any, Federal regulators and regional grid operators should play in relation to distributed energy technologies, an issue that this committee will continue to explore.

Joining us in this hearing, we have witnesses representing a wide range of energy technologies along with witnesses from utilities who are successfully attempting to implement and accommodate new types of grid technologies. I would like to welcome our

witnesses. I want to thank you for contributing your experience and expertise to this hearing.

I am confident this hearing will help us better understand the role that technologies such as distributed energy, microgrids, demand response, and battery storage play in the 21st century electricity system. Furthermore, today's hearing will also shed light on the challenges that are preventing advanced technologies from deploying in more areas around the country and at faster rates.

The U.S. electricity sector is one of the most regulated sectors in the American economy, evidenced by the numerous oversight entities positioned at both the State and the Federal levels. This regulatory structure has been crafted for good reason and remains critical in ensuring that all Americans have access to affordable and reliable electricity. However, when it comes to advanced energy technologies we must make sure that the country's regulatory structure and policies continue to be updated and modernized so they do not stand in the way of innovation.

With that Mr. Chairman, I yield back the balance of my time and again thank the witnesses for participating in our series of hearings.

[The statement of Mr. Walden follows:]

PREPARED STATEMENT OF HON. GREG WALDEN

We continue our "Powering America" hearing series today with a closer look at how new energy technologies are benefiting and empowering electricity consumers.

While the committee continues its review of wholesale power markets and ensuring reliability and affordability, this hearing is intended to examine the ways in which the traditional model of delivering electricity through a centralized system and one-way power flows is being disrupted by an increasingly decentralized system with power being generated and managed by a growing number of new distributed technologies located at the edge of the grid.

You don't have to look far to see examples of how innovation is transforming the way electricity is being generated, delivered, and consumed, and how consumers are interacting with the grid. For example, in my district, Oregon Tech uses geothermal power to operate its entire campus and sells excess energy back to the grid. I visited Oregon Tech's one-of-a-kind geothermal plant in August, and saw firsthand how they are taking advantage of this great renewable resource in the Klamath Basin.

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Mr. UPTON. The gentleman yields back. The Chair would recognize the ranking member of the full committee, the gentleman from New Jersey.

OPENING STATEMENT OF HON. FRANK PALLONE, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW JERSEY

Mr. PALLONE. Thank you, Mr. Chairman, for holding this hearing examining the role of technology and its impact on electricity consumers.

Today's electric grid is incorporating technology in ways unimaginable 20 years ago. Electricity and information on the grid no longer flow in one direction and as a result consumers are embracing the ability to take control of their energy needs not just through internet-connected devices such as smart thermostats, but also by turning their homes into generators of electricity through technologies like rooftop solar. And this is all good news.

And as electric technologies evolve, they are demanding a grid that accommodates two-way flows of electricity and information. Our job is to recognize these advancements and align policies to facilitate new technologies, empower consumers, and deliver a grid that is more resilient and efficient.

2 weeks ago we held a hearing to look at how we define reliability in a transforming electricity industry. At that hearing, Gerry Cauley, president and CEO of the North American Electric Reliability Corporation stated that over the past 6 years the 50 largest events impacting the grid were caused by severe weather. Clearly, in today's world, making our grid more reliable means making it more resilient to the impacts of extreme weather.

And nowhere is this more evident today than in Puerto Rico which is suffering from the aftermath of Hurricane Maria. While the overall toll is still being assessed, the island has lost at least 80 percent of its transmission and distribution infrastructure. The lack of electricity means there is no power for lighting, air conditioning, drinking water treatment, refrigeration for food and medicine, and so much more.

And this is catastrophic. We must keep the people of Puerto Rico in our hearts and minds and help them in any way we can. And it would be nice if the President could turn his attention away from the NFL games long enough to realize that everything in Puerto Rico is not fine and this is a humanitarian crisis and they need our help now.

Hurricane Maria followed Hurricanes Harvey and Irma which also resulted in widespread outages in Texas and Florida. These

hurricanes should serve as a wake-up call to prioritize investments in the technological advancements that can make our grid more resilient and help us adapt to the catastrophic potential of climate change.

Some of the new technologies we will discuss today like battery storage and microgrids are uniquely positioned to provide considerable resiliency benefits to the electric grid. These new technologies are also enabling us to generate and store power close to where it is consumed. Until recently, grid resiliency meant building more transmission lines and fortifying substations. That is simply not the case today thanks to increased deployment of battery storage and microgrids as well as solar and other distributed energy resources.

These new technologies are providing greater localized solutions to keeping critical facilities powered in the aftermath of severe weather that has caused large-scale damage to the grid. In the aftermath of Superstorm Sandy, I spoke to a lot of local officials in my district who were interested in developing microgrids in their area. And thankfully, New Jersey recently announced a plan to develop 13 microgrids across the State.

And this is a good start, but more needs to be done to fully protect our grid from another major storm. The Federal Government should also be doing more to incentivize this shift to utilize new technologies to make our grid more resilient. Earlier this year, committee Democrats introduced the LIFT America Act which includes $4 billion for modern, efficient, and resilient electric grid infrastructure. We need to make real and significant investments in our country's grid infrastructure now, so we can protect our grid from a major, long-term outage like we are now seeing in Puerto Rico.

And we have a knowledgeable group of witnesses before us today and I look forward to hearing their testimony. I yield back, Mr. Chairman.

[The statement of Mr. Pallone follows:]

PREPARED STATEMENT OF HON. FRANK PALLONE, JR.

Thank you for holding this hearing examining the role of technology and its impact on electricity consumers.

Today's electric grid is incorporating technology in ways unimaginable 20 years ago. Electricity and information on the grid no longer flow in one direction. As a result, consumers are embracing the ability to take control of their energy needs, not just through internet-connected devices such as smart thermostats, but also by turning their homes into generators of electricity through technologies like rooftop solar. This is all good news. And as electric technologies evolve, they are demanding a grid that accommodates two-way flows of electricity and information. Our job is to recognize these advancements and align policies to facilitate new technologies, empower consumers, and deliver a grid that is more resilient and efficient.

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We have a knowledgeable group of witnesses before us today, and I look forward to hearing their testimony.

Thank you, I yield back.

Mr. UPTON. The gentleman yields back. We are ready to start with our testimony and I think you all know the routine. Each of you, thank you for submitting your testimony in advance. We have had an opportunity to go through that. You will each have 5 minutes and then we will start a question and answer after that.

And we will start with Mr. Ganesan. Is that correct?

Mr. GANESAN. That is correct.

Mr. UPTON. Vice President of Federal Policy at Advanced Energy Economy, welcome.

Mr. GANESAN. Thank you.

STATEMENTS OF ARVIN GANESAN, VICE PRESIDENT OF FEDERAL POLICY, ADVANCED ENERGY ECONOMY; KAREN BUTTERFIELD, CHIEF COMMERCIAL OFFICER, STEM; MONICA LAMB, DIRECTOR, REGULATED MARKETS, LO3 ENERGY; BRYAN J. HANNEGAN, PH.D., PRESIDENT AND CHIEF EXECUTIVE OFFICER, HOLY CROSS ENERGY; VAL JENSEN, SENIOR VICE PRESIDENT FOR CUSTOMER OPERATIONS, ComEd; AND TODD SANDFORD, SENIOR VICE PRESIDENT, NORTH AMERICA DISTRIBUTED ENERGY AND POWER, DIRECT ENERGY

STATEMENT OF ARVIN GANESAN

Mr. GANESAN. Thank you, Chairman Upton, Ranking Member Rush, Vice Chairman Olson, and distinguished members of the committee. I am honored to testify today on the evolving role of consumers in the electricity system and how technological innova-

tion is transforming our grid for the better. My name is Arvin Ganesan and I am vice president for Federal Policy at Advanced Energy Economy.

We are a national trade association representing over 120 advanced energy corporations across the United States and our member companies deploy, produce, or use a wide variety of different energy technologies including, but not limited to, storage in different forms, small modular nuclear reactors, solar, wind, and a variety of smart grid technologies in addition to many others. I am happy to join two of our member companies on this panel.

Over the last 6 years, this sector, the advanced energy sector, has grown by close to 30 percent. Our industry supports jobs across the country, as well with more than three million jobs supported by our growth. So I want to talk about what is driving that growth: two factors—declining costs and consumer preferences. Renewable energy has increasingly been a significant provider of energy and will continue to grow in the United States based on economic competitiveness.

Since 2007, the cost for utility-scale wind and solar power has declined by 66 and 85 percent, respectively. In their most recent analysis, the investment house Lazard finds that wind and solar PV have become increasingly cost-competitive with conventional generation technologies—this is the most important part—on an unsubsidized basis. Because of this rapid decline in costs, large-scale renewable energy purchases that were once driven primarily by State policies such as RPSs are now increasingly being made on economics and on corporate preference.

But the consumer demand is in no way limited just to corporations. Declining costs also have a significant impact on the everyday consumer. More consumers are increasingly exercising choice and control over their energy needs, whether that means purchasing solar panels for their rooftops, charging electric vehicles in their garages at night, or managing their household energy consumptions from their phone, which is connected to a smart thermostat, consumers are increasingly active participants in the grid. For example, U.S. revenues from home energy management systems such as Nest thermostats grew from $91 million in 2011 to $1.3 billion last year. And through consumer engagement, companies like Oracle have helped more than 15 million households in the United States save more than $1 billion in energy costs.

This transformation is changing the very nature of the electricity system. We are shifting from a rigid, centralized grid to a more dynamic and diverse one and this transformation will further help improve the stability of the grid. Allow me to give one example of how a dynamic and diverse grid can help improve resiliency.

During the 2014 polar vortex, the extreme cold, winter cold, caused a winter record demand for electricity and contributed to the failure of 22 percent of the generation in PJM. Of the unplanned power outages, coal plants accounted for 26 percent of the total and natural gas 55, due to the freezing of onsite fuel supplies like coal piles, frozen control and sensor equipments, and the inability to receive fuel from outside providers due to natural gas pipeline constraints.

Facing this situation, grid operators were able to turn to demand response which paid consumers to reduce their consumption during peak times, and wind energy to meet electric power needs to recover to keep the lights on when other resources failed.

Let me wrap up my testimony by making some brief remarks about the potential role for Federal policy. As we all know and believe, competition brings out the best in everyone and the same is true for energy technology. By enabling true competition, the main beneficiaries will be consumers. For example, in parts of PJM they have seen over $11.8 billion in savings in just 1 year from demand response and energy efficiency, which was enabled by rules that allowed these resources to compete against building additional power generation.

However, these competitive markets continue to suffer from technology-specific barriers that prevent advanced energy from providing a full suite of benefits. In fact, some market rules prevent new and emerging technologies from selling their services on the open market, stifling innovation and keeping our electricity system from being modernized for higher performance.

For example, in Indianapolis, Indianapolis Power and Light recently constructed a state-of-the-art lithium ion battery facility utility-scale that had the ability to improve the reliability of the grid. But that facility was not able to get compensated because out-of-date definitions of storage were baked deep into RTO policies and prevented anything from older definitions of storage from simply competing.

Mr. Chairman, I really appreciate this series of hearings and I really appreciate the opportunity to testify before the committee. Thank you for your attention and your vision on these issues.

[The statement of Mr. Ganesan follows:]

ADVANCED ENERGY ECONOMY
the business voice of advanced energy

September 26, 2017

Summary of Written Testimony of Arvin Ganesan, Vice President of Federal Affairs at Advanced Energy Economy for House Energy and Commerce Committee

1. **Declining costs and consumer preferences – including those of Fortune 100 and Fortune 500 corporations – will continue to drive market growth and innovation in the advanced energy industry**
    a. Renewable energy will continue to grow in the United States based on economic competitiveness with the levelized cost for utility-scale wind and solar power declining by 66% and 85%, respectively, since 2006.
    b. Large energy customers – most notably Fortune 100 and Fortune 500 companies – are driving demand for renewables. Many states are leading the way in creating a market that meets the needs of these customers, including Texas, Oklahoma, North Carolina, Ohio, and Illinois.
    c. More consumers are increasingly exercising choice and control over their energy needs. Customers are now active participants in the grid, making it much more dynamic.

2. **Advanced energy enhances the reliability and resilience of the grid by increasing fuel diversity, promoting a more flexible energy system, and responding to extreme weather events.**
    a. Grid operators are now routinely managing high levels of wind and solar generation, sometimes exceeding 50% of load, without compromising reliability, levels that would have been viewed as impossible just a few years ago.
    b. During the 2014 Polar Vortex, grid operators were able to turn to demand response and wind energy, along with nuclear power, to meet electric power needs and keep the lights on even when other resources failed.
    c. Utilities are implementing more advanced energy solutions to prepare for extreme weather events, as well.
    d. Modernizing the aging energy infrastructure that has supported American prosperity for decades and moving toward a more diverse and dynamic energy system are the keys to maintaining a reliable grid in the future.

3. **Federal policy should pursue technology-neutral competition in wholesale markets to maximize benefits to consumers and enhance the reliability and resilience of the grid**
    a. Technological innovation benefits consumers by increasing competition in the marketplace between energy technologies, increasing customer choice, and driving down the cost of electricity.
    b. While some wholesale markets overseen have opened opportunities for advanced energy technologies to compete, others have maintained legacy established rules technologies from competing on price and performance.
    c. FERC is addressing these issues with proposals to remove barriers for storage and aggregated distributed energy resources (DER). AEE fully supports, and is engaged with, this effort. The Commission also has a NOPR related to primary frequency response.

September 26, 2017

Written Testimony of Arvin Ganesan, Vice President of Federal Affairs at Advanced Energy Economy, Before the U.S. House of Representatives, Energy Sub-Committee of the Energy and Commerce Committee

Thank you, Chairman Upton, Ranking Member Rush, Vice Chairman Olson, and Distinguished Members of the Committee. I am honored to testify today on the evolving role of consumers in the electricity system, and how technological innovation is transforming our electric grid for the better.

My name is Arvin Ganesan, and I am Vice President of Federal Affairs at Advanced Energy Economy (AEE). AEE is a national business association representing over 120 advanced energy businesses across the United States.

As an energy business association, we are unique. Our businesses currently produce, deploy, or use over 50 different energy technologies including battery storage, advanced natural gas generation, small modular nuclear reactors, solar, wind, demand response, energy efficiency, combined heat and power, electric vehicles, and smart grid technologies, among many others. In addition, many businesses that want to source their energy needs from advanced energy are joining AEE to reduce policy hurdles preventing them from doing so.

Today, I want to talk about the benefits of technological innovation for the grid and for consumers. Within that theme, I will discuss three points:

1) Falling costs, technological innovation, and consumer preferences are driving a transition to a more diverse resource mix in which advanced energy plays an increasingly dominant role.
2) Advanced energy brings numerous benefits such as increased reliability and resilience. At the same time, these technologies give consumers more control over their own energy use.
3) Technological innovation ultimately benefits consumers by increasing competition in the marketplace among energy technologies, driving down the cost of electricity, and increasing opportunities for customers to exercise choice in their power sources and save money by controlling their utility bills.

Declining costs and consumer preferences – including those of Fortune 100 and Fortune 500 corporations – will continue to drive market growth and innovation in the advanced energy industry

The advanced energy industry is a major economic engine in the United States. The U.S. industry generates $200 billion in revenue, equal to pharmaceutical manufacturing and approaching wholesale consumer electronics. In the six years that AEE has been tracking, advanced energy in the United States has grown by an average of 5% annually for a total of 28% compared to 2011. And it supports jobs across the country, as well, with more than 3 million jobs supported by the advanced energy sector. This includes nearly 2.2 million workers in energy efficiency, more than 650,000 workers

in advanced electric power generation, 100,000 workers in advanced grid technologies, and 250,000 jobs in advanced transportation. With the growth of the industry, technological advancement and deployment of advanced energy has accelerated as well.

Renewable energy has increasingly become a significant provider of energy, and will continue to grow in the United States based on economic competitiveness. The most basic indicator of power technology competitiveness is the levelized cost of energy (LCOE), which measures the average cost of electricity over the life of a project, including the costs of upfront capital, operations and maintenance, fuel, and financing. Since 2007, Lazard, a financial advisory and asset management firm, has tracked the LCOE of power technologies using a consistent methodology. Lazard's annual analyses show that from 2009 to 2016, the LCOE for utility-scale wind and solar power has declined by 66% and 85%, respectively. In their most recent analysis, Lazard finds that "wind and solar PV have become increasingly cost-competitive with conventional generation technologies, on an unsubsidized basis, in light of material declines in the pricing of system components...and dramatic improvements in efficiency, among other factors."

Additionally, while the addition of large scale storage is not required to add more solar or wind to the system, utility-scale solar photovoltaic and utility-scale technology combined with storage are poised to become the next cost-effective, fully dispatchable resources. New solar-plus-storage and wind-plus-storage systems are currently cost-competitive with new conventional resources and provide operational flexibility and enhancements to support grid reliability.

Because of this rapid decline in costs, large-scale renewable energy purchases that were once driven primarily by state policies (e.g., renewable portfolio standards) are now increasingly made based on economics and consumer preference. Large energy customers – most notably Fortune 100 and Fortune 500 companies – are the most significant drivers of this demand. AEE has been actively engaged with a number of these companies in numerous states pursuing policy opportunities to help meet this demand for renewable energy from corporate buyers.

Policies supporting corporate procurement of renewable energy can be a strong economic development tool at the state and local level. The ability to control energy costs and sources is a key priority for many companies, and – as mentioned a growing number of corporations are specifically seeking opportunities to purchase advanced energy – a choice often backed by an internal sustainability or renewable energy target. As of last year, AEE found that 71 of the Fortune 100 companies and 43% of Fortune 500 companies had set a renewable energy or energy-related sustainability target. This trend currently spans all industry sectors, with businesses in healthcare, chemical, apparel, financial services, and technology committing to purchasing more renewable energy.[1]

Many states – including those represented on the Committee – are leading the way in creating a market that meets the needs of these customers. As of this month, according to data compiled by the Business Renewable Center of Rocky Mountain Institute, Texas had the largest market for renewable energy contracted by corporates from offsite facilities, with 2,965 MW of deals signed. Other leading states include Oklahoma with 1,279 MW, North Carolina with 407 MW, Ohio with 390 MW, and Illinois with

[1] https://info.aee.net/growth-in-corporate-advanced-energy-demand-market-benefits-report

373 MW.[2] These states show that customers working proactively with utilities and developers are driving a massive expansion of the renewable energy market across the country.

Examples across the country demonstrate the extent to which U.S. corporations have succeeded in pursuing renewable energy within a competitive environment. For example, General Motors has committed to power 100% of its energy usage by renewable energy. While it has operations all around the country, the auto giant has signed the majority of its renewable contracts in Texas. This is both due to the favorable economics of wind energy and there the competitive market structure in the Lone Star State, which readily accommodates corporate procurement. GM has also recently announced additional purchases of renewable energy, from wind farms in Ohio and Illinois.

Many other companies have put in significant effort to develop creative solutions, such as Amazon Web Services, which has collaborated with Dominion Energy in Virginia to develop a new market-based rate to bring over 250 MW of new solar energy onto the grid in Virginia.[3] Through an entirely different mechanism, Microsoft recently contracted with its local utility provider in Wyoming to power its facilities from renewable energy and onsite backup natural gas generators, which the utility can call upon in times of need to provide additional reliability to the grid.[4] Walmart, headquartered in Bentonville, Arkansas, and with stores in all 50 states, has also pursued a number of different strategies to work toward its 100% renewable energy goal. As of May 2017, the company had installed 364 onsite solar facilities across the United States, with a goal to grow that number to 480 by 2020. The company has also pursued offsite purchases, including a recent transaction through its local utility in Alabama, Alabama Power, to purchase energy from a 72 MW solar facility.[5]

Declining costs and increased adoption of advanced energy also have a significant impact on the everyday consumer. More consumers are increasingly exercising choice and control over their energy needs, whether that means purchasing solar panels for their rooftop, charging electric vehicles in their garages at night, or managing their household energy consumption from their phone that is connected to a smart thermostat. Customers are now active participants in the grid, making it much more dynamic. Consumers are driving this change, and federal policy must recognize the increasing role of the consumer in the grid.

States are also recognizing the consumer value of advanced energy. Brooklyn, New York, is a notable example of how new regulatory policies can benefit consumers. As a population and economic boom takes place in Brooklyn, energy demand has spiked. The city estimated that a $1 billion investment in new equipment was needed to meet this demand. In response, the New York Public Service Commission (PSC) determined that the energy demand could be managed more cheaply through the use of other technologies, such as demand-side management and energy storage, and reduce the projected cost to $200 million. By making use of distributed energy resources (DERs), Brooklyn

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[2] http://businessrenewables.org/downloads/brc_nov_2016/State-of-the-market.pdf

[3] https://www.greentechmedia.com/articles/read/amazon-and-dominion-power-forge-a-new-renewable-energy-path-in-virginia and https://www.amazon.com/p/feature/gkkwdp34z5ou7ug

[4] http://www.utilitydive.com/news/how-microsoft-and-a-wyoming-utility-designed-a-data-center-tariff-that-work/430807/

[5] Walmart, "Scaling clean, affordable, renewable energy," 2017 Global Responsibility Report, http://corporate.walmart.com/2017grr/opportunity

consumers will receive a $800 million savings.[6]

Advanced energy enhances the reliability and resilience of the grid by increasing fuel diversity, promoting a more flexible energy system, and responding to extreme weather events.

We are currently undergoing a transition to a more diverse energy resource mix. Ten years ago, nearly half of U.S. power generation was supplied by a single resource: coal. Today, coal and natural gas each supply about one third of our electric power, nuclear one fifth, and hydro and non-hydro renewables another one fifth. This greater fuel diversity gives us more options for meeting electric power needs, increases competition, and drives down prices.

This transition has been primarily driven by consistently low natural gas prices, followed by flat electricity demand and competition from renewable energy, which has sharply fallen in cost. With grid management and operational techniques becoming more sophisticated, grid operators are now routinely managing high levels of wind and solar generation, sometimes exceeding 50% of load, without compromising reliability, levels that would have been viewed as impossible just a few years ago. These changes in resource mix are improving – not reducing – the reliability and resilience of the electric power system, as demonstrated by extreme weather events.

During the 2014 Polar Vortex, the extreme cold caused a winter-record demand for electricity and also contributed to the failure of 22% of the generation in PJM Interconnection territory. NERC conducted an assessment of the Polar Vortex event and found that, of unplanned power plant outages, coal plants accounted for 26% of the total and natural gas 55%. Outages due to extreme cold were caused by the freezing of onsite fuel supplies like coal piles, frozen control and sensor equipment, and the inability to receive fuel from outside providers due to natural gas pipelines constraints.[7,8] Facing this situation, grid operators were able to turn to demand response and wind energy, along with nuclear power, to meet electric power needs and keep the lights on even when other resources failed.

Utilities are implementing more advanced energy solutions to prepare for extreme weather events, as well. Austin Energy – one of country's largest community owned utilities serving more than a million people – contracted with Schneider Electric to implement an advanced distribution management system (ADMS). ADMS integrates the millions of data points from the grid into one easily accessible system. This allows grid operators to have access to fast and highly reliable information to understand and communicate the status of outages when responding to weather events, like the summer storm season in Austin. ADMS helps to fully integrate demand response and other distribution system services that creates a more resilient grid.

Other advancements in technology help maintain grid reliability. The New York Power Authority currently benefits from greater digitalization in the energy grid. NYPA is the state's largest public power

[6] http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=45800
[7] NERC. "Polar Vortex Review." (Sept. 2014) available online at http://www.nerc.com/pa/rrm/January%202014%20Polar%20Vortex%20Review/Polar_Vortex_Review_29_Sept_2014_Final.pdf.
[8] PJM Interconnection. "Response to Consumer Reports on 2014 Winter Pricing." (19 Sept. 2014) available online at http://www.pjm.com/~/media/documents/reports/20140919-pjm-response-to-consumer-reports-on-2014-winter-pricing.ashx.

organizations with more than 1,400 circuit miles of transmission lines and has transmission cables that connect Westchester County to Long Island underneath Long Island Sound. Over the last five years, ship anchors have hit some of the transmission lines causing electrical problems for the area. The digital system can now let ships know when they are too close to wires, and to avoid dropping anchor there. A more cloud-based energy system also helps to anticipate problems and find outages quickly instead of having trucks driving around residential areas.[9]

Advanced energy companies are also empowering customers to take control of their own energy use, which has positive impacts for the grid. By providing personalized and actionable energy insights, Oracle has helped more than 15 million households save energy. These families have saved more than $1 billion on their energy bills by reducing their usage by more than 15 terawatt-hours. These savings are concentrated during peak hours, helping utilities manage the grid more efficiently.

Modernizing the aging energy infrastructure that has supported American prosperity for decades and moving toward a more diverse and dynamic energy system are the keys to maintaining a reliable grid in the future. Competition and innovation will drive down costs while meeting our energy needs as they evolve. And as mentioned earlier, this process has not only improved the overall functioning of the grid but acted as an economic engine as well. Giving these resources the chance to contribute to and compete in the U.S. energy system has resulted in growth and prosperity, and will continue to do so going forward.

Federal policy should pursue technology-neutral competition in wholesale markets to maximize benefits to consumers and enhance the reliability and resilience of the grid

Technological innovation benefits consumers by increasing competition in the marketplace between energy technologies, increasing customer choice, and driving down the cost of electricity. Organized competitive wholesale power markets are driving development of a 21st century electric system that adopts innovative technologies, drives down costs, and improves reliability and resilience through greater use of advanced energy technologies and services.

A 2016 paper by the conservative think-tank R Street Institute, *Wholesale Electricity Markets in the Technological Age*, emphasizes that well-functioning markets incentivize technological innovation while producing a reliable and affordable grid.

"RTO/ISOs have exhibited strong reliability performance and provide incentives for market participants to engage in reliable behavior. The open-access organized market model is better positioned to reduce barriers to entry, lower transactions costs, provide clear investment signals to investors that spur innovation and compensate resources fairly and efficiently in a manner consistent with market fundamentals."[10]

Real life examples show these principles to be true. For example, the Midwestern and Mid-Atlantic states in the PJM territory have seen $11.8 billion in savings in just one year from demand response and energy efficiency, enabled by rules that allowed these resources to compete against additional

[9] https://dailyenergyinsider.com/featured/5244-digitizing-electric-sector-well-way-power-execs-say/
[10] https://www.rstreet.org/wp-content/uploads/2016/08/67.pdf

power generation.[11] As mentioned above, PJM also credited these resources with helping to keep the lights on during periods of system stress, such as the Polar Vortex.

Competitive wholesale power markets have opened important new opportunities for advanced energy technologies to provide reliability, resilience, and cost savings to consumers, but continue to suffer from technology-specific barriers that prevent advanced energy from providing a full suite of benefits. While some markets overseen by the Federal Energy Regulatory Commission (FERC) and managed by Regional Transmission Operators (RTO) and Independent System Operators (ISO) have opened opportunities for advanced energy technologies to compete on a level playing field with traditional generators and transmission operators, others have maintained legacy established rules (or even sought to enact new ones) that prevent advanced energy technologies from competing on price and performance; none has provided a completely level competitive playing field.

In fact, some market rules prevent new and emerging technologies from selling their services on the open market, stifling innovation and keeping our electricity system from being modernized for higher performance. Market rules vary by RTO/ISO but there are generally three common barriers to fair, open, technology-neutral competition:

1) Requirements that all energy resources have characteristics (such as size or operating time) that match the characteristics of traditional generating units;
2) Categorizing resources based on what they are (such as a power plant) rather than what they can do (such as produce, store, or save electricity); and
3) Prioritizing supply-side resources (such as power plants) over demand-side resources (such as efficiency).

In July 2017 testimony to the House Science, Space, and Technology Committee, AEE member AES Energy Storage highlighted a notable example of current market rules impeding innovative technologies from getting full compensation for its services in the market.[12] Indianapolis Power and Light (IPL) had difficulty integrating a new 20 megawatt battery storage system (developed by AES Storage for IPL) onto the grid, and getting fully paid for the reliability benefits that system provides. IPL faced difficulties interconnecting to the grid because Midcontinent Independent System Operator's (MISO) definition of a "storage" product was designed for older versions of storage, specifically "flywheel." MISO's rules had not been amended to allow for newer, advanced energy technologies to participate and be fully compensated, such as lithium ion batteries.

Similarly, compensation for grid services has not caught up with the capabilities of advanced energy technologies, such as solar and storage, as a fast-responding, reliable resource. The current framework incentivizes generators to run at full capacity, rather than configuring their inverters to leave the appropriate headroom required to offer these services, because there is no compensation for doing so. For example, First Solar recently completed a demonstration project with the California Independent System Operator (CAISO) and the National Renewable Energy Laboratory (NREL) to measure the

[11] Monitoring Analytics, the Internal Market Monitor for PJM. "Analysis of the 2013/2014 PJM Base Residual Auction Revised and Updated, September 20, 2010. Page 52.
[12] https://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-115-SY-WState-KKumaraswamy-20170719.pdf

capability of utility-scale solar to provide flexibility to the grid.[13] The test data shows that utility-scale solar plants can provide services that range from spinning reserves, voltage support, ramping, frequency response, variability smoothing and frequency regulation, and offer them faster and with more accurate results than conventional generation.

FERC is aware of these issues, and is beginning to address them. The Commission currently has a Notice of Proposed Rulemaking (NOPR) related to removing barriers for storage and aggregated distributed energy resources (DER) – such as electric storage resources, electric vehicles, and distributed generation – participation in wholesale power markets. AEE fully supports, and is engaged with, this effort. The Commission also has a NOPR related to primary frequency response. This is an excellent start to address issues of compensation and the possible solutions that advanced energy can offer, but does not do enough, as it is limited to this one grid service and does not address larger utility-scale issues and capabilities for providing reliability to the grid. We look forward to working with FERC and Congress to ensure that federal rules and regulations do not impede innovative advanced energy technologies from fully participating in markets and receiving full compensation for the grid services they provide.

AEE appreciates the opportunity to testify before the Committee today, and looks forward to working with each of you to ensure that technological innovation continues to thrive in the United States to preserve a reliable, resilient, and affordable energy system.

Thank you,

Arvin Ganesan

[13] NREL, CAISO and First Solar, *Using Renewables to Operate a Low-Carbon Grid* (January 2017), available at http://www.caiso.com/Documents/UsingRenewablesToOperateLow-CarbonGrid.pdf

Mr. UPTON. Well, thanks very much. Thanks for your kind words and we are glad that you are here.

And we will go next to Ms. Butterfield, who is chief commercial officer of Stem. Welcome.

STATEMENT OF KAREN BUTTERFIELD

Ms. BUTTERFIELD. Chairman Upton, Ranking Member Rush, Vice Chairman Olson, and distinguished members of the subcommittee, thank you for the opportunity to provide this testimony on the role of consumers in the evolving electricity grid. My name is Karen Butterfield and I serve as chief commercial officer of Stem, a technology and services company that operates the world's smartest energy storage network. We applaud the subcommittee for thinking through how consumers can play a more active role in the modernization of our electric infrastructure.

We believe that software-driven energy storage enables consumer participation, drives down costs, increases U.S. competitiveness, and helps the grid. Stem was founded 8 years ago when the idea that lithium ion batteries combined with superfast and superintelligent software would become highly valuable to both electricity consumers and the Nation's critical electric grids. We install battery storage systems to help businesses and institutional customers save money, take greater control of their energy usage, and more actively participate in energy markets.

Stem provides storage as a service, financing the hardware so that customers pay nothing up front but rather pay a monthly subscription fee to save and participate. Our software then automatically charges and discharges the batteries to maximize savings and help balance the needs of the grid. We install battery systems at local facilities including businesses, schools, and Government sites in what is called behind-the-meter energy storage.

Installing at the site allows the system to play many different roles related to capacity, energy, and voltage. We then connect these batteries together virtually, using super intelligent software known as Athena. Athena takes data from all the sites from weather stations and from the grid and creates virtual power plants or VPPs.

Stem is now active in seven major U.S. markets as broad-ranging and complex as California and Texas. Our market traction demonstrates that strong commercial demand exists today. We have over 700 customer sites installed or in deployment. We have eight contracts with U.S. utilities to build battery networks with enough capacity to power 30,000 homes for 4 hours.

We also have over $500 million in project financing. The traditional thinking of the grid is evolving as new technologies become more cost effective. Consumers are looking for more control and behind-the-meter energy storage gives them second-by-second control. It also makes decisions automatically without impacting their operations.

Today, Stem empowers forward-thinking companies like Cargill, Extended Stay America, Macy's, Marriott, Albertsons, and a host of schools, hospitals, and Government locations. At one customer site, the StubHub Center, a professional soccer stadium, we were

saving them thousands of dollars on their utility bills by charging and discharging their storage systems at the right time.

They called us and asked us whether we could modify the software to allow them to discharge the battery to help deliver on a demand response program with their local utility. We made a few changes through Athena, uploaded the algorithms in the cloud, and were able to save them tens of thousands more using the same exact hardware at the site.

This may sound futuristic, but Stem is delivering network storage just like this today. For example, one day last month when the California grid was strained by a record-breaking heat wave, Stem software automatically dispatched 14 VPPs that included batteries in over a hundred of our customers' buildings spread across the State. Not only were we able to deliver exactly when called upon, our customers enjoyed knowing they were helping keep the lights on in California.

The Federal Government can drive the modernization of our electric infrastructure by putting this technology option in the hands of the consumers. FERC has taken the first step by opening a rulemaking on how energy storage and distributed energy resources can participate in wholesale markets. This proceeding should move forward with urgency to capture the value of energy storage.

The Federal Government can also take a leadership role in education and standardization of interconnection and permitting rules. Stem has served customers in over 75 different U.S. jurisdictions and knows firsthand how the lack of standards and education increase barriers to installation.

In summary, now more than ever the consumer-driven electric grid requires super intelligent energy storage to optimize usage and to operate virtual power plants when and where they are needed most. Customer adoption of energy storage will be an essential facet of modern, vibrant energy markets here in the United States and around the world.

I am honored to testify before the committee on Stem's experience with customers. Thank you and I am happy to answer any questions about energy storage and the role of the consumer in modernizing the electric grid.

[The statement of Ms. Butterfield follows:]

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Testimony

before the

United State House of Representatives

Committee on Energy and Commerce

Subcommittee on Energy

(written statement)

by

Karen Butterfield

Chief Commercial Officer

Stem, Inc.

Chairman Upton, Ranking Member Rush, Vice Chairman Olson, and Distinguished Members of the Subcommittee, thank you for the opportunity to provide this testimony on the role of consumers in the evolving electricity grid. My name is Karen Butterfield, and I serve as Chief Commercial Officer at Stem, a California-based technology and services company that operates the world's smartest energy storage network. We applaud the interest of the Subcommittee to explore how consumers can play a more active role in the modernization of our electric infrastructure, and we believe that software-driven energy storage enables such participation, empowering consumers to reduce their energy costs while providing important services to the grid.

The key themes that I'll be covering in this testimony include:

- Energy storage for commercial and institutional electricity customers is no longer a future concept. Stem is proving that it is viable and cost-effective today.
- Energy storage is key to enabling consumers to both take control of their energy cost and become active participants in dynamic energy markets.
- Networked energy storage, managed by advanced software, can provide the same benefits as traditional power plants, improving the reliability and resilience of a modern electric grid.
- The federal government can accelerate the deployment of this technology by helping open energy markets to consumers that are using energy storage and by helping reduce the time and money required to install energy storage.

Introduction to Stem

Stem was founded in 2009 on the premise that energy storage could provide a range of services that would be highly valuable to both electricity consumers and the reliability of one of the nation's most critical infrastructures – the electrical grid. We start with installing energy storage systems (lithium ion batteries) to help a wide range of business and institutional electricity customers save money on their monthly bills, take greater control of their energy usage, and more actively participate in energy markets. This is known in the industry as customer-sited or "behind-the-meter" energy storage that performs real-time energy optimization. For our customers, we provide storage-as-a-service based on a monthly fee with no upfront payment. We finance the hardware so that customers only pay a subscription, making energy storage a

cost-saving operating expense rather than a capital investment. Our software then automatically charges and discharges the storage to produce the most savings by providing energy from the battery to the building rather than from the grid. Customers save money from day one and can often save up to two-to-three times what they pay each month in subscription fees.

We then network all these storage installations together into what we call Virtual Power Plants (VPP) and manage those networks with the world's smartest artificial intelligence (AI) for energy storage, Stem's "Athena". Only a "superintelligence" like Athena can handle millions of data points from the grid, the weather, and the buildings' histories to optimize, in real-time, the benefits energy storage can provide to customers and the grid. Our traction in the market demonstrates that cost-effective, flexible energy storage is in strong commercial demand today:

- Since 2012, we have been operating storage systems ranging from 30 Kwh (e.g. for a small hotel) to 2.5 MWh (e.g. for a large integrated office park).
- We have 8 contracts to provide grid services to U.S. utilities totaling 350 MWh (enough to power roughly 30,000 homes for 4 hours).
- We currently have over 700 customer sites and 150 MWh installed or in deployment
- Stem is active in 7 major markets as broad ranging as California and Texas.
- Managed by the Athena AI, the Virtual Power Plants in the Stem network have successfully responded to more than 500 dispatch requests from utilities and grid operators to help grid reliability over the past three years.

- We have secured over $500 million in project financing, the most in the industry.

The Engaged Consumer

The traditional paradigm of large-scale electricity generators sending energy over long distances to passive customers is evolving at different speeds around the country as new technologies become more and more cost-effective. Consumers, starting at scale with commercial and institutional ones, are looking for more energy control, first to reduce their energy costs, and increasingly to participate in US energy markets. Enabling more customer control depends on advanced energy technologies and software, transacting over a highly efficient electrical infrastructure, in a modernized grid.

All types of energy providers are looking for more customer satisfaction options, and utilities increasingly agree that cost-effective energy storage at homes, businesses, and institutions is integral to facilitating this heightened customer interest. Behind-the-meter energy storage gives a consumer second-by-second control over the timing of their energy usage to reduce their energy bills, and software-driven storage makes those decisions and market transactions automatic, without impacting the consumer's operations, freeing the customer to focus on their core business. Stem empowers dozens of Fortune 500 leaders, such as Adobe, Cargill, Extended Stay America, Intercontinental Hotels, JC Penney, Macy's, Marriott International, Albertsons, Wells Fargo, and Whole Foods. For our public sector customers, such as University of California, the resulting energy cost savings are important resources to redirect to other critical budget needs.

Now, more than ever, the consumer-driven electric grid requires AI-driven energy storage to manage real-time energy optimization and to connect and activate virtual power plants when and where they are needed most.

The Modernized Grid

The modern economy is more and more dependent on an electrical system that is efficient, flexible, resilient, and managed with artificial intelligence. Energy storage is emerging as the key technology to help with all of those needs. As both supply and demand become more variable with technologies like wind, solar, and electric vehicles, the grid needs more flexibility, with resources that can respond quickly to steep ramps, up or down, to help balance the grid. Advanced energy storage is the fastest, most flexible resource, with the ability to respond to a signal in under a minute and to be precisely-positioned within distribution grids, to address system "peaks" in the grid and smooth out spikes in demand, as we are showing in our system tests for Hawaiian Electric. Energy storage can also engage customers in systems that directly work to integrate renewable energy resources, as we have contracted to do in Texas with Austin Energy.

Utilities and their regulators also increasingly seek to get the most of our energy infrastructure at the lowest cost to ratepayers. Networks of energy storage are perfect for creating "non-wires alternatives" to traditional investments in grid infrastructure, as we have contracted to perform in the Brooklyn Queens Demand Management distribution deferral project for

Consolidated Edison in New York. Large scale grid operators and policymakers are attracted to the reliability of these networks to provide an improved type of "demand response" or load reduction when called. Finally, major incidents in the last few months and years have highlighted the growing need for resilience, or the ability to maintain critical infrastructure and bounce back from major events that disrupt electricity delivery. Networked energy storage can not only provide resilience to specific buildings, but can also improve resilience at the level of the community, city, or regional grid.

By joining Stem's energy storage network, the engaged electricity customer participates in Virtual Power Plants during the times that their storage system is not needed for their own site's interests. In this way, the customer's system can provide other services in energy markets, contribute to the reliability and resilience of the grid, and be compensated for it. In this way, customers engaged by Stem in Virtual Power Plants not only benefit themselves but can meaningfully help their community, as well.

Virtual Power Plants are Real Today

Although "Virtual Power Plant" sounds like a futuristic concept, they exist today and Stem is proving how they work. Stem's Athena-branded software "brain" manages dozens of VPPs across the Stem network, grouping customers in certain specific regions to respond automatically to the needs of the grid while continuing to save each customer money on their own bills.

For example, on a single day last month, when the California grid was strained by a record breaking heat wave, Stem's Athena AI dispatched over 100 energy storage systems within 14 VPPs spread across the state—all without manual intervention. In the first half of 2017, Stem's network responded to over 150 real-time grid events with only 5-minute notice for just the smallest of California's major utility companies, San Diego Gas & Electric. And, as we'd expected, our customers enjoyed learning that they were helping California reduce strain on the grid and avoid blackouts. In fact, Stem's California and Hawaii VPPs have led to industry awards such as this year's Innovator of the Year from the Smart Electric Power Association.

Spread the Success

The Federal government can help drive the modernization of the nation's electric infrastructure by empowering consumers everywhere with the technology and policies that Stem and others are proving successful today. The primary initiative should be to evolve energy infrastructure around the country with market mechanisms that fully value and compensate all the services customer-sited energy storage can provide. FERC has begun this effort by opening a rulemaking on enabling energy storage and distributed energy resources to more fully participate in wholesale energy markets. Both the storage and DER portions of this proceeding should move forward with urgency since together they have tremendous potential to increase market competition, driving down energy costs while increasing reliability and resilience.

The other areas ready for Federal leadership are in education, quantitative analysis, and standardization of interconnection and permitting of energy storage systems. As an example of

the latter, hundreds of local jurisdictions as well as state and local regulators are beginning to develop policies and processes for installation of storage at private and public buildings. Stem has installed in over 75 different jurisdictions in the US and knows firsthand how the lack of standards and basic education can be a major barrier to permitting, costing considerable time and money with unrelated code review. Moreover, Stem and other storage industry leaders have been working with the National Fire Protection Agency on a forthcoming fire safety code with an entire chapter on energy storage, NFPA 855. The federal government can help disseminate knowledge of these new storage standards. Creating consistent and streamlined best practices for these installations would allow for much more efficient storage deployment, reducing costs for consumers and the grid without sacrificing important safety reviews.

Conclusion

In summary, I am honored to have the opportunity to testify before the Committee on Stem's experience with engaging customers; thank you. We appreciate the Subcommittee's exploration of public policy and new technologies and services that can spur engagement of the 21st century energy consumer in the modernization of electric grid infrastructure. We conclude that customer demand for software-driven energy storage will be an essential facet of a modern, participatory grid and will increase the reliability and resilience of vibrant energy markets. We look forward to working with Members of the Committee to answer any questions about energy storage and the interests of the consumer in building a safe, reliable energy infrastructure.

Mr. UPTON. Thank you very much.

We are joined next by Monica Lamb. Ms. Lamb, Director of Regulated Markets, LO3 Energy, welcome.

STATEMENT OF MONICA LAMB

Ms. LAMB. Thank you, Chairman Upton, Ranking Member Rush, and members of the subcommittee. Thank you for the opportunity to testify today. My name is Monica Lamb and I serve as director, Regulated Markets for LO3 Energy, an energy technology company that enables an interactive multisided marketplace to allow customers, producers, and utilities to deploy and manage energy assets in an increasingly open and competitive electricity market using distributed ledger information architecture built on a blockchain data structure.

LO3 Energy is a young company with deep roots in energy, finance, and technology. We are passionate about the future of an increasingly flexible, responsive, and reliable utility grid. We are developing ways to give people and utilities opportunities to shape that future. The community energy marketplaces that we are building enable utilities and neighborhoods to share in the responsibilities and the benefits of reliable distributed energy resources.

You may be familiar with the concept of the internet of things, the idea that our devices, machines, thermostats, automobiles, and appliances are able to use built-in sensors and computing power to communicate information, coordinate with each other, and manage our environment and our energy use intelligently and independently by following the rules that their owners program into them. Our blockchain platform activates an internet of things within the local power grid, enabling it to generate market signals that will govern and balance neighborhood loads, generation, and storage assets, and allowing it to coordinate with the broader interconnected transmission grid.

Currently, LO3 Energy is developing such a marketplace within the community of Brooklyn, New York, through a benefit corporation called Brooklyn Microgrid. The goal of this project is to enable a multisided, multiparticipant marketplace for consumer choice that is envisioned by the energy regulators in New York, and to improve the local community's energy security during extreme weather events and other emergencies.

This community energy marketplace in Brooklyn, which can be replicated in hundreds more communities around the U.S. and globally will create a locally optimized energy network that also coordinates with the broader power grid. These local energy resources provide resiliency for emergencies, reduce customer costs, optimize the utility infrastructure investments, and enable renewable electricity, energy efficiency, and energy storage deployments within that community. Meanwhile, the new market drives community investment and jobs boosting the local economy.

The role of public policy is key in enabling the community energy marketplace. Policy can enable the integration of new, peer-to-peer, local consumer choice energy markets with the existing wholesale markets.

In summary, we think the community energy marketplace enabled by the internet of things through blockchain will be critical

to enabling consumers to participate in and benefit from community-based energy resources both during normal operations and in emergencies. We see this as a win for the consumer, a win for the utility, and a win for the grid. We are grateful that the committee is discussing these important issues and we look forward to serving as a resource as you continue these conversations.

Thank you again for the opportunity to testify and I look forward to addressing any questions from the members.

[The statement of Ms. Lamb follows:]

Testimony

before

United State House of Representatives

Committee on Energy and Commerce

Subcommittee on Energy

Monica Lamb

LO3 Energy Inc.

Summary of Points

- LO3 Energy applies tools from energy, finance, and computing to build a blockchain platform for a community-based, peer-to-peer, real-time energy market.
- A distributed energy marketplace can leverage distributed computing power to incentivize energy use and investments in energy assets and to efficiently track energy transactions.
- Federal policy can recognize and streamline the integration of new community energy marketplaces with the wholesale markets.

Testimony

Chairman Upton, Ranking Member Rush, and Members of the Subcommittee, thank you for the opportunity to provide testimony for "Powering America: Technology's Role in Empowering Consumers." My name is Monica Lamb and I serve as Director, Regulated Markets for LO3 Energy, an energy technology company that enables an interactive, multi-sided marketplace to allow consumers, producers, and utilities to deploy and manage energy assets in an increasingly open and competitive electricity market using distributed ledger information architecture, built on a blockchain data structure.

LO3 Energy is a young company with deep roots in energy, finance, and technology. We

are passionate about the future of an increasingly flexible, responsive, and reliable utility grid. We are developing ways to give people and utilities opportunities to shape that future. The community energy marketplaces that we are building enable utilities and neighborhoods to share in the responsibilities and benefits of reliable distributed energy resources.

You may be familiar with the concept of the "internet of things," the idea that our devices, machines, thermostats, automobiles and appliances are able to use built-in sensors and computing power to communicate information, coordinate with each other, and manage our environment and our energy use intelligently and independently, by following the rules that their owners program into them. Our blockchain platform activates an internet of things within the local power grid, enabling it to generate market signals that will govern and balance neighborhood loads, generation, and storage assets, and allowing them to coordinate with the broader interconnected transmission grid. Our platform enables this functionality by implementing a market in which neighbors, independent power producers, energy services companies, and utilities can choose to buy and sell energy and energy services on a peer-to-peer basis in real time. For example, a neighborhood resident may run his washing machine when electricity in the local peer-to-peer market is least expensive, perhaps when energy output from his neighbor's solar panels reaches its peak in the early afternoon; or a department store may dial back its air conditioning when that local electricity is most expensive, for example when a local utility transformer is being over-taxed in the late afternoon on a hot summer day.

Currently, LO3 Energy is developing such a marketplace within the community of Brooklyn, New York, through a benefit corporation called Brooklyn Microgrid. The goal of this project is to enable the multi-participant marketplace for consumer choice that is envisioned by the energy regulators in New York, and likewise to improve the local community's energy

security during extreme weather events and other emergencies.

This community energy marketplace in Brooklyn—which can be replicated in hundreds more communities around the U.S. and globally—will create a decentralized, peer-to-peer energy network that also coordinates with the broader power grid. By sending appropriate price signals for energy and energy services, these locally optimized networks engage all market participants to deploy distributed energy resources and infrastructure upgrades in the most efficient manner. These local energy resources also provide resiliency for emergencies; reduce customer costs; optimize utility infrastructure investments; and enable renewable electricity, energy efficiency, and energy storage deployments within that community. Meanwhile, the new market drives community investment and jobs, boosting the local economy.

This is a new opportunity for the energy consumer who, until now, has been dependent on the grid but not able to directly participate in, control, or contribute to the reliability or source of the electricity on the grid. LO3 Energy, and distributed energy marketplaces enabled by the internet of things more broadly, will enable consumers to truly determine their energy future—their source of energy, when they want to use that energy, and the price they pay for that energy.

The role of public policy is key to enabling the community energy marketplace. Federal policy can recognize and streamline the integration of new community energy marketplaces with the existing competitive wholesale markets operated by the Independent System Operators and Regional Transmission Organizations under FERC's jurisdiction. Policymakers can help lift roadblocks to the participation of individuals and local governments in energy transactions in community marketplaces and encourage cooperation, communication, and interaction between these new community energy marketplaces and the wholesale markets. Federal policy can clarify that behind-the-meter consumer energy assets should access energy markets on equal footing

with in-front-of-the-meter energy assets, and that distributed energy resources like batteries, thermal storage, active demand management, microgrids, and other hybrid energy resources can transact energy services in the same manner as traditional generation.

In summary, we think the community energy marketplace, enabled by the internet of things through blockchain, will be critical to enabling consumers to participate in and benefit from community-based energy resources, both under normal operations and in emergencies. We see this as a win for the consumer, a win for the utility, and a win for the grid. We are grateful that this Committee is discussing these important issues and look forward to serving as a resource as you continue these conversations.

Thank you again for the opportunity to deliver this testimony. We look forward to addressing any questions the Members of this Subcommittee have about LO3 Energy and our energy marketplace platform.

Mr. UPTON. Thank you so much.

We are joined next by Dr. Bryan Hannegan, president and CEO of Holy Cross Energy. Welcome to you.

STATEMENT OF BRYAN J. HANNEGAN

Dr. HANNEGAN. Good morning, Mr. Chairman and Ranking Member Rush, Vice Chairman Olson, and distinguished members of the subcommittee. Thank you very much for the opportunity to be here today to testify on how innovations in electricity technologies are opening up whole new realms for empowering customers. My name is Bryan Hannegan, and I am president and chief executive officer of Holy Cross Energy in Glenwood Springs, Colorado.

Before I start, I just want to say our thoughts continue to be with those affected by the hurricanes in Texas, Louisiana, Florida, Puerto Rico, and the Virgin Islands, as well as those affected by the wildfires out in the West. As residents of these States work to rebuild their homes, businesses, and communities, I want to recognize the ongoing events of the efforts of the thousands of utility employees that are working around the clock to safely restore power. It is during these difficult times that we are all reminded of the critical importance of our Nation's energy infrastructure, especially the electric grid.

Holy Cross Energy was formed in 1939 as a not-for-profit, member-owned, electric cooperative utility that provides electricity, energy, and energy services to more than 56,000 customers in the western Colorado counties of Eagle, Pitkin, Garfield, Mesa, and Gunnison. The more than 3,000 miles of transmission and distribution lines that we maintain deliver energy to farmers, ranchers, and hardworking communities and towns of the Colorado Western Slope. Our workforce includes 158 skilled and dedicated employees that are committed to serving the energy needs of our member-owners and we are governed by a seven-member board of directors that is democratically elected from the local communities in which they reside.

So empowering the customer and empowering the consumer is vitally important to Holy Cross in everything that we do. Working together, our board and our staff make decisions on long-term investments and near-term operations in order to efficiently optimize our resources on behalf of the members that we serve, providing them with safe, affordable, and reliable energy supply. However, several of you noted in your opening statements the landscape on which we are doing this is rapidly changing and I am pleased to share our views with you on how these changes will benefit our members and the Nation as a whole.

In my testimony today I make five key points which I would like to call to your attention. The first, as it has been said several times this morning, the architecture of the U.S. electricity grid is rapidly changing from a conventional hub and spoke model with large generation and relatively passive customers to a grid which is more dynamic, decentralized, and distributed. And this offers a tremendous opportunity for customers, but it also has profound implications for how we design, operate and manage the grid.

This change in architecture is being driven by several factors. Not only the decline in costs for solar PV and other distributed energy technologies, but by the increasing digitalization of the grid, the availability of metering data, and the software platforms, some of which my colleagues have hinted at that allow us to bring new services to customers.

The third main point I would like to make is that the Department of Energy's grid modernization initiative is already yielding significant benefits for the Nation as it responds to these changes, in many cases in public-private partnership with companies like those that you see here, and it merits continued support by this Congress.

Several of the many projects supported by the grid modernization initiative are already yielding benefits. For example, in Hawaii, we are using power electronics located on the back of distributed solar panels to absorb the shock of the variability those solar panels provide to the grid and actually allow us to emplace on those grids several times more solar than engineers thought possible only a few years ago. We are doing the same thing with utility solar installations in California and elsewhere where we can actually ramp solar production up and down in accordance with the needs of the grid.

So too can we do this with wind turbines depending on what demands are needed in the marketplace. In Vermont, local utilities are using advanced distribution management systems to directly control energy storage and other DER on the grid in new ways that avoid the need for system upgrades and optimized asset utilization. And in Washington State, two university campuses and a national lab are engaging in transactive energy where buildings and even building components can interact directly with the marketplace and tailor their production to the needs of the grid.

Because cooperatives are member-owned, member-governed, not-for-profit utilities, we are naturally consumer-centric and so as a result we put the needs of the consumer first and we will be responding and developing and deploying these technologies where it makes sense to provide safe, affordable, and reliable electric supply.

I thank the committee for the opportunity to testify today and I look forward to your questions.

[The statement of Dr. Hannegan follows:]

"Powering America: Technology's Role in Empowering Customers"

September 26, 2017

Before the Subcommittee on Energy

House Committee on Energy and Commerce

U.S. House of Representatives

Washington, DC

Testimony of Bryan J. Hannegan

President and Chief Executive Officer

Holy Cross Energy

SUMMARY

- The architecture of the U.S. electricity grid is rapidly changing from a centralized, "hub-and-spoke" model to a much more distributed, decentralized, and dynamic model that offers tremendous opportunity for consumers.

- This change in architecture is being driven by several factors, including technological progress in a number of areas, increased demands by consumers for more resilient and secure power supply, aging infrastructure, and the impact of digitalization.

- The Department of Energy's (DOE) Grid Modernization program is already yielding significant benefits for the nation as it responds to these changes, and merits continued support by this Congress.

- America's electric cooperatives are responding to these changes as well by leveraging new technologies, offering new services, and continuing to provide affordable, reliable power for the communities they serve.

- Changing technologies, evolving public expectations and the immense diversity within the nation's electric system will require local decision-making, innovation and flexibility. The Committee should keep this principle in mind when considering future legislation related to the electricity industry.

PREPARED TESTIMONY

Good morning Chairman Upton, Ranking Member Rush, and members of the Subcommittee. My name is Bryan Hannegan, and I am President and Chief Executive Officer of Holy Cross Energy in Glenwood Springs, Colorado.

Thank you for the opportunity to testify on how innovations in electricity technologies are empowering consumers. Our thoughts continue to be with those affected by the devastating hurricanes in Texas, Louisiana, Florida, Puerto Rico and the Virgin Islands, as well as those affected by the wildfires currently burning throughout the West. As residents of these states work to rebuild their homes, businesses and communities, I want to recognize the ongoing efforts of the thousands of utility employees that are working around the clock to safely restore power. It is during these difficult times that we are all reminded of the critical importance of our nation's energy infrastructure, especially the electric grid.

Holy Cross Energy, formed in 1939, is a not-for-profit, member-owned electric cooperative utility providing electricity, energy products and services to more than 59,000 consumers in the Western Colorado Counties of Eagle, Pitkin, Garfield, Mesa, and Gunnison. The more than 3,000 miles of transmission and distribution lines that we maintain deliver energy to the farmers, ranchers and hard-working communities and towns of the Colorado Western Slope. Our workforce includes 158 skilled and dedicated employees committed to serving the energy

needs of our member-owners, and we are governed by a seven-member Board of Directors that is democratically elected from the local communities in which they reside.

Working together, our Board and staff make decisions on long-term investments and near-term operations designed to efficiently optimize our resources on behalf of the members we serve, providing them with safe, affordable and reliable energy supply. The landscape on which we are doing this is rapidly changing, however, and I am pleased today to share with you our views on how these changes will benefit our members and the nation as a whole.

A Changing Landscape

For the last century, our extensive, reliable electric power grid has fueled the nation's growth. Access to electricity is such a fundamental enabler for society that the National Academy of Engineering named "electrification" the greatest engineering achievement of the 20th century.

Today's electric grid was built largely around a "hub-and-spoke" architecture consisting of several components, including:

- large, central-station power plants;
- a one-way transmission and distribution delivery system; and
- fixed, predictable and passive customer loads.

This architecture fit the purpose of the time – to provide safe, reliable and affordable supplies of electricity as an input to a growing economy. In more recent years, however, we have called upon the Nation's electric grid to take on additional challenges, including:

- a changing and increasingly variable mix of electricity generation resources;
- new opportunities for customers to participate in electricity markets with distributed energy and smart grid technologies;
- growing consumer and business demands for a more resilient and reliable grid protected from all hazards (including weather, cyber and physical attacks);
- an increasing dependence of the electricity grid on interconnected digital information and control systems; and
- an increasingly aging electricity infrastructure, much of which was first constructed many decades ago.

Meeting these additional challenges will require modernizing our electric grid for the 21st century following a new architecture comprised of:

- multiple sources of electricity generation of various shapes, sizes, and variability;
- a two-way, dynamic delivery infrastructure; and
- active, engaged customers that can both produce and consume energy as best fits their needs and the needs of the grid at the time.

In 2015, I was pleased to be co-leading a team of experts from our National Laboratories that identified six key challenges in grid modernization:

1. Development of *devices (vehicles, appliances, storage, etc.) and integrated systems of devices (like microgrids)* that can seamlessly provide grid-friendly energy services.
2. *Sensing and measurement technologies* that can allow us to better monitor and predict the condition of the grid at any point in time and space.
3. *New approaches to real-time operations and control of the electric grid* and the technologies connected to it, with the ability to scale from a few hundred large power plants to millions if not billions of connected devices on the grid of the future.
4. *Improved design and planning tools* that can be used to develop new blueprints for electric grids that blend existing assets with new technologies across multiple scales.
5. *Technologies and practices for grid security and resilience* that allow us to better identify threats and hazards (regardless of cause) and improve our ability to protect, respond and recover from those events.
6. *Institutional changes in policies, regulations, and business models* that may be needed to enable new services to consumers.

These ideas have been developed and implemented as the Department of Energy's (DOE) Grid Modernization Initiative, a multi-year collaboration among 14 DOE National Laboratories and regional partner networks of utilities, grid operators, technology firms, academia, and civil society organizations. This portfolio of Federally-funded activities will help set the nation on a cost-effective path to an resilient, secure, sustainable, and reliable grid that is flexible enough to provide an array of emerging services while remaining affordable to consumers.

Several of the many projects supported by the Grid Modernization Initiative are already having a significant impact on how we think about the future electric grid:

- In Hawaii, the electric utility is partnering with solar providers to use "advanced inverters" to reduce the impact from large amounts of rooftop solar on the local distribution grid. The advanced inverters can function as shock absorbers to the grid by modifying how they convert the DC power from the solar panels into the AC power needed on the grid or in the home.

- In California, these advanced inverters are doing the same thing with utility-scale solar plants up to 300 MW in size. This allows a utility solar installation to provide more flexibility to the grid in the form of "ancillary services" such as ramping control and frequency response, which help keep the grid stable and avoid the need for backup generation capacity. Similar functions are now standard issue for all wind turbines.

- In Vermont, the local utilities and their main technology providers are deploying a new form of software known as an Advanced Distribution Management System, or ADMS, to directly control energy storage on the distribution grid in new ways that avoid the need for system upgrades and optimize asset utilization.

- In Washington State, two universities and a National Lab are teaming to form a multi-campus network allowing for testing of "transactive energy" concepts that allow individual buildings to respond to real-time price signals with specific changes in their

energy use that help the grid and also save money.

- In Louisiana and Alaska, communities and villages are designing and deploying "microgrids" of local resources, including energy storage, to improve the resilience and reliability of their electricity supply where grid service either does not exist or is prone to impacts from natural events like hurricanes.

These are but a few of the important projects comprising the Grid Modernization Initiative, which is a vitally important investment in our Nation's energy future, and one that I hope you will see fit to continue.

Implications for Electric Cooperatives

Because they are member-owned, member-governed, not-for-profit utilities, America's electric cooperatives like Holy Cross are naturally "consumer-centric". Through a variety of mechanisms we regularly hear from our members about their wants and needs for energy services, which are rapidly changing given the array of new technologies able to serve them.

At Holy Cross, we have responded with an array of "consumer-centric" programs, particularly in the area of energy efficiency and renewable energy:

- Through our "WE CARE" program we provide an array of energy efficiency services and incentives that are intended to achieve a 0.5%/year energy savings across our system. Under this program we provide:
    - free energy audits for existing homes and businesses;
    - rebates for residential lighting, thermostats and appliances;
    - rebates for commercial lighting, heating/AC systems, and efficient motors; and
    - partnerships with incentives for our largest commercial/industrial members

- We also provide our members with "green power" options that enable them to purchase blocks of wind energy or local hydropower resources if they so choose. We are exploring expanding this program to include solar energy as well.

- We have nearly 30 MW of distributed clean energy resources on our system, including:
    - 11.5 MW of biomass fueled with beetle-kill salvage lumber from nearby forests;
    - 3.5 MW of community solar, including the first such community solar project anywhere in the nation;
    - 6 MW of small hydro resources;
    - 3 MW from coal mine methane; and
    - 6 MW of distributed and utility-scale solar.

  Additionally we have 10 MW in new solar under development, expected in 2018.

- We were one of the first electric cooperatives to have Advanced Metering Infrastructure fully deployed throughout our distribution system.
    - Our "smart meters" and related communications and control infrastructure allow us to detect outages in many cases before the member calls us.
    - We can also use this data for several purposes:
        - to optimize our maintenance activities;
        - to determine where best to install distributed energy resources; and
        - to sequence our future investments to maintain a reliable grid.
    - In the future, we may be able to use this data to predict the future state of the grid in real-time, at a specific location, so that we can take steps to prevent outages and disruptions in service **before** they occur.

Cooperatives like Holy Cross are benefiting their members across the country through an array of projects reflecting new technologies and new ideas.

- In South Dakota, co-ops help ranchers deploy solar-powered stock wells in remote locations to avoid the need for expensive grid extensions and upgrades.
- In New Mexico, a co-op installed a solar micro-grid on a community campus to provide extra reliability and access to generation resources desired by members.
- In Minnesota, a co-op is providing a free water heater to members so it can be used as energy storage for power generated by solar and wind.

- Seven Colorado co-ops (including Holy Cross) are partnering with a regional non-profit organization to construct community solar facilities dedicated to serving their lowest-income members.
- In states around the country, co-ops are providing high-speed broadband service to consumers who otherwise lack access.

As the future electric grid evolves towards a 21st century future, cooperatives like Holy Cross will continue to invest in new technology, develop new programs and services, and evolve their businesses to meet the local needs of their consumers in light of local conditions, needs, and consumer preferences. Changing technologies, evolving public expectations and the immense diversity within the nation's electric system will require local decision-making, innovation and flexibility from our industry. We encourage the Committee to keep this principle in mind as it considers any future legislation affecting the electricity industry.

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

Mr. UPTON. Thank you so much.

Next, we have Mr. Val Jensen, Senior VP of Customer Operation, ComEd. Welcome.

STATEMENT OF VAL JENSEN

Mr. JENSEN. Thank you, Chairman Upton, Ranking Member Rush, Vice Chairman Olson, members of the subcommittee. My name is Val Jensen. I am senior vice president of Customer Operations at Commonwealth Edison, a electric distribution company serving about 3.8 million customers in Chicago and northern Illinois, and also one of six member utilities of the Exelon family of utilities serving about ten million customers in Delaware, Illinois, Maryland, New Jersey, Pennsylvania, and the District of Columbia. Thank you so much for the opportunity to testify today.

And I am going to probably sound at this point in the panel like I am plagiarizing. I assure you I am not, but hopefully I can offer some insight into the issues my co-panelists have been talking about from the perspective of an electric utility. Change for our industry is not a choice. It is inevitable. It is imperative. And it is driven by four immutable truths. The first of these is that technology will continue to get better, faster, smaller, cheaper, more pervasive, and more powerful.

Second, this technology will be ever more interconnected offering new opportunities for control both on the part of the customer and the grid itself. Data, the lifeblood of technology, will continue to proliferate exponentially offering opportunities to better understand our customers.

And most importantly, customers have an inherent desire to exercise choice and control, something that has not been allowed to them for most of the history of our industry, but will be as technology improves. We know that these truths are rendering our industry's business model obsolete. The model that will ultimately emerge will be more decentralized, distributed, and community-focused.

The industry that we imagine will be obsessively focused on helping customers do their jobs or live their lives that are better, faster, cheaper, greener, and more customized. Historically, our business was to generate, distribute, and sell kilowatt hours, a linear process like a pipeline or an assembly line. But today, distribution utilities in competitive States like ComEd in Illinois act much more like platforms, entities that make it possible for other parties to exchange products and services.

Today at ComEd, a customer essentially buys access to the grid and to a variety of energy-related services. They can purchase power and electricity. They can get access to energy efficiency programs. They can install rooftop solar and sell the output of that array to Commonwealth Edison, and they can share energy data with parties who offer other products and services. Tomorrow they will use our grid to buy and sell energy services among themselves. The value of this platform grows directly as a function of the number of transactions that occur on it and we believe it is in our business interest to promote as many of those transactions as possible.

There is no useful conversation about the future of this industry that isn't also a conversation with policymakers about the inter-

locking set of statutes, rules, regulations, and orders that together form the regulatory policy superstructure for our industry and there is no question that local, State, and national policymakers are vital to the transformation that serves the public interest.

So I will leave you with a few thoughts for your consideration. First, we need a collective purpose that drives us forward, particularly when things seem most unclear as they may today in our industry. And to me that purpose is to maximize the net value that we create for our customers and to ensure that all customers can share in that value. And I don't mean this as kind of a lofty policy preamble, but as a very real standard for judging the value of our investments. The old standard of simply minimizing costs sells customers short in a world in which value is proliferating.

Second, we need to honor the pervasive uncertainty we face during this transition. The natural urge is going to be to hunker down and take actions that create the illusion of certainty, when what we need to do is place as many small bets as we can. Many will not pay off, but the more we place the higher the chance that one pays off big for us. We need policies that don't prematurely close off options.

And third, our federalist system remains a brilliant model for fostering innovation. We can argue with what any individual State might do, but the ability for different States to explore different approaches is enormously valuable to us. It reduces risk and makes the overall regulatory policy system much more robust.

So again, we should be cautious about solutions in the name of certainty that freeze that experimentation and ultimately make the grid and its policy framework more rigid and vulnerable. I got involved in electricity policy almost 40 years ago because it seemed like an area that offered some clear opportunities to find practical solutions to tough problems and I haven't been disappointed. In fact, I have been rewarded by living long enough and being given a job that presents me with what I think is the chance to participate in the greatest policy opportunity of all, the remaking of this industry in the image of the customers that it serves.

Thank you very much again for the chance to appear.

[The statement of Mr. Jensen follows:]

The utility industry is being reshaped by the progress of technology and the pull of changing customer preference and behavior. In order to create a lasting, technology-enabling clean grid that is affordable to customers while growing with them to fuel their changing expectations and needs, the industry must adapt to four core truths: *1) Technology will continue to get smarter, faster, cheaper and more pervasive; 2) This technology will be ever more interconnected even as it becomes more distributed, and to some extent, autonomous; 3) Data, the lifeblood of technology, will continue to proliferate exponentially, and 4) Customers will increasingly demand the ability to exercise control over their lives by being given real choices.*

While we will continue to need strong, central energy generation and transmission, we must shift our delivery system from a pipeline model – moving central station power across wires to customers at the other end – to a platform architecture, which is the business architecture of the 21st century. Under this model, the utility will move from energy delivery to energy democratization, using our infrastructure to create a market that customers can access to buy and sell energy and energy services. As with Facebook and the iPhone, the value of the platform is in the number of transactions it generates.

This new platform business model is the foundation of the utility of the future, where the electric grid, as the enabling, organizing platform for the increasingly connected economy, can deliver new and unexpected value to our residential and commercial customers.

To successfully implement this new vision, we need new policies that address: 1) How to set prices in a distribution services/platform business; 2) How to define standard service in a way that allows for customer customization, and 3) How to treat utility investments that carry risk.

Good morning Chairman Upton, Ranking Member Rush, and members of the Energy and Power Subcommittee of the House Committee on Energy and Commerce. My name is Val Jensen and I am Senior Vice President for Customer Operations at ComEd. We are one of the largest electric utility companies in the nation, delivering power to 3.8 million homes and businesses in Chicago and northern Illinois. Thank you for the opportunity to testify today as your Committee explores technology's role in empowering energy consumers.

We have immersed ourselves in the policy implications of our dynamic energy environment, and I'm pleased to report that the Illinois legislature has provided us the opportunity to unlock new levels of value and choice for our customers. ComEd is completing a $2.6 billion investment program to modernize our electric grid with infrastructure investments, including a smart meter for every customer. At a time when our economy was in a trough, ComEd created thousands of jobs through this grid modernization. This modernization program is also significantly improving service and reliability and giving customers more choice and control over their energy use.

ComEd now has access to an abundance of data regarding our customers' power usage and can use it to help them manage their energy usage, energy efficiency and bills, while preserving security and privacy. For example, our peak time savings program enables participants to earn a credit on their energy bill for voluntarily reducing energy use during peak time savings hours. Smart Meter Connected Devices give customers access to near real-time electricity usage information by connecting in-home wireless devices to their smart meter. Also, through hourly pricing, our customers can pay the hourly market price for electricity and manage energy costs by shifting energy use to lower-priced times.

While we will continue to invest in the grid, technology is marching on and it is time for reinvention. We can, and we must, anticipate and embrace the inevitable advancement of technology and data, because it decreases costs and puts increasing control, convenience and choice into the hands of customers. Advances in solar generation and storage, electric vehicle technologies, and their supporting platforms, are giving consumers and businesses the opportunity to customize their energy sources. Consumers' ability to make better, more informed choices continues to increase as prices of these technologies decrease.

Our industry has a choice, too. Innovate — or go the way of the Rolodex and the pay phone. We believe that the electric grid is, and will continue to be, the foundation — the backbone — for economies around the country. The one-hundred-year old grid powered our economy in the 20th Century while also generating vast improvements in quality of life. It connects massive generating stations capable of powering each and every machine and device that uses electricity in every home and business. The central question we must now address is: How can we make the next transformational step in order to create a lasting, technology-enabling clean grid that is affordable to customers while growing with them to fuel their changing expectations and needs?

I. KEY TRUTHS SHAPING THE CUSTOMER AND ENERGY LANDSCAPE

The electric power grid network is enormous, representing hundreds of billions of dollars of investment. It is 99.9 percent reliable. It is pervasive, adaptive and constantly evolving and being reshaped by the progress of technology and the pull of changing customer preference and behavior.

As our utility network is at the edge of another evolutionary jump, ComEd has embraced four core realities:

*1. **Technology will continue to get smarter, faster, cheaper and more pervasive*** – Arguably the most important truth is that technology advancement underpins every significant societal improvement since the beginning of human history. The continued, inevitable advancement of the power of technology and decreases in its cost will put increasing control, convenience, and choice into the hands of customers. Current advances in solar generation, storage, and electric vehicle technologies, and in the organizing platforms that optimize these resources, are giving consumers and businesses the opportunity for unprecedented customization of their energy sources, and their ability to make better, more informed choices continues to increase as the cost of these technologies decrease. This opportunity extends to nearly every aspect of our customers' lives as digitization, automation, and miniaturization offer people and businesses more control and flexibility in how they manage their daily lives and operations. Technology innovation provides new solutions to old problems, and is helping to break down the barriers to an energy future where customers demand — and deserve — the speed and quality of service they receive in virtually every other aspect of their lives. We don't even know what the next new technology will be in 10 years, but we know it is coming and we know we need to be ready for it.

*2. **Data is exploding*** –The mechanisms by which we capture data are improving. The number of devices that surround us, capturing personal, environmental, operational, relational, locational, and every other type of data are innumerable, ostensibly providing us everything we need to know. While all these devices provide data, it must still be organized into information that is useful and valuable through aggregation, analysis, and socialization on a platform that provides the necessary connectivity. Consequently, the more data we collect, the greater the utility we derive from the technology collecting and organizing that data, especially

with improvements in data analytics and artificial intelligence that enable the personalization of technology. The Nest thermostat and the Alexa personal assistant provide examples of data's ability to enrich our lives through devices that anticipate our needs. The data we collect from millions of smart meters in ComEd's territory, which we leverage to improve operational efficiencies, is also provided back to our customers through mechanisms such as Green Button Connect, which allows customers to share their usage data with third party providers. Through the smart meter program technology, ComEd can also remotely check a meter for service trouble when a customer reports an outage. When a customer outage is reported, a signal or "ping" is sent to the smart meter. This reporting functionality was recently named Program of the Year for Customer Engagement at the 2017 DistribuTECH Conference. When used as a tool, data and its utilization lay at the intersection of commercial and consumer benefits. At the same time, utilities must increasingly recognize the necessity for responsible security of data and personal privacy.

3. ***Everything is connected*** – Just as data imbues technology with greater utility, the amalgamation of data from similar and disparate spheres of our lives lends greater value to the data itself. This is a significant motivator for the increasing pervasiveness of connected devices in our homes, cities, and workplaces. In addition, the increasingly mobile nature of our lives, with advances in smartphones, tablets, wearables, and other mobile devices necessitates our ability to capture information and manage the functions of technology in a decentralized way. The expansion of the Internet-of-Things ("IoT") and artificial intelligence supports this, and as this network continues its dramatic growth, businesses and individuals will continue the cycle of technology innovation to find even more novel applications.

4. ***Customers will increasingly demand the ability to exercise control over their lives by being given real choices*** - The velocity of technology innovation, the expansion of data capture

and analysis, and the ubiquity of connected devices have given our customers more choice, more control, and more convenience than ever before, and because of that, our customers *expect* more choice, more control, and more convenience as it relates to the products and services that they consume.

These four truths have had a tremendous impact on the preferences of the customers and communities that we serve. Taken together, these truths also represent the powerful force that is rendering our existing business model obsolete.

II. A NEW UTILITY BUSINESS MODEL

Since its inception, a pipeline model has characterized the utility business. Our job was to distribute and sell kilowatt-hours and ancillary services — a linear process. However, we envision a new business model that accommodates customer expectations and maximizes the value we are creating for our customers, communities, economy, and the environment.

Here at ComEd, we're initiating our delivery system's shift from today's pipeline architecture — moving central-station power across wires to customers at the other end — to a platform architecture, which is the business architecture of the 21st century. This new model is more decentralized, distributed, and democratic.

Under this model, the utility will move from energy delivery to energy democratization, using our infrastructure to create a market that customers can access to buy and sell energy and energy services. Utilities would then be compensated with fees on transactions and charges for services they provide.

The success of any platform model — of any business model actually — hinges on its ability to help customers do a job. The key is understanding what that job is.

Unfortunately, as an industry, we've largely forgotten or ignored that wisdom. We have been preoccupied with kilowatt-hours and kilowatts, volts and vars because producing those is our job. Our customers have their own jobs to do and just happen to need electricity and power and voltage to help do them. In most cases, they need less and less of the commodities our industry produces, and increasingly there are places besides the utility to get these commodities. Witness the fact that it takes 60 percent less energy to drive the same growth as it did in the mid-1970s.

What isn't going away are customers' needs. In fact, those needs have proliferated and become increasingly sophisticated as the four technology truths show themselves throughout the economy. Satisfying customer needs — producing energy services —still requires a variety of inputs like power, current, voltage, equipment, data and labor. Those inputs need to arrive with extremely low latency and very high reliability and resiliency.

The emerging platform model fosters interactions between the utility, producers of products and services, and our consumers and energy producers. As with Facebook and the iPhone, the value of the platform is in the number of transactions it generates. Each breakthrough app we download increases the value of our smart phone with accessibility, convenience, and — ironically — communication. Value will be created and captured in dynamic and personalized ways without compromising the security, reliability, and resiliency of our electricity supply. That said, there will be the continued need for strong, central energy generation and transmission. Without it, the grid can't deliver on its promises to customers.

The platform becomes the place customers can come to acquire the things they need to produce the energy services they want. Today, the utility platform provides some of these inputs, but if the platform remains limited in what it offers, value will be drained from the utility to fill

someone else's value pool. We need to re-envision our platform as the place where customers come to find everything they need to meet their energy service needs; however they want to meet them.

III. THE UTILITY OF THE FUTURE

This platform is the foundation of ComEd's vision of the Utility of the Future. As we seek to maintain the customer as the central motivation for everything we do as a company, we envision a future that accommodates these preferences and maximizes the value we are creating for our customers, our communities, and our economy.

While we believe that the function of our industry, and the electric grid that we steward, are at the threshold of a fundamental evolution, there are many elements of this transition to the utility of the future that resemble the beginnings of our industry. A primary motivator for the early innovations that would become the grid we have today was the invention of the lightbulb. The grid was merely a vehicle for extending the benefits of light — productivity, and safety and security after daylight hours — into the home and workplace. Similarly, our current reimagining of the future grid is largely driven by technology advances in photovoltaic systems and battery storage among other inventions. Technology and innovation are essential elements of the future grid. Again, advancing technology holds the potential to enhance productivity, and safety and security.

Furthermore, while establishment of the grid served the major purpose of lighting the world at night, it made possible a myriad of additional innovations that could not have been conceived during the grid's early days. Electricity in the home made possible the electrification of nearly every aspect of daily life and supported the advent of refrigerators, washers, dryers, dishwashers, and on and on. In this way, it provided a platform upon which much of America's

mid-20th century economy was built. Likewise, as we look toward the future of the grid, while our primary objective will always be the provision of safe and reliable electric power to our customers, we allow for new ways in which the grid, as the enabling, organizing platform for the increasingly connected economy, can deliver new and unexpected value to our residential and commercial customers. We see a future where more of the economy is electrified in areas such as transportation, heavy machinery, and ports.

The utility of the future will likely see a greater proliferation of DER, distributed-energy resources. Much of this increase in DER penetration will be attributed to customization reflecting more customer choice, control, and convenience — value propositions aligned with, for example, customer-sited generation and energy storage, or grid-sited energy storage. Increases in the adoption of DER may also provide an opportunity to mitigate climate change impacts. As it accelerates, this transition will impact the utilization of the grid, as customers and utilities come to better understand, measure, and apply energy use where it has the greatest value to all customers and communities, not just those with the means or desire for specific outcomes.

The rise of DER will fundamentally change the role of consumers on the system. Given the intermittency of renewable energy sources, there will still be significant reliance on the grid by these customers, but with generation capabilities these *consumers* will be more appropriately recognized as *prosumers* (consumers AND producers). The grid could conceivably look less like a pipeline that delivers electrons from a central station to residential and commercial customers, and more like a network of prosumers relying on the organization and operational standards of a platform that optimizes their opportunities and provides the data and information needed to make informed decisions.

Over time, with increasing numbers of active prosumers on this network, innovative new products and energy-linked services will develop, and a cycle of innovation, cost improvement, and economic development will be set in motion. This network, if appropriately planned and executed, should enable optimization of resources in real-time into the consumption point (with time/location/feature-based granularity), improving overall system utilization. A distribution market platform and other means of integrating this transaction-based or "transactive" market into distribution system operations will increasingly be needed to facilitate providing customers service beyond the existing standards.

Prosumers will likely be able to transact with one another in both real-time and forward markets based on highly differentiated preferences regarding reliability, quality, environmental friendliness, and timeliness. These transactions may even occur at the device level, as the sophistication of the IoT universe continues its dramatic expansion and smart devices in the home and workplace continue to proliferate. The degree to which these transactions are automated or require human intervention will depend entirely on customer preference.

Transactions on the grid of the future will not be limited to prosumers. There will be a host of additional market participants, including entire communities, which will transact on the grid for the purpose of developing their own energy-related solutions by providing value-added products and services. Products related to solar and energy storage or services related to energy efficiency ("EE") and demand response ("DR") can be offered in an increasingly customized way due to their access to increasingly granular customer data. The resulting interdependence inherent in these interactions enables market participants to not only gain value from, but also provide value to, one another and their communities. In this future, businesses of all sizes, situated across a broad range of industries and communities, are in a position to innovate, create

jobs, and drive the economy forward by developing and attracting business from the smallest incubator to the largest industrial plant.

In sum, the powerful force of customer preference will shape the utility of the future and result in demand for access to a wide variety of services that the grid operator can effectively provide in such a way that it will no longer be characterized as a simple two-way exchange of value between the utility and the electricity consumer. Rather, it should evolve toward a platform serving the utility, producers of value-added products/services, and their consumers/prosumers. The linear two-way phone call, by way of example, evolves into a Skype platform that allows communication by many more participants in a variety of ways.

IV. POLICY CONSIDERATIONS

For this vision to succeed, and capture as much customer value as possible, we need policymakers at the state and local level, where we are regulated, as co-developers. After all, the utility industry will remain an industry imbued with the public interest. This commitment to the public interest also translates into an obligation to find ways for everyone, including the less fortunate, to enjoy the benefits of this new technologically advanced grid.

The superstructure for this model is the interlocking set of statutes, regulations, rules and orders that constitute utility regulatory policy. Our industry is subject to that policy, and any transformation will continue to be the product of a complex choreography of public and business interest.

The platform model represents not just a shift in value from the centralized to the distributed; it offers the opportunity to unlock significant new value through new types of

transactions that technology enables. But while technology might lead, regulation rules when it comes to how the value will flow.

Our industry's existing business model was forged in a world that rewarded increasing electricity consumption, because average price decreased as sales increased. That world is gone. We don't expect to see sales growth return to any extent. New policies, then must address:

- How to set prices in a distribution services/platform business
- How to define standard service in a way that incents us to customize service to align with customer needs, and
- How to treat utility investments that carry risk

It may be useful to look to the states for examples of policies that support customer needs and demands. Together, the Illinois legislature and ComEd have already looked beyond the Smart Grid. Working together with a wide range of stakeholders, we developed the Future Energy Jobs Act ("FEJA"), a statute that will be recognized as a landmark in our Utility of the Future scenario.

The IL legislation allows utilities to capitalize and earn a return on energy efficiency program expenditures. When combined with new decoupling provisions, this means that energy efficiency is now as financially important to utilities as traditional grid investments. Under FEJA, funding for energy efficiency nearly doubles, from $250 million to $400 million annually by 2030, creating more than $4 billion in consumer savings and reducing the CO2 equivalent to removing 18 million cars from the road. As a result, ComEd's customer energy efficiency program, already one of the largest in the country, will almost double in size. Since its inception in 2008, ComEd's energy efficiency program has saved customers over $2 billion. For the seventh time and fourth consecutive year, the U.S. Environmental Protection Agency awarded

ComEd with the 2016 ENERGY STAR® Partner of the Year – Sustained Excellence Award for its Energy Efficiency Programs. We look forward to continuing our significant progress in this arena.

FEJA also made important changes to the state's renewable energy funding mechanisms. The net result is that we expect to see thousands of megawatts of utility-scale, community and rooftop solar developed over the next decade. Rebates for installation of smart inverters will be available to our customers. These rebates will also be capitalized, allowing us to effectively earn returns on distributed solar.

Finally, FEJA will spur economic development as it provides up to $10 million in funding for job training programs across Illinois, as solar and energy efficiency jobs emerge in the years ahead. The Act also restarts ComEd's CARE programming to support veterans and active or disabled military personnel (CHAMP), seniors and families, local nonprofits, and low-income customers. CARE programming will provide $50 million over five years in financial assistance.

In total, the enactment of this IL statute transformed our distribution utility into an energy service utility and provided the incentive to continue building the platform that will enable more energy efficiency and distributed solar transactions.

V. CONCLUSION

The Utility of the Future is based on the continued, inevitable advancement of the power of technology and decreases in its costs that will put increasing control, convenience and choice into the hands of customers; the need to organize, utilize and share with customers the exploding level of data available on the Smart Grid; and the growth in interconnected devices that will provide customers with more choice, control and convenience — and to expect it.

ComEd appreciates the opportunity to participate in the Committee's discussion of how customer demands are changing the utility industry. We're eager to work with the Committee and other stakeholders to develop a shared perspective on the need for and desired direction of change in the business and regulatory models to ensure the realization of the Utility of the Future.

Mr. UPTON. Thank you.

Mr. Sandford, Senior VP, North America Distributed Energy & Power, Direct Energy, thank you for being here.

STATEMENT OF TODD SANDFORD

Mr. SANDFORD. Thank you, Chairman Upton, Ranking Member Rush, Vice Chairman Olson, and members of the committee. Thank you for the opportunity to testify this morning. My name is Todd Sandford. I am a senior vice president with Direct Energy and I look after our Distributed Energy & Power group in North America and it really is a pleasure to be with you today.

Direct Energy is North America's largest competitive energy and energy services company and serving close to five million customers in the U.S. and Canada and our corporate vision is to provide energy and services to meet the changing needs of our customers. And there is no doubt that our customers' needs are changing and that change is being empowered by technology in ways we couldn't imagine just a couple of years ago.

We now live in a world where a hospitality company like Airbnb, which owns no property, is worth more than the Hilton and Hyatt hotel franchises combined; or Uber, a company that maximizes the value of other people's time and vehicles is now estimated to be worth $70 billion. Today's consumer has very high and increasing expectations: convenience, personalization, ease, on-demand, and efficient. These are the standards by which so many of us are being measured now.

And while regulators and policymakers can drive change, the greatest force for change today is consumer behavior and that is being aided and magnified by advances in technology. We at Direct Energy see two primary trends driving consumer behavior around energy: the digitization and distribution of energy. As our industry increasingly moves from an analog world to a digital one, Direct Energy is turning that digital data into unique insights that deliver value to both our residential and business customers.

For residential customers, one example we see is our Direct Your Energy tool that uses customers' smart meter interval data, disaggregates their electricity bill into the consumption and spending by appliance, and while it is a simple idea it is something customers haven't seen before and they are engaging, they are learning, and they are taking action.

In Texas we sell a smart-meter-enabled offered to residential customers called Power-to-Go. It is a prepaid energy product and these customers engage with us much more frequently with other customers. And the net result of that engagement is we see them using 14 percent less energy than their peer or comparative group.

For business customers, advancements in technology are enabling most buildings to install cost effective, real-time energy monitoring devices. We offer an energy insight solution called Panoramic Power that lets our customers see exactly how their businesses use energy right down to the device or circuit level. Our typical building installation is generating 250 million data points a year. Compare that to 12 for a standard electromagnetic meter or about 35,000 for a smart meter.

This robust data set is being translated to real-time, actionable insights for our customers allowing them to reduce energy waste, identify equipment not operating properly, and improve operational efficiency. The insights and use cases around the digitization of energy are exciting and demonstrate clearly that customers will engage with energy when given the opportunity.

The second trend that we see is around distributed energy. New, smaller, and cleaner sources of energy like solar, batteries, gas-fired generators, combined heat and power to name a few, are being developed closer to the point of need. These sources are being linked to intelligent systems that help businesses manage demand and consumption.

Today's consumer can decide how much energy to take from the grid and how much to produce themselves. They can track and manage the use to become more efficient. They can store energy to use later. They can sell surplus energy back to the grid. They can get paid to reduce or delay their energy consumption and smooth out the peaks in their demand. All of this is allowing consumers to save on energy costs and get a more predictable and reliable supply. Customers are asking for and executing distributed energy products because it meets their most stated goals: cost savings and reliability.

I look forward to your questions and thank you very much.

[The statement of Mr. Sandford follows:]

Testimony of Todd Sandford
Senior Vice President, North America Distributed Energy & Power
Direct Energy

Prepared for

The House Energy & Commerce Committee
Subcommittee on Energy
"Powering America: Technology's Role in Empowering Consumers"
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SUMMARY

The electricity system is undergoing a fundamental, structural change. We are moving away from an exclusive and, in many ways, inefficient central power generation system to a system where generation is more distributed and variable, where consumers can better monitor and manage their energy use, and where new technologies and business models can thrive. Essentially, instead of a top down energy supply, technology is putting consumers in control of their energy usage and assets.

Consumers can now decide how much energy to take from the grid and how much to produce themselves. They can track and manage their energy usage to become more efficient, store energy to use later, sell surplus energy back to the grid, and get paid to reduce or delay consumption in order to smooth out peaks in demand. All of this is allowing both residential and business customers to save on energy costs and gain a more predictable and reliable supply.

We believe there are areas of focus that can help develop a smarter, more flexible energy system that helps put consumers in control of their energy usage and assets:

- Support modern grid infrastructure so that 1) consumers can use the technology that they are already investing in, and 2) the benefits of the digitization of energy can further be realized.
- Oppose legislation or policies that would pick one winner to provide these products or services across a utility footprint.
- Support the growth of new markets for flexibility especially at the local (distribution) level.

TESTIMONY

Chairman Upton, Ranking Member Rush, Vice Chairman Olson, and members of the committee, thank you for the opportunity to testify this morning. My name is Todd Sandford, and I serve as Senior Vice President of North America Distributed Energy & Power for Direct Energy. It is a pleasure to be here with you today.

Headquartered in Houston, TX, Direct Energy is North America's largest competitive energy and energy services company, earning over $14 billion in U.S. revenue last year and serving close to 5 million customers in restructured power and gas markets across the U.S. and Canada. Our home services line of business includes a number of well-known regional providers of HVAC, plumbing, and electrical installation and repairs, and operates in all 50 states. Direct Energy is a wholly owned subsidiary of Centrica plc, an integrated energy company headquartered in Windsor, England, which also owns a global connected home products business under the name Hive. Our corporate vision is to provide energy and services to satisfy the changing needs of our customers.

Consumers and businesses are being empowered by technology in ways that we couldn't imagine just a couple of years ago. We now live in world where a hospitality company like Air BNB, which owns no property, is worth more than the Hilton and Hyatt hotel franchises combined. Uber, a company that maximizes the value of other people's time and vehicles, is now estimated to be worth $70B. It makes me wonder what the most valuable energy company in America in 5 or 10 years will look like – I suspect very different from the traditional players.

Times change. Consumers change. Today's consumer wants their choice to happen immediately. Today's consumer wants to use the newest and coolest technology. Today's

consumer isn't pulling out their checkbook to write a paper check at the store...they're not even driving to the store. Today's consumer buys items by telling Amazon Alexa what they want, and it shows up at their home in two days. Convenient. Simple. Easy. Efficient. Those are the standards by which we are all measured now. And while regulators and policy makers can drive change, the greatest force for change today is consumer behavior ... aided and magnified by advances in technology. We at Direct Energy see two primary trends driving consumer behavior around energy today- the digitization of energy and the availability of distributed and designed energy.

First, there is digitization – moving from an analog world to a digital one, both at the utility meter and beyond. This digitization allows for a deep and more meaningful understanding of customer usage. Moving from one monthly analog data point to thousands or millions of digital snapshots of energy usage is a fundamental transformation...one we need to achieve our customers' goal of being more efficient energy consumers. At Direct Energy, we are turning that digital data into unique insights that deliver value to both our residential and business customers.

For residential customers, we are doing this through our "Direct Your Energy" tool. Using our residential customer's smart meter interval data and engineering algorithms, which effectively act like a thumb print for the energy appliances in your home, we can now disaggregate your electricity bill into what you're spending by appliance. This product is automatically provided to all of our residential customers. It's a simple idea, but one where we see our customers engaging, learning, and taking action.

In Texas we sell a smart-meter-enabled energy product called Power-to-Go that is commonly called a "prepaid" energy product. We've conducted a study with the help of an

outside consulting firm that compared these customers' behavior to a control group who had traditional postpaid products over the years 2014 through 2016 and found significant behavioral energy efficiency. Customers on Power-to-Go do frequent transactions on their energy use just as they would with buying gas for their car and that engagement makes them more aware of their usage and more efficient. The study found an average energy efficiency benefit of 14% for customers on Power-to-Go. This energy efficiency finding excludes periods of disconnection, so this is not an efficiency from denial of service but a true behavioral efficiency.

For business customers, advancements in technology are enabling most buildings to install cost effective, real time energy monitoring devices. Direct Energy offers an energy insight solution, Panoramic Power, that lets our customers see exactly how their business uses energy – right down to the device or circuit level. Our typical building installation today is generating over 250 million data points each year compared to 12 data points from a traditional electromagnetic meter and 35,000 data points from a smart meter. Through advanced data analytics and algorithms, this robust data set is being translated to real-time, actionable insights for our customers allowing them to reduce energy waste, identify equipment not operating properly, and improve operational efficiency. Let me give you a few examples.

- In just two months, a school district identified the potential for annual energy savings of nearly $23,000. Our Panoramic sensors revealed that some rooftop air conditioning units, cafeteria food warmers, water heaters, and lights were operating during non-school hours. The data also showed that as much as 25 percent of the schools' electricity was being used by small appliances that were left plugged in at

night and on weekends. It's not that the school district was intentionally using too much energy or didn't care; they simply didn't realize that power was being wasted. No big capital. No big building project. Just big savings.

- A healthcare customer deployed the Panoramic solution in a relatively new, all electric building. It quickly discovered sub optimal sequencing of its electric boilers and reduced its annual spend by 50%.
- A food manufacturer using the Panoramic insight identified an incorrect sequence of operation of its compressors. The result was an annual saving of over $100,000.
- Finally, a manufacturing customer using the Panoramic insight discovered a conveyor motor was overloading and tripping out, which in turn was creating a bottle neck in their process. This never before available energy data helped this customer change their production process, resulting in a $250,000 annual savings at just one location.

From a policy perspective, we must begin to really focus on grid modernization supported by a robust roll out of smart meters to further realize the benefits of this digitization, particularly at the residential level. Questions around access to customer data must also be addressed as data access and transparency are foundational to unlocking innovation in this space. Currently, access to a customer's energy usage data is regulated on a state by state basis. Our position is that any customer protections must be applied equally to all potential technology suppliers, not just those subject to regulation by the state public utility commission.

The second trend we see relates to distributed and designed energy. At a time when businesses are under pressure to manage costs, strengthen resilience, and ensure long term growth, technology is:

- opening up new possibilities,
- decentralizing energy supply, and
- handing power back to the customer.

New, smaller, and cleaner sources of energy (wind, solar, batteries, generators, combined heat and power) are being developed closer to the point of need. These sources are being linked to intelligent systems that help businesses manage demand and consumption. Consumers can now decide how much energy to take from the grid and how much to produce themselves. Consumers can track and manage use to become more efficient, store energy to use later, sell surplus energy back to the grid, and get paid to reduce or delay consumption in order to smooth out peaks in demand. All of this is allowing consumers to save on energy costs and get a more predictable and reliable supply.

Here are some examples of how we are helping our customers turn their energy challenges into a business advantage:

- We helped a university customer upgrade and overhaul its energy infrastructure by installing solar, combined heat and power (CHP), new lighting, variable frequency drives, building controls, and a new boiler. The customer's goals for doing this were better reliability, cost savings, and carbon reduction. The customer had the project completed with no initial capital outlay and is saving about $500,000 per year.

- A health and fitness customer was looking for better reliability and cost reduction. The customer installed a combined heat and power (CHP) system along with a standby generator. The CHP system is designed to run all the time and in parallel with the grid. In the event of a grid outage, the combination of the CHP and the standby generator can satisfy the peak load requirement ensuring the facility will remain open for its customers and community. In addition to the reliability benefits, the annual savings to the customer is around $250,000 a year.
- Lastly, a grocer in an urban setting was looking for better reliability and didn't want to necessarily pay for it. Outages for this customer result in lost business when the store is closed and lost money due to food spoilage. The customer is located in an area where the grid operator was looking for customers that could reduce their load during certain times of the day. Direct Energy was just contracted by the customer under a structure where the customer will get the reliability certainty he is looking for at no upfront cost. We will do this by installing a generator and working with the customer to dispatch the asset in accordance with various local demand management programs and utilize the revenues earned through those programs to pay for the installation and maintenance of the generator.

Conclusions

The electricity system is undergoing a fundamental, structural change. We are moving away from the linear flow of electricity from large generators through networks and onto to passive consumers to a system where generation is more distributed and variable, where consumers can better monitor and manage their energy use, and where new technologies and business models can thrive. I hope I have demonstrated how Direct

Energy is working hard to adapt to this new energy landscape by putting consumers in control of their own energy and deliver a more flexible power grid.

We believe there are areas of focus for policy makers that can help develop a smarter, more flexible energy system that helps put consumers in control of their energy usage and assets:

- Support modern infrastructure so that 1) consumers can use the technology that they are already investing in, and 2) the full benefits of the digitization of energy can be realized.
- Oppose legislation or policies that would pick one winner to provide these products or services across a utility footprint.
- Realize the potential of larger energy consumers to benefit from a smarter energy system.
- Support the growth of new markets for flexibility especially at the local (distribution) level.

Direct Energy looks to work with all of the players in this area, both old and new, to create a better 21st century economy fueled by a more consumer-driven, digitized, and personalized energy world. I want to thank the Committee for seeking input into our countries' evolving energy needs. Direct Energy stands ready to bring its unique, competitive, consumer-focused perspective to work with the broader energy industry and help drive our energy future forward.

Thank you for your time and attention today, and I look forward to your questions.

Mr. UPTON. Well, thank you all. Thank you all for your testimony. We will now move to questions from the dais here.

Ms. Lamb, you talked about interactive devices, and how many States allow you to do that? For Michigan it is a rather recent phenomena, the legislation that Governor Snyder signed into law last year allows that to happen. But how many States allow you to do that and therefore, you know, figure out how many States don't?

Ms. LAMB. I actually will have to get back to you with the answer to that question.

Mr. UPTON. Does anyone know the answer to that question? OK. All right, I look forward to your response back.

Mr. Ganesan, you talked about 30 percent growth in jobs, three million around the country. What type of training do you insist on? Are there community colleges that help? Is this is a operation where not interns but journeymen and women go into the field? What type of training and how many jobs are actually available? If you had your way you would have x amount of jobs that are you looking to fill at this point?

Mr. GANESAN. It is a great question. The vast majority of those three million jobs are in energy efficiency, so that is contractors who can go into houses, kind of take other trade training to make houses or other buildings more energy efficient. The vast majority of the jobs are in that sector.

With respect to workforce training this is a major issue, a gap that needs to be addressed, and if I could give you an example from Michigan about this. There was a large wind turbine manufacturer that wanted to take some of the excess welding jobs from Detroit and from Michigan and reapply them to turbines, to welding turbines, but the skills associated with welding cars are very, very different than the skills associated for welding turbines.

So that is a gap and that is the workforce development gap that needs to take place. In order to bring those jobs to Michigan that particular company had to finance training of those workers to repurpose them towards welding turbines. So your point is spot on, there is a workforce development gap to retrain workers who are in other sectors to capitalize into this sector.

Mr. UPTON. So a quick question, and I don't know if you know the answer to this. But as we look at the tragedy in Puerto Rico, maybe months without power, probably a mass, you know, migration to the States during this very troubled time, what type of technology did Puerto Rico have? We have heard about the inadequacies of the grid, you know, a whole host of things, but I am just thinking about, you know, these folks as they leave, forced to leave and move to communities around the country. Did Puerto Rico have any sizeable trained folks that maybe this would be an avenue for them?

Mr. GANESAN. So I am not, I unfortunately am not a Puerto Rico expert, but a couple of general observations. I think as they rebuild their grid there are a lot of folks that can start to either get retrained into these new sectors or they can redevelop their grid in a more resilient way. And I agree with you that there is an opportunity.

Mr. UPTON. So Mr. Jensen, as we see bad storms, a variety of things that usually the industry is very responsible, you know, they

team up to help the neighbor in need. You know, I see American Electric Power, I see Consumers Energy, I see DTE, I see, you know, Pepco, and others send trucks and crews to help wire communities when they have real difficulties. We saw that in Florida with Irma, we saw that in Texas.

Puerto Rico is a different situation because you can't drive there with those trucks and technicians. Do you know in terms of the industry itself what they have been able to reach out and help our citizens, our fellow citizens in Puerto Rico?

Mr. JENSEN. Mr. Chairman, I do know that actually today a number of conversations are going on involving FEMA and the utility industry as the co-op industry as well as the investor-owned industry to try and figure out what the best response could be. Clearly it is difficult logistically to land equipment and personnel in Puerto Rico. I think part of the challenge is we just don't know how bad it is yet in terms of the destruction.

Mr. UPTON. It is pretty bad based on what we have seen on the news.

Mr. JENSEN. It is. It will take months if not years to fully rebuild. So the industry is standing ready in force to help when it can, but to land people now would be counterproductive because we don't have the equipment.

Mr. UPTON. Last question, as I have 1 second left. Technology, talked about it, cyber, you know, as people sign up and see these new devices where is the needle on vulnerability in terms of cyberattacks on either the company providing that technology or the business or homeowner themselves in terms of protections so that things don't go haywire at some point?

Mr. JENSEN. Well, I think the experts will tell you that there is no system that is completely impregnable, but we spend about $10 million a year on cybersecurity. They don't honestly tell me much about what they do because for obvious reasons, but we have hired experts from NSA, the CIA, FBI. We have a very well developed defensive in-depth strategy for cybersecurity. When we do connect devices to the grid those cybersecurity experts pay special attention to ensure that we are not creating new portals into our system that would make us vulnerable. I would say it is probably the most important issue in most utilities today.

Mr. UPTON. Thank you. The Chair will recognize Ranking Member Mr. Rush for 5 minutes.

Mr. RUSH. I certainly want to thank you, Mr. Chairman.

Mr. Ganesan, again I want to welcome you to this hearing, this very important hearing. In your written testimony you reference the 2014 polar vortex and other natural disasters and of course these are in the forefront of our minds and our attention. And you know that fuel diversity including battery storage and you also mentioned bringing more renewables on to the grid that it actually helps reliability and resilience.

Can you discuss how adding advanced energy and greater fuel diversity helps make the grid more reliable while it also increases competition and drives down costs? And I would like to also hear from Ms. Butterfield on the role of energy storage in making the grid more reliable.

Mr. GANESAN. Thank you for the question, Mr. Rush. Fuel diversity as polar vortex shows is crucial to ensure that any one fuel source if it is compromised you can't put yourself in a situation where the compromising of one fuel source leads to mass outages. During the polar vortex, which was a very rare and hopefully a phenomenon we are not going to see any time soon though these events seem to happen more and more frequently, coal piles froze which shows how cold it was. Mechanical equipment such as gas turbines and coal turbines froze given the significant cold.

And what occurred to keep the lights moving was the fact that PJM brought in a diversity of different technologies including advanced energy technologies. It paid consumers to reduce their demand in demand response, which reduced the overall amount of electricity that the system needed, and they were able to draw on wind resources that didn't have the same susceptibility to cold weather as natural gas and cold did.

So fuel diversity is absolutely crucial. As you bring in more of these technologies including storage, which my colleague will talk about, it allows your grid to have a more diverse fuel sourcing so that you are not relying on one particular type of technology. And storage as will be discussed brings about a lot of different capabilities to deal with a lot of different types of weather events.

Ms. BUTTERFIELD. Thank you for your question. Obviously lithium ion battery storage lasts for just so long, right, we have cell phones and we have now automobiles that run on lithium ion batteries. So in a situation where we want resilience in a community where we want to deal with a storm or outages after a storm we need a design that allows for microgrid or islanding. So in, for example, in Puerto Rico we have an island system that really got wiped out and, you know, on the mainland United States various grids would have been able to support that; in the case of Puerto Rico it cannot.

So the new design of the system should be distributed and in a way that allows certain segments of the grid to come back up after a disaster. This is, you know, called a microgrid. And battery storage in a lot of these commercial buildings or even in homes can be tapped into that kind of backup or standby generation as you bring up other generation sources and it is a perfect solution to complement microgrids. Unfortunately, today our systems are really not designed that way, so as we rebuild or as we redesign systems they need to be compartmentalized like that.

Mr. RUSH. Well, so are you suggesting then that as we go forward that that should be a part of the planning for the future, and how aggressive should we be in terms of trying to implement this new system?

Ms. BUTTERFIELD. Right. We believe that energy storage and battery storage has a perfect application in a grid, in any grid, a big grid or a small grid, a microgrid, and that it can bridge the gap between outages or it can, you know, charge and discharge just at the right time in the grid. It can reduce the need for peaker plants that might only go on for 15 or 20 minutes. So a combination of battery storage within the grid is healthy.

Mr. RUSH. I want to thank you, Mr. Chairman. I yield back.

Mr. OLSON [presiding]. The gentleman yields back. The Chair now calls upon the chairman of the full committee, Mr. Walden from Oregon, for 5 minutes.

Mr. WALDEN. Thank you, Mr. Chairman. Again I want to thank our witnesses, really good testimony and most helpful. Pretty exciting about what is out there and what we are on the edge of. I toured one of the national labs, the one in Richland, Washington, with Secretary Perry earlier, I think it was in August we were there, and it is phenomenal the work they are doing and the work they are doing on battery storage and all that. So I think it makes you feel good about your investment here where we make some of these funding decisions and all to see it actually play out there.

I guess as we talk about these hearings we are having on energy we want to make sure we get it right and that we understand fully what is happening in your world because you are living it every day, every electron. And what I would like to know is are the markets working? Are they serving their intended purpose and what is it we could do or should do if they are not?

Now, my charge to the committee and the staff has been put the consumer first, and if the consumer is winning, that means you have got a competitive market. You have got choice. That will drive innovation. That should drive down price. I mean, that is if you believe in the market effects, which you all described are taking place.

But I was intrigued by your comment that buried somewhere in an RTO is that storage doesn't include battery, and I think most of us would shake our heads at that. So are there things like that? And what can we do, because I mean we can, in theory, write the laws. Now some of this is best at the local level or State level and I get that. But from a Federal perspective, from this committee's perspective, what would you have us do that would be helpful?

Mr. GANESAN. I don't profess to have all the answers but I—and if I did, good on me.

Mr. WALDEN. That is why we have other panelists.

Mr. GANESAN. So the example that I used actually is a great illustration of the role of this committee. And just to give a little bit of background here, in that particular case, the rules of the RTO defined storage as a process that involved moving a flywheel, so it is a very, very old definition of what storage used to be and still used all over the country.

Mr. WALDEN. Well, can they change that or do we have to?

Mr. GANESAN. They can. The RTO can change that but it has been, I think, 10 or so years and there has been no progress in the change of the definition. It is an example of a very arcane definition that illustrates whether or not a facility can be built and whether that facility can get compensated for all the reliability services that it provides.

Mr. WALDEN. Got it.

Mr. GANESAN. So the one point I would make for a role for this committee is to embrace competitive markets, which you have. We embrace it. And I think that the role of this committee and FERC is to ensure that all the competitive markets in the United States do not have a technology bias. They simply, the RTOs set outcomes

and let the market and technologies come in to fill how to get to that outcome.

Mr. WALDEN. All right. Can we just go down the panel and each of you just, what are your thoughts? And then I only have 2 minutes so.

Ms. BUTTERFIELD. I will just offer one example in the California ISO obviously regulated by FERC we have a duck chart which is the shape that the solar provides the State. The belly of the duck is negative pricing. If we could charge our batteries and get paid to charge our batteries in the belly of the duck that would be a perfect market solution. Today we can't do that. That is the kind of——

Mr. WALDEN. Is that a FERC issue or is that a State issue?

Ms. BUTTERFIELD. It is a State issue, but the FERC NOPR that has been opened has to do with allowing distributed energy resources to participate in wholesale markets across the board.

Mr. WALDEN. OK.

Ms. LAMB. The technology platform that LO3 Energy is developing enables a local community energy marketplace. And so what policymakers can do is recognize and help streamline the integration of local community energy marketplaces with the wholesale markets and encourage communication and cooperation and interaction between those markets.

And Federal policy can also clarify that distributed behind-the-meter consumer energy assets can access energy markets on equal footing with in-front-of-the-meter energy assets and that distributed energy resources like batteries and thermal storage and active demand management can transact energy services just like traditional generation. And that will allow consumers to make choices, to exercise choice by selecting sources and suppliers of energy that are aligned with their values.

Mr. WALDEN. All right.

Dr. HANNEGAN. Mr. Chairman, you have hit on the first point which is with all of the differences in technologies and the differences in regional and customer needs the local decision making has to remain paramount. So I would encourage you not to think of this as a one-size-fits-all solution because each utility, each community is going to take on different paces of innovation and flexibility.

And then the second thing related to that is keep in mind someone has got to keep the lights on. Someone has got to maintain the poles and wires. Someone has got to interact with the customer. Someone has got to provide that obligation to serve. And it is not clear how those functions get compensated, taken care for, and guaranteed in a purely market environment. There is some blend of the two that the committee will likely have to keep in mind.

Mr. WALDEN. All right.

Mr. JENSEN. I would offer two things, Mr. Chairman. First, we could probably debate forever what the right competitive market structure looks like, but there is no disputing the fact that customers have benefited to the billions of dollars from the markets that we do have. Our customers in the PJM zone certainly have.

Secondly, I would say Federal support for R&D is absolutely essential. The work that the national labs have done, as you have

pointed out, has literally transformed our industry just creating the technology that is forcing the changes that we are now dealing with. So to maintain that investment in that precious resource, I think, is very important.

Mr. SANDFORD. Quickly, I know we are short on time, but I would just say continue or really support the growth of new markets for flexibility. Everything that we have talked about today requires a level of flexibility bilateral that we have never had before and that is really what would allow customers to engage in energy.

Mr. WALDEN. All right. I appreciate the indulgence of the committee to get all the way down the panel. Thank you.

Mr. OLSON. The Chairman yields back. A point of personal privilege, Ms. Butterfield, I want to recognize the duck model. Our chairman is an Oregon Duck—well played.

The Chair now calls upon the ranking member of the subcommittee, from California, Mr. McNerney, for 5 minutes.

Mr. MCNERNEY. I thank the chairman. I thank the panelists, very interesting testimony, very enthusiastic testimony as well. I am going to start with Mr. Sandford. In your view, should we improve on the current patchwork of State-by-State regulations on consumer protections of smart meter data?

Mr. SANDFORD. I think obviously data security and data privacy is a huge challenge for our industry and others. You know, I think from our perspective the most important thing is that it is a level playing field for everybody and that we are not just, you know, looking to impose a level of requirements on regulated bodies, but everybody who is accessing the data, I think, should play by an overarching level set of rules.

Mr. MCNERNEY. So there should be maybe a Federal rule that preempts State-by-State regulations?

Mr. SANDFORD. Yes.

Mr. MCNERNEY. Thank you. In your experience, Mr. Sandford, is the electric sector properly utilizing the data that is collected from smart meters?

Mr. SANDFORD. No. I mean the industry has come a long way, but there still is a very low penetration rate of smart meters and subsequently, you know, low use of that. I think, you know, the most important thing from engaging, which is a big step, is would we actually be bold enough to show all consumers real-time pricing and send price signals and invite that level of engagement? I think that would really unlock the power of the data that is coming out of these types of devices.

Mr. MCNERNEY. Thank you.

Mr. Jensen, do you believe there is adequate models and structures in place regarding the future of our electric grid? I mean you mentioned you didn't think there was an overall purpose. Do you think there is out there some vision of what we should be doing?

Mr. JENSEN. I would say at this point, Congressman, there is pervasive uncertainty. I don't think any of us are quite sure where this is going to end up. I think the industry is beginning to coalesce around this notion of the platform business model and the utility becoming an enabler for customers and third parties to transact independently across that network, but I would be lying if I said there is unanimity across the industry at this point.

Mr. MCNERNEY. Well, do you think that the PUCs' and the ISOs' policies have kept pace with the development of technology?

Mr. JENSEN. I don't think any of us have kept pace with technology. I think it has been moving so quickly lately. I think commissions are making a very honest, sincere effort to understand the implications for their regulatory environments in their respective States. I know our Illinois Commerce Commission has been a leader in promoting innovation in our business.

So I think everyone is trying to do what they can. I have never seen the industry so characterized by consensus around the need to work together as I do today.

Mr. MCNERNEY. Well, that is good news, I guess.

Ms. Lamb, what role will electric vehicles have on the grid and how can we increase their presence and capitalize on the potential benefits that they offer?

Ms. LAMB. Sure. Electric vehicles are storage location for electricity that can interact dynamically with the grid and what we can do is enable, you know, a marketplace that allows owners of vehicles to transact that energy on the grid like other sources of energy.

Mr. MCNERNEY. So there is a significant potential benefit from these——

Ms. LAMB. Certainly.

Mr. MCNERNEY [continuing]. For the grid instability.

Ms. Butterfield, it sounds like most of your customers are governments or businesses, and there aren't too many residential customers in your model. Is that because businesses and governments have time-of-day pricing and residences don't, or is there some reason you haven't gone to residential customers?

Ms. BUTTERFIELD. I think that is the primary reason, also scale. It is an early stage of our industry and so by putting a large battery and putting this complicated software into a larger facility it is much more cost effective when we can scale that way.

Mr. MCNERNEY. OK, thank you.

Mr. Ganesan, we have heard a lot about the potential benefits for energy storage to the electric system. How will FERC's proposal to remove the barriers for storage and distributed energy resources in the market help consumers?

Mr. GANESAN. Well, I think first it allows them to compete to provide services. It doesn't mandate them on the grid, but I think that given the declining costs of storage, their ability to access the wholesale market through competition is what many types of storage need to simply get their product deployed. So it is a significant opportunity for them.

Mr. MCNERNEY. Great. And I am going to go back to Mr. Sandford for my last question. How does the smart meter technology benefit consumer choice particularly in the retail markets?

Mr. SANDFORD. Again I think for, you know, if I take an example from a business and a consumer residential separately, for a business customer, you know, we talked a little bit about demand response today. And now if I know more through smart metering or other device level exactly how much energy I am using, I really can proactively optimize my participation in some of the flexible pro-

grams that ultimately are benefiting the grid and do that with confidence.

So demand response is looking for greater participation faster and that is scaring customers, but customers that are really armed with actually how their process runs, how much energy they use are much better prepared to participate.

On the residential side, again a lot of our business customers pay time-of-use rates or pay a rate that is somewhat reflective of when they use it. Most residential customers kind of pay towards a curve, but we have had programs for residential customers trying to promote weekend use. So we have had free Saturdays, for example, as a program really trying to send a signal ahead of how everything gets settled out to consumers that using your dishwasher on a weekend is much more cost effective and better for the grid in trying to incent and push usage away.

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

Mr. OLSON. The gentleman yields back. The Chair now calls upon the vice chairman of the full committee, the chairman emeritus of the full committee and a fellow Texan, Mr. Barton, for 5 minutes.

Mr. BARTON. Thank you, Mr. Chairman.

Mr. Sandford, your company is called North America, I think, Distributed Energy. Do you do business in all 50 States, or, I guess, 48 States?

Mr. SANDFORD. So the company in North America is Direct Energy, and then we have got a group that I look after that does distributed energy and power and we look beyond some of the regulated States that our traditional supply business operates. Direct Energy is owned by a company called Centrica in the U.K., so that is a geographical distinction just in the hierarchy of our overall business.

Mr. BARTON. But in the United States do you do business in both regulated and deregulated States?

Mr. SANDFORD. We have energy—yes, we do.

Mr. BARTON. OK. Do you see any differences of approach for your product in a regulated versus an unregulated State like Texas?

Mr. SANDFORD. Yes. And so my answer is right that we do do business, but we do different business depending on whether a State is open for competition or continues to be regulated. So.

Mr. BARTON. Then let me fine-tune it one more time.

Mr. SANDFORD. Sorry.

Mr. BARTON. Does this great new world that everybody is alluding to work in a regulated State?

Mr. SANDFORD. It can work in a regulated State. I think today there is much more engagement, in more companies like ours, in those competitive markets with customers today. So I think it is happening in those areas quicker, but there is nothing stopping it from happening in a regulated State.

Mr. BARTON. Well, the gentlelady Mrs. Lamb is operating this microgrid for L03 in Brooklyn, New York. I assume that is a regulated market; is that correct?

Ms. LAMB. Certainly. And we have been working closely with our local regulators to enable a system, to transition over to a system

where community members and neighbors can transact energy over the public wires.

And I would like to point out that—well, for example, we think that our technology can be the core of these new markets. It will ultimately be up to the utilities to manage those markets and set the rules for transactions. And we expect that because every jurisdiction has different needs that each utility will customize those markets to fit with the cultural and regulatory context that they are operating in.

Mr. BARTON. Mr. Jensen, does Commonwealth Edison serve Brooklyn, New York?

Mr. JENSEN. No, sir.

Mr. BARTON. They don't, OK. What is the utility that serves Brooklyn?

Ms. LAMB. ConEd.

Mr. BARTON. What is it?

Ms. LAMB. ConEd.

Mr. JENSEN. Consolidated Edison.

Mr. BARTON. Consolidated, OK. All right, I had it wrong. Well, let me go back to Mr. Stanford. My staff says that you are a Texas-based company. Is that right?

Mr. SANDFORD. Yes. Our headquarters in North America are in Houston.

Mr. BARTON. Houston, OK. And you have a school district in Carrollton, Texas that saved, according to my staff, $23,000. Who paid for the initial cost to deploy that system, do you know?

Mr. SANDFORD. The school district did.

Mr. BARTON. The school district did. Is it proprietary how much it costs to deploy the technology?

Mr. SANDFORD. I don't have the price point for that. Generally speaking—and that was the Panoramic Power device level circuit breaker technology I talked about earlier today—we generally talk to customers and expect them to see 10 to 15 percent savings on their bill. Generally we are looking at a 6- to 9-month payback on something like that.

Mr. BARTON. 6- to 9-month, that is great.

My last question I will go back to Ms. Lamb. I am co-chairman of the Privacy Caucus. And if I understand correctly, your technology requires your consumers to give up a lot of their privacy rights; is that true or not true?

Ms. LAMB. No. In order to operate a blockchain all of the users do have to have access to a single ledger, but the users in that ledger can be anonymized and so that they are only identified by our randomly generated alpha-numeric code. So it actually does allow consumers to have more choice over what they do with their energy, but does not require it to be public.

Mr. BARTON. Well, the data that your program collects, is it monetized in any way? Do you sell it to other entities or keep it totally in-house?

Ms. LAMB. It is a private blockchain which means that the data is used to settle the market internally.

Mr. BARTON. So you don't collect it and——

Ms. LAMB. Sell it to others?

Mr. BARTON [continuing]. Offer it for sale to people that might want to use it to market?

Ms. LAMB. No. So individual users are not, do not need to be identified. They can remain anonymous.

Mr. BARTON. OK. Thank you, Mr. Chairman.

Mr. OLSON. The gentleman's time is expired. The Chair now calls upon another gentleman from Texas, Mr. Green, for 5 minutes.

Mr. GREEN. Thank you, Mr. Chairman, and thank you and the ranking member for having this hearing today. While I am glad to hear from our experts today on how technology is empowering our consumers, I would first like to use some of my time to address a serious issue that is happening in our district in the Houston area.

While Houston has begun to recover from the terrible effects of Hurricane Harvey, we are not receiving the clear help communication from the EPA in regards to possible environmental disasters. EPA has removed 517 containers of unidentified potentially hazardous material from supersites in Texas which the agency reviews to provide any information about the nature of the waste or the threat to human health, especially the San Jacinto Waste Pits—it is in Congressman Babin's district—and also the U.S. Oil Recovery in Pasadena, which these are superfund sites and the one in Pasadena is in my district. The one in San Jacinto Waste Pits has been in and out of our district over a number of years.

EPA has not been forthcoming in response to the benzene leak at the Valero refinery in our district which might now be more than double than what initially was reported. Our office has been pressuring EPA for answers, but all we receive is radio silence. Our administrator, Mr. Pruitt, still has not appeared before the committee to date, an unprecedented absence this fall under a new administration. Congress has oversight over Federal agencies, it is time we start answering questions about the job they are supposed to be doing.

Now to the issue of the day, the power industry is undergoing a major transformation due to the technological information, innovation, and changing consumer preferences. While technology provides the ability for continued grid optimization, consumer expectations are also shaping consumption and generation as they continue to take more control over their energy habits.

Mr. Sandford, I am glad to hear your unique perspective as a retailer when it comes to these issues, particularly since you serve in the Texas market in our district. In your testimony you talk about other changing markets like hotel industry, transportation industry that have undergone shifts in the last 10 years. Can you talk about how digitalization in the retail market has changed that landscape?

Mr. SANDFORD. So I think again I come back to a handful of examples where we see customers choosing to engage in energy and at the early stages generate, you know, significant efficiencies in a market where we are, you know, challenged to think about not only the traditional delivery model but how much supply do we need to build new power plants.

And there is great latent efficiency opportunity out there and the digitization is really empowering customers to take advantage of

that and actually save themselves some money and take some stress off the grid near term.

Mr. GREEN. Well, not only for individual consumers but your business customers, they realize that they can control their energy costs.

Mr. SANDFORD. Correct.

Mr. GREEN. Do you find that the demand from consumers for data, does that demand drive consumer habits? How does this play into the Power-to-Go program you offer?

Mr. SANDFORD. So the Power-to-Go program is really a fantastic success because it is a prepaid program. And in a lot of markets customers that have some of the worst credit wind up paying the highest energy prices and so by a prepay program you are now, you know, offering customers a lower cost option. And we are seeing our customers on that program on average engage or make five to six payments a month and so they are engaging with energy, it is top of mind.

And I alluded to in my testimony we have seen a 14 percent reduction against a control group, so just that level of engagement, daily text what is my balance, not only are we offering a more affordable rate to those customers, we are actually helping them use less energy.

Mr. GREEN. Typically when a State or a city is trying to encourage an industry to move there, energy costs are one of the big issues. And would you say that because industry can control their costs now or at least know what their costs will be it is a plus for a State like Texas?

Mr. SANDFORD. Definitely.

Mr. GREEN. Right now, and I want to access the consumers' energy, usage data is regulated on a State-by-State basis. Does Direct Energy in its other States do you find certain frameworks are better suited than others when it comes to regulating the energy usage data?

Mr. SANDFORD. I alluded to earlier in an answer that I mean ultimately what we are looking for is a level playing field. But you know that part of the business is not something I am a resident expert on, but we certainly can get you a follow-up answer.

Mr. GREEN. OK. Well, I am almost out of time. But my next question would be do you feel like there is a Federal framework in this space or if so what should it look like? Of course I come from an area if it ain't broke don't fix it, but should there be a Federal framework in this space?

Mr. SANDFORD. On the data, consumer privacy of the data?

Mr. GREEN. Yes.

Mr. SANDFORD. Yes. Again I think I would defer to providing you some written answers to that question.

Mr. GREEN. OK, thank you. Thank you, Mr. Chairman.

Mr. OLSON. The gentleman's time is expired. The chairman now calls upon himself for 5 minutes. The Texas run continues.

First, I would like to start by thanking you, Mr. Sandford, and all the people at Direct Energy. As you know you all played a big role in helping most of the power stay on as Hurricane Harvey hit my hometown and my home State not once but twice. Hit us head-on. It would be the most expensive hurricane in American history.

280,000 Texans lost their power and that is a lot, but in terms of our population that is .01 percent. That is amazing. Thank you very much. Puerto Rico, we know, will be much worse. They may have lost all their power for up to 6 months, a half of a year.

Mr. Sandford, Mr. Ganesan mentioned reliability in a disaster in his testimony, but some storms like Harvey and Irma and Maria are just too strong. Can you talk about how next generation energy can help improve the strength of our grid during natural disasters, lessons learned from Harvey maybe already and Maria or even Irma?

Mr. SANDFORD. Yes. I mean there are some great examples in Texas of customers that have had, you know, gas-fired and diesel standby generators that have been able to keep stores open for their communities and have been able to kind of be a presence at a time of need. Certainly as we see in the business space, consumers looking for a level of reliability we see consumers opting for a baseload application like a combined heat and power that really, you know, ensures that regardless of what happens to the transmission and distribution wires as long as natural gas is flowing they have got power.

And a lot of them will accompany that with a standby generator to kind of top up their peak demand and have absolute confidence, you know, that for days in an event like that they can keep their businesses open. And a lot of them, you know, consider themselves strong foundations of the community and not only from a business continuity perspective but from public good perspective that is very important to them.

Mr. OLSON. Anyone else want to comment on that the importance of reliability in an emergency situation, a disaster? Mr. Ganesan, I know it was in your testimony.

Mr. GANESAN. Yes, absolutely. So if you look at examples, I think it is too early for me at least to comment on the disasters that have struck your district and others recently. But if you look at recent ones in 2014, like polar vortex, it is this diversity that allowed certain assets to stay on line during key times. So if you look at the hospitals in New York during Superstorm Sandy, they stayed on line by microgridding, by using combined heat and power, and a litany of other resources and those are the types of lessons that we can apply going forward.

Mr. OLSON. Mrs. Butterfield, do you care to comment on that reliability of the grid in an emergency?

Ms. BUTTERFIELD. I concur with Mr. Ganesan. I will say that you know, the idea that military bases or universities or hospitals that can become community locations, even churches, and as we design our communities to have these resilient places in the community it is very helpful.

Mr. OLSON. Mrs. Lamb, care to comment, ma'am, on our grid in an emergency?

Ms. LAMB. Sure. And I agree with my colleagues here and I would point out that the type of community energy marketplace that we are developing helps enable the installation of these types of distributed energy assets. And so enabling a community energy marketplace where these assets can be used and monetized all the

time obviously makes them more available during an emergency as well.

Mr. OLSON. It sounds like to your model having power generation stations, smaller ones, scattered all over is much more reliable. For example, Puerto Rico might have power to the island with power right now that they don't have, so that is maybe let's—going forward.

Dr. Hannegan, your comments about our grid in an emergency?

Dr. HANNEGAN. I think the key here is to think of grid and reliability in the same breath as you think about your disaster preparedness. So identify those vital resources you are going to need as part of your recovery strategy and then build whether it is a microgrid, whether it is storm hardening, whether it is backup supplies that can be moved in, you have got to incorporate that into your overall disaster preparedness.

Mr. OLSON. Thank you. Mr. Jensen?

Mr. JENSEN. Yes, sir. In addition to the ideas offered so far, I think there is a serious role for grid hardening. I think if you look at a lot of the damage it is a function of infrastructure that perhaps hadn't been as strong as it could have been. We have embarked on a major rebuilding program on our grid to have reduced seven million customer outages as a result of just making the core infrastructure stronger.

Mr. OLSON. Well, I think back home they have done this. They have buried a lot of power lines instead of put up on poles, because poles tend to break in heavy winds and floods.

So my time is expired. Now I call upon the gentleman from Pennsylvania, Mr. Doyle, for 5 minutes.

Mr. DOYLE. Thank you, Mr. Chairman, and thank you for holding this hearing today. I want to take this opportunity to welcome another Pittsburgher, Todd Sandford, before our committee today. Glad to have you here, Todd.

Let me ask you. I know Direct Energy has worked with many businesses in or near my district including Excela Health, Carnegie Robotics, and the home ice for the back-to-back Stanley Cup champions, the Pittsburgh Penguins. Yes, thank you. PPG Paints Arena, I also want to point out, was the first LEED Gold Certified major sports venue in the country.

Mr. Sandford, can you explain how demand response programs affected the Arena's power use and any other benefits to the arena?

Mr. SANDFORD. Yes. I mean they are a fantastic partner and they have done some great things with that arena including hosting some really good hockey teams. But clearly, you know, the great thing about their participation in demand response is it hasn't impacted their power usage at all, right. And that is one of the values that it has actually helped and it helps the grid locally but is very manageable by that customer.

So that is a very progressive customer looking to do everything they can from an environmental and efficiency perspective and saw demand response and see demand response as a very practical, nonintrusive way where they can actually earn some revenue by not using energy when it is most needed by the grid.

Mr. DOYLE. Excellent. I also appreciate you featuring combined heat and power systems in your testimony. You know, a 2016 study

from the Department of Energy found that Pennsylvania ranked fourth nationally in potential onsite generation. The Mid-Atlantic CHP Technical Assistance Partnership, which is headquartered at my alma mater Penn State, estimates that there are over 12,700 potential CHP sites in our home State. However, there are only 168 currently operating. These existing sites and systems create good jobs and significantly reduce carbon emissions, avoiding 248 million metric tons of CO_2 per year.

So tell me, what makes Pennsylvania such a good State for CHP and what can we do at our committee to increase deployment of these systems?

Mr. SANDFORD. So one of the big drivers of the economics behind CHP is really the spark spread, and Pennsylvania and the Northeast are, you know, is one of the most attractive markets nationally for spark spread. So there is a good foundation. There are a number of Federal and some State programs to promote and incent CHP, you know, which is fantastic.

And then there still is tremendous untapped opportunity to really convey the message to kind of first-time adopters who haven't had CHP on their premise that are great applications to start to kind of understand the role of reliability and some of the other engagement tools we have talked about today, how now might be an even better time to think about CHP than in the past.

Mr. DOYLE. Thank you.

Mr. Ganesan, you highlighted the deployment of incredible cost savings of distributed energy resources in Brooklyn. As you explained, the cost of that project went from $1 billion down to a projected cost of 200 million. Now that is for an area that is experiencing an incredible population and economic boom. How can this be applied to more established cities? Does the rapid growth contribute to this dramatic decline in costs and deployment?

Mr. GANESAN. I think that that particular example is a testament to the regulators as well as the local utility who were able to kind of piece together a solution to a complicated problem by bringing in different types of distributed technologies as opposed to simply the usual solution which is to build out additional capacity there.

So I think that the lesson that can be applied elsewhere is, you know, a collaboration at all levels including, you know, utilities, vendors, regulators. That is the way that you can get these technologies deployed and lower the cost for consumers.

Mr. DOYLE. Thank you.

Mr. Jensen, in your testimony you explain that because of the new existence of consumer producer, you know, a cycle of innovation, cost improvement, and economic development will be set in motion. So tell me, how do we as policymakers accelerate this cycle?

Mr. JENSEN. Well, one way, Congressman, I think, is again by your support for the U.S. Government's R&D structure. The technology that is driven out of the labs has been absolutely instrumental to everything we do not just on the consumer side but on the utility reliability side as well. That I think is probably the single most valuable investment the Federal Government has made is in that lab structure and the technology that it has produced.

Mr. DOYLE. Yes. And I hope my colleagues are paying attention to that. We see more and more resources being taken away from Federal research. And because of the downward pressure on our budgets on nondefense discretionary spending that pot of money keeps going down this way. And I think it is penny wise and pound foolish for us to be cutting resources for R&D in this country.

So thank you for your testimony. Mr. Chairman, thank you. I yield back.

Mr. UPTON. The gentleman yields back. The Chair would recognize Dr. Murphy for 5 minutes.

Mr. MURPHY. I appreciate that Mr. Chairman. Since we had a series of Texas questions it is only appropriate we have a couple of Pennsylvania ones as well.

I want to address my first question to Mr. Stanford on this. We talked a little bit before of this about the low-hanging fruit of dealing with emissions, et cetera, is really conservation which is what your company works with. You showed me a little device. Could you have that with you that tell me how that works that a homeowner can use this, or is this more of a corporate—tell me how that works.

Mr. SANDFORD. Yes. I mean today this is really a business application, but it could be used in a house, and this is our Panoramic Power. I talked earlier about our real-time device capture and this is a wireless current transformer that you can put on a circuit breaker or isolate a piece of equipment. And this signals real-time, six-times-an-hour data feeds up to the Amazon web and allows customers to see real-time what their energy is.

And so it is really important, you know, for the 90-plus percent of nonresidential businesses that building controls today are cost-prohibitive for, this is a really powerful behavioral tool that allows customer to get alerts on their phone real-time, their air conditioning is running at an hour when they said that their air conditioner shouldn't be running, to take action. Rather than a report 45 days after the fact telling you what you should have done, it can tell you the next morning that that decision to not do anything cost you $75.

Mr. MURPHY. So given that, have you worked out metrics in terms of if a number of businesses or residential facilities use this what we are looking at in terms of actually reducing how much energy has to be produced on the grid by power plants if——

Mr. SANDFORD. You know, we haven't done the math, but I stated earlier what we are seeing with all of our deployments on average is Customer seeing in the 10 to 15 percent reduction and that is on the behavior. There are ancillary benefits of predictive maintenance and operational benefits to some manufacturing customers that would be on top of that.

Mr. MURPHY. So given this, I mean our grid it is a strange thing to say, but sometimes the way our power plants and grid is set up it is based upon an assumption of inefficiency. I mean yours is working towards efficiency. And given that since there is the principle there is always in equal ops a reaction, my understanding is that part of the problem is, is the benefits associated with these advanced energy technologies may also be that there could be some

increased electricity costs, displacement of baseload resources, or decreased system reliability. Am I correct on that?

Any other panelists may also answer that too, perhaps Mr. Jensen or Dr. Hannegan. Am I correct in that, that there are also some problems that could occur and how do we deal with that?

Mr. SANDFORD. I mean clearly the whole grid is a delicate balance of supply and demand, and if consumers are really empowered and engaged and significantly change not only the amount of energy they use but when they use it there are certainly ramifications to the grid. But those could be net positive or negative depending on the situation.

Mr. MURPHY. Mr. Jensen, do you have a comment on that?

Mr. JENSEN. I think with respect to energy efficiency technologies there is nothing but upside for the grid and for our customers. We have estimated over the next 13 years we will save $4 billion for customers. That may result in some increase in price just because of the strange economics of the utility business, but overall cost for customers will fall by $4 billion. So from our perspective, energy efficiency is the first best option.

Mr. MURPHY. Dr. Hannegan?

Dr. HANNEGAN. In terms of operating the grid there is a tremendous amount of potential in that federally funded R&D that we have been supporting to take the advanced metering data, the grid sensor data from devices like the one Mr. Sandford showed and incorporate that into software that I referred to in my testimony, advanced distribution management software, and then the same at a building level to actually provide the sheet music for the storage and the electric vehicles and the solar panels and everything to work in balance.

And when you do that, what we are finding is you actually have a more reliable solution not a less reliable solution because you are able to separate and then reconnect to the grid at times where it makes sense to operate as a microgrid versus connect into the larger scale resources.

Mr. MURPHY. Now it was also referenced too that sometimes with the overproduction of power referencing that some utilities would offer or are offering customers an opportunity of free electricity on weekends when they could adjust that. Does that over time mean that energy companies would say let's just produce less, we don't need as many power plants? Is that another issue that comes up?

Dr. HANNEGAN. It ends up increasing the asset utilization so you are able to more optimize the amount of resources that you are providing. You can optimize when and where and how you provide them. So platforms like Ms. Lamb's blockchain now allow for trading among customers at a level below where we would trade with each other as utilities.

You heard Mr. Sandford talk about their Saturdays program. I think that creates the opportunity for us in the utility space to design new programs, perhaps a flat rate program for our low and middle income consumers that takes the variable cost of energy and makes it a fixed one.

Mr. MURPHY. What is fascinating about this whole thing, Mr. Chairman, is that energy use was very often passive for the residential customer and commercial customer; now it is very much ac-

tive. Perhaps the democratization of the whole process, everybody with data has a vote in this process. Do you want to use it or not use it; higher price, lower price. Tremendous responsibility and really pretty a cool thing for consumers.

Thank you, Mr. Chairman. I yield back.

Mr. GRIFFITH [presiding]. I thank the gentleman and now recognize the gentleman from Iowa, Mr. Loebsack, for 5 minutes.

Mr. LOEBSACK. Thank you, Mr. Chair. This has been a great panel. One of the advantages of sitting so far down is that I get to hear a lot of really great things from you folks and from my colleagues.

I do want to state at the outset, along with Mr. Doyle and I am sure others here, the importance of this Federal R&D. I think Federal support for R&D, I really do believe that is really, really critical and I hope that we can continue to get really great bipartisan support for that. So thanks for those of you here who have expressed that concern that we consider to support R&D at the Federal level.

I do want to begin, Mr. Ganesan—is that how we pronounce that?

Mr. GANESAN. Exactly.

Mr. LOEBSACK. All right, thank you. You mentioned that the cost of wind and solar has been dropping over the years. You may know that in Iowa, and the poor folks here they get to hear me talk about this all the time. But, you know, upwards of 37 percent of our electricity in Iowa is generated by wind. We are increasing our production of electricity via solar as well. I just did a solar farms tour not long ago in one of my counties.

In terms of the cost for wind and for solar, you know that the PTC and the ITC, for example, are on kind of a 5-year phase out, if you will. How much are we talking about here as far as those credits? How has that contributed to the reduction in the cost of solar and wind? And it is great for consumers obviously. That is the bottom line for me. And if those were to be phased out entirely what are we looking at?

Mr. GANESAN. So as you mentioned they are phasing out. They are on a phase-out trajectory that Congress agreed to. The market has priced that in. After they phase out there is no need for additional tax credits for those technologies. At this point right now, even if you have removed the value of the ITC and the PTC, wind resources in Iowa are cost-competitive with other generation sources. So the phase out is working and the market is working as well for those resources.

Mr. LOEBSACK. And I guess we should credit the credits in that sense too for helping to create those industries in the first place.

Mr. GANESAN. That is right. That is right. Those credits, when they started in play several decades ago now, they started spurring an industry and then the industry has matured to the point where it is cost-competitive now.

Mr. LOEBSACK. Thank you. I want to move on to rural co-ops. And Dr. Hannegan—and I—well, of course as in so many rural parts of America we have so many of these RECs that are doing a great job, provide a great source of energy and great jobs. That is a big part of it. Going forward, when we talked about sort of all

these technological changes that RECs can incorporate as well, any idea of what kind of effects that might have on the jobs that now exist with respect to these RECs?

Dr. HANNEGAN. Thank you for that question, Congressman. Many of our rural co-ops have extremely small staffs by the measure of my colleague here from Chicago, and one of the challenges that we are facing is how do we retrain—and we talked a lot about workforce training and retraining from other fields.

But even in the position that they are in today, how do our linemen now do their work in light of all these new technologies coming on to the grid? How do our member service coordinators interact with these new customers that see things on the TV or read about something in a magazine and say I want this? How do we rethink our business model which at its core is about service to the member and kind of giving the members what they want? How do we rethink that and then maintain the financial viability because we are such a great employer and such a pillar in our communities?

So it is forcing us to really rethink the cooperative principles in a new light. And all of us are working together collaboratively to sort through this. I will say it is very exciting because the technologies are evolving in such a way that now we have access to these wind and solar and renewable resources and these distributed generation technologies where the price points really are watched. And so we can now engage and think about new opportunities that we might not have even a decade ago.

Mr. LOEBSACK. And how to retrain workers as well.

Dr. HANNEGAN. And how do we train workers to deal with those and how do our members some of whom aren't, you know, advanced technology experts either, how do they see the potential to get their needs met in a lower cost, more reliable, and perhaps more sustainable way.

Mr. LOEBSACK. Right. And I don't have a lot of time left. I don't really have another question, but I do want to reiterate what has been said. Already my friend, Dr. Murphy from Pennsylvania, he and I agree on a good number of things and one of them is this democratization I think that he mentioned of individuals. It is one thing to talk about businesses and having more control over, you know, their energy consumption and what have you, but individual consumers in homes need to have more control as well. And I really hope that we can continue to advance the technology on that front too.

I like some of these ideas about the weekend, you know, doing certain things on the weekend. We need to have more of that and more educational opportunities for individual consumers in residential areas too. So thanks to the panel and thank you, Mr. Chair, and I yield back.

Mr. GRIFFITH. I thank the gentleman and now recognize Mr. Latta of Ohio for 5 minutes.

Mr. LATTA. Well, thank you, Mr. Chairman. And thanks very much to our panel for being with us today. It has been a very good panel discussion today.

And Dr. Hannegan, if I could, we are not picking on you here now, but my district has the largest number of electric co-ops in

the State and in your testimony you mentioned the electric co-opters are naturally consumer-centric because they are member-owned, member-governed, and not-for-profit utilities.

Would you discuss the process, and again this is—we have been kind of going around talking about this in different ways—but would you discuss the process that you use to determine which technologies to deploy to benefit consumers? And referred from Mr. Sandford a little bit earlier of the different devices with his testimony with Dr. Murphy, but are your consumers seeking a more active and dynamic role in the energy usage out there?

Dr. HANNEGAN. Thank you, sir. I appreciate that question. Cooperatives are very heavily embedded in the communities that they serve. We are at the town parades. We are at the city hall meetings. We are at the local picnics and events. Folks stop by to pay their bill, still, with a check. Not everybody is paying electronically. And some folks even use that as an opportunity to connect with their neighbors.

We have annual meetings and open board meetings where attendance from the community comes in and gives us all sorts of feedback. I and my senior team are also out there with our large customers, our towns, our communities, and even our individual folks that call in for a service outage. So we have no shortage of feedback and input as to what kinds of things our members desire and I know the same is true for other cooperatives.

The challenge is that a lot of times when we hear from them in terms of different demands for things again it comes, as I mentioned in the previous question, in the form of reading an article, something in the newspaper and well, can we get that here? And I think that is forcing a pace of innovation on America's cooperatives that really needs to be tempered by the local needs of the communities that we serve and their willingness to pay, their ability to absorb risk, and that is the challenge of cooperative boards all throughout the country is to make sure that we strike that balance appropriately.

Mr. LATTA. Ms. Lamb, if I could ask you. In this past Congress, Peter Welch of this committee and I had the Internet of Things Working Group, but what other potential applications exist for the internet of things within the electricity sector and how would this lead to greater benefits for the consumer?

Ms. LAMB. Well, distributed energy marketplaces that is enabled by the internet of things through blockchain will allow customers to choose, you know, based in response to market signals that are generated from that marketplace allow them to choose the source of their energy and time when they use that energy and to choose how much they are willing to pay for it.

So for example, imagine a community energy marketplace where a neighborhood resident might choose to run their dishwasher or washing machine at a time when the peer-to-peer market has the lowest cost of energy, or a department store might dial back on air conditioning when a local utility transformer is overloaded because that local market is sending them the accurate price signal just making the entire local grid function more efficiently.

Mr. LATTA. Well, thank you very much.

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

Mr. GRIFFITH. I thank the gentleman and recognize the gentleman from New York, Mr. Tonko.

Mr. TONKO. Thank you, Mr. Chair. Certainly I want to thank our witnesses for testifying. We have heard some great examples of how technology has tremendous potential to improve efficiency, resiliency, reliability, and flexibility while empowering our consumers and our businesses out there, so I think this is the hallmark of a modernized grid.

Before I ask questions I do want to associate my voice with the comments heard earlier today about Puerto Rico, Virgin Islands, and the territories in general and the need to have a sense of urgency that addresses this issue. Waiting until October until we perhaps agree on a bill is one thing, but there needs to be, I think, a spin-up immediately coming from this administration from the President. Focus on this as a high priority. People will be dying without the assistance here, literally. And so I underscore that with those comments made by my colleagues earlier.

Mr. Ganesan, how much has consumer preference and in particular corporate consumer preference contributed to innovation and deployment of advanced energy technologies?

Mr. GANESAN. Significantly. I think that we have seen just as an example data centers and of driving huge amounts of renewables coming on the grid. We see other large corporations doing other types of microgridding on more distributed resources. It is a major function. It is a major reason why there is such an increasing amount of advanced energy on the grid.

Mr. TONKO. Thank you. My district is home to a high-tech, precision manufacturing that needs not just reliable power but quality power. Even a flicker of the lights can throw off their processes and cost them significantly. One solution they obviously reach to is exploring the microgrid.

So Mr. Ganesan and Ms. Lamb, can you explain the potential for microgrids to ensure power for facilities where an outage is not an option, whether it is a military installation, a hospital, or this sort of precision manufacturer?

Ms. LAMB. Sure. So again as several of my colleagues have mentioned, a grid that relies on a wide variety of energy resources is much more reliable. And those distributed resources can be distributed generation, active demand management, or microgrids that can function in isolation. And to the extent that a local marketplace enables these energy resources to be developed and deployed and to function in real-time in a self-executing way so that the different loads and generation on the grid can respond in real-time, you know, that is exactly the sort of energy future that we are hoping to enable.

Mr. GANESAN. If I could just answer that, I think there is a reason why data centers are going, or use advanced energy technologies and that is because they care about green, but not green environmentally. One minute of data center outages costs about $10,000, so having a multitude of advanced energy technologies helps hedge the risk of local reliability problems.

Mr. TONKO. All right. When I was at NYSERDA—before this job I headed NYSERDA and data centers were a prime focus because of the energy usage. Mr. Ganesan again, do you believe that all the

benefits of advanced energy resources, the reduced emissions and air pollution, increased reliability and resiliency amongst others, are adequately compensated by the market currently?

Mr. GANESAN. I think the simple answer is no. I think that there are a whole host of services that advanced energy provides in terms of resiliency, reliability, not even going into the environmental sphere, that are not compensated in the market. When you price in other environmental attributes, it is a very State-by-State issue.

Mr. TONKO. Are there other incentives that could ensure that these technologies are being property valued?

Mr. GANESAN. Well, I think a lot of this is a State issue, but when you are talking about wholesale markets or competitive markets that Congress oversees, I think ensuring that some of the attributes of advanced energy are eligible for compensation is the key way to get there.

Mr. TONKO. And Ms. Butterfield, cost-competitive storage resources are going to build much more reliability and resilience into a modernized grid, but I would like you to clarify something. We often think of storage in conjunction with wind and solar since it is a nice complement to those variable resources, but storage for the most part is fuel neutral, is it not?

Ms. BUTTERFIELD. Absolutely fuel neutral. You can connect it to a storage system, but you can just have it connected to the grid.

Mr. TONKO. OK. And so is storage able to provide significant benefits to the grid even in areas of the country without high penetration of renewable resources?

Ms. BUTTERFIELD. Absolutely.

Mr. TONKO. Well, I thank you for that. I just wanted to clarify that. It should be clear that advanced energy technologies are not being supported or adopted because of some environmental policy agenda. They provide tremendous benefits to the grid in all areas of our country and are desired by consumers especially businesses that know reducing their energy bill is going to save them money and in the case of the private sector make them more competitive. So as we go forward I hope we keep that in mind.

And with that I yield back, Mr. Chair.

Mr. GRIFFITH. I thank the gentleman and recognize the gentleman from West Virginia, Mr. McKinley.

Mr. MCKINLEY. Thank you, Mr. Chairman. Unfortunately, Peter Welch is not here and he and I have been co-chairing, for the last 5 years we have been co-chairing the Energy Efficiency Caucus.

So Mr. Jensen, we agree with the potential of $4 billion in savings with that, something we have been advocating for some time, and so I applaud your comments that several of you have made about energy efficiency with that. But I would like to spend the bulk of my time dealing with the issue of the microgrids as it relates to rural America.

Oddly enough, I haven't heard that term used here with you all when we are talking about rural areas. I have heard about Brooklyn, St. Louis, Boston, New York and elsewhere about the microgrid, but I want to see, I would like to understand more about how that would work in rural areas. Because we don't have a good track record in West Virginia that the aversion and the lack of

cost-effectiveness we can't get broadband into every community. We can't get good cell phone service.

So I am curious about how we might be able to incentivize, or what are the advantages or incentives that might be necessary to develop microgrids in some of these little communities that we have, if there is—if I guess the framework would—the advantages of having a microgrid system? So would someone—I would think—I would think it would be cost-effective to have a thousand-megawatt facility operating keeping my cost down as low versus a 50-megawatt facility, I have got to think the cost is going to be higher.

And in West Virginia despite what Mr. Ganesan said earlier, I think in that PJM market when the polar vortex hit I don't know of, I am unaware of any coal-fired power plant that went down in West Virginia. I am aware of gas-fired facilities that shut down. So if someone could tell me a little bit about the advantages or what would we need to do congressionally to help if this microgrid system could work in rural areas.

Dr. HANNEGAN. Congressman, I would be happy to take that one on. We serve rural areas. That is what rural cooperatives do and there are a number of examples where microgrids or microgrid-like activities are already creating great value for our members.

One of them in New Mexico, a rural part of New Mexico, the cooperative there installed a solar-fueled microgrid on the community college campus that was nearby and did so in a way where that generation resource, when it wasn't serving the needs of the community college, provided energy supply to the surrounding community. And the resulting economics were comparable with what you would get from bringing this community into the grid. Extending the lines out there which are significantly costly and time-consuming in a lot of jurisdictions, instead of doing that they decided on a local set of resources because the economics were comparable and they were also able to provide a service, not just the community, the college, but to the community.

The same is true in places like Alaska and other parts of the country that have rural-like features where you are improving resilience and reliability of supply at a comparable cost point without having to extend the infrastructure in an expensive way.

The other area where we look at it in our service territory is for natural hazards. So we don't have hurricanes, but we have snowstorms and other severe weather events in Colorado, places where there are tornadic activities in the Midwest and increasingly up and down the East Coast. And they also want to harden their infrastructure and Mr. Jensen can speak to that. And there a microgrid solution helps in addition to the grid supply, because you can have the power plants generating in bulk and certainly the economy of scale helps there, but if you have no way to get that power to the consumer then a local solution is the better option.

Mr. MCKINLEY. If you would, please, I don't think you have it here today, but I would like to understand maybe a listing of some of the microgrid systems in rural America. Because again I am working under the premise if we can't get broadband why do we think we are going to have a microgrid system?

Dr. HANNEGAN. We would be happy to provide that for the record.

Mr. MCKINLEY. Provide some examples of that so we can learn from that.

Dr. HANNEGAN. Absolutely.

Mr. MCKINLEY. OK. Mr. Chairman, I yield back the balance of my time.

Mr. GRIFFITH. I thank the gentleman and recognize the gentlelady from Florida, Ms. Castor, for 5 minutes.

Ms. CASTOR. Thank you, Mr. Chairman. And thank you to our witnesses today for an outstanding hearing.

I think the transformation of electric power generation and the modernization of the grid is one of the most exciting areas of public policy right now. And there are extraordinary benefits to distributed energy, microgrids, smart meters, storage, and management. They include cost savings to consumers, higher paying jobs in these new sectors, and greater resiliency for the grid overall.

Last Congress I sponsored the Clean Distributed Energy Grid Integration Act. I am updating that bill right now based upon because the technology evolved so quickly. And I recommend you take a look at that bill and give me some recommendations on it because we have to do better here in America and I heard what you said, it is inevitable. The technology is moving quickly. We have to think about the architecture of how we—of our new grids.

And now we have an opportunity, one we didn't ask for, but one that is upon us with as we begin to understand the devastation from Hurricane Irma, from Hurricane Maria, it appears that we have never had an electric grid as decimated as we do now, in Puerto Rico especially. And I was reading a little bit from Bloomberg that said that in Puerto Rico the power plants are clustered along the southern coast and they have large transmission lines across the country. The fact that they will be without electricity from 4 to 6 months, just put yourself in the shoes of the people that live there and how they recover.

So I appreciate the comments of Chairman Upton, Mr. Olson, Mr. Rush, and my colleagues here today. We need to harness everything we know about the modern grid to put it to work now, especially in Puerto Rico. The electric utility leaders in America need to help us do this. Usually in emergency aid packages, you know, they are focused on repairs, but now they are more and more focused on resiliency for the future.

In the past, and I know in Superstorm Sandy in that emergency aid package there was no line item, really, for the Department of Energy. It seems like it is time now to begin to really focus on rebuilding the grid there in a modern way. And we need to do it right because you are asking taxpayers all across America to fund these emergency aid packages and why would we rebuild the grid? It was already known as Bloomberg reported, it was kind of an aging, outdated grid. It had already the Puerto Rico Energy Commission and Puerto Rico Electric Power Authority already were in great debt owing billions of dollars to bond holders.

So if you are going to ask American taxpayers to help rebuild the grid, we need to do it so that it is resilient for the future so that you don't keep calling upon emergency aid packages, that this is going to work to help rebuild the island, the economy there, serve the people for the future. Can you all comment on that? Can you

give us, get into a little more granularity on what you would recommend as an emergency process to focus on?

We have FEMA with some DOE personnel and electric utility operators there now, but who would like to explain what would be needed in the near term? Is this a competition type of thing? Is the DOE in the lead based upon the technological tools they have? Who can make some specific recommendations for us?

Dr. HANNEGAN. Congresswoman, I think you hit on it with your last point. There is a tremendous growth in capacity of our grid design and planning tools now to integrate both the traditional utility solutions—the power plants, the transmission lines—with these new distributed energy technologies that are emerging onto the scene.

Under the Grid Modernization Initiative there is a series of projects that DOE is supporting with the national labs and utility partners that are employing these new tools. One suggestion, just off the cuff, might be to inquire with the Department and the labs as to would they be able to deploy these new tools in support of redesigning the Puerto Rican grid for much more resilience to this kind of activity going forward. It is now sadly a blank sheet of paper.

So can we rebuild and rebuild better as we have done in other communities that have been hit by tornadoes or winter storms or Superstorm Sandy as you mentioned?

Ms. CASTOR. Who else can make some specific recommendations for us as we move forward? Mr. Jensen, I see you thinking it over.

Mr. JENSEN. Yes, I am thinking. I am not sure I am coming up with a great response. I think Dr. Hannegan sort of hit it on the head. We have the know-how and the resource in the continental United States to do this is in the right way in a way that will make that system much more resilient. I think the challenge is how do you marshal those resources and provide some assistance in the near term? I think the concern is that we will be overwhelmed with just the problem of getting some basic power back up to those folks.

But I think we have learned lessons in places like Haiti with the earthquake and so forth where rather than trying to come in and solve the big problem all at once, by solving smaller problems you can actually build a more sustainable solution for the long run.

Ms. CASTOR. Very good. Thank you and I yield back.

Mr. GRIFFITH. I thank the gentlelady and recognize the gentleman from Michigan, Mr. Walberg.

Mr. WALBERG. Thank you, Mr. Chairman, and thanks to the witnesses for being here today.

Ms. Butterfield, recently this subcommittee held a hearing to examine the issues relative to PURPA reform. I have been very interested in that myself feeling that there is potentially some significant modernization we can do in reform with PURPA. Do you believe that your storage technologies should qualify under PURPA as a qualifying facility?

Ms. BUTTERFIELD. Probably not. We are sited behind the meter and we typically do not export to the grid. You know, in the changing policy landscape it is possible that a system sited at a customer's facility could export to the grid. At this time it is the paperwork and the registration is just too cumbersome.

Mr. WALBERG. I appreciate that. It is good to know where people are positioned in the field as we look toward that, so thank you.

Mr. Jensen, in your testimony you state the electric industry has a choice, either innovate or go the way of the Rolodex and the pay phone. I know of both of those.

Mr. JENSEN. So do I, yes.

Mr. WALBERG. So do you feel there are some within the electric industry hesitant to innovate even despite all the benefits it could bring consumers, and if so, why?

Mr. JENSEN. I don't know that I would characterize it as hesitant to innovate. I think everyone recognizes the need to do that. I think depending on the structure of your company given the jurisdiction that you operate in you will have different incentives to put that innovation into place and offer it to customers versus use it on the grid.

We have the advantage of being in a competitive State. We don't own any generation at Commonwealth Edison, and so it is much easier for us to align with what our customers are trying to do and to try and deploy that information for their benefit.

Mr. WALBERG. Mr. Sandford, in your testimony you explain that one of the primary trends driving consumer behavior is digitization. How does moving from the analog world to a digital world affect the way consumers interact with the grid?

Mr. SANDFORD. Yes. So I think it is about empowering customers to understand that they have choices and give them actual signals to act on their choices. I think in the traditional analog world our customers were, you know, largely data ignorant and they didn't know exactly how they were using it. It wasn't something that they chose and, you know, it is really exciting to see at both the residential and business level when given the tools and the insights and the visibility to see customers positively engaged and for their own benefit.

Mr. WALBERG. What causes them to do that more significantly?

Mr. SANDFORD. I think, I mean I come back to for the business customers it is all about cost savings and reliability and if you can show me a way to learn more about how to run my business more efficiently either by using less energy or changing my process I am going to do that.

I think for residential customers, the Power-to-Go example I have cited earlier today in my testimony, it is really about a customer who, you know, that next dollar that he or she is spending on energy is a precious, scarce dollar, and if they can do anything in their power to go put that to a better use, they are going to do that. And so I think you are going to have people driven by different factors.

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

Mr. GRIFFITH. I thank the gentleman. And, seeing no Members on the other side of the aisle, I recognize myself for 5 minutes. And thank you all very much. It has been a very interesting hearing.

I have been really interested in some of the comments about rural areas and Puerto Rico because I think as we rebuild that grid system we may learn some things for the rural areas as well. I represent a district somewhat like Mr. McKinley's who brought that issue up earlier. Mountainous areas of western Virginia as opposed

to West Virginia, but I do think we may be able to learn some things and hopefully we will be able to help the folks in the U.S. territory of Puerto Rico as well as learning some things that might help my district.

I was, you know, it was interesting when we asked and I am not going to ask you all to give it to me today necessarily, but if you can think of some other aspects for rural microgrids that would be helpful. Because, you know, I have some small areas that might be 30 to 45 minutes, maybe even an hour from the nearest community college. That was one of the examples.

And you have a mountain or two in between the two, which is why I think Puerto Rico makes sense because all the production is one side of the mountain apparently, or most of it, and they are shipping it to the other side. But let me ask you about that in another way, because we are looking at some projects in my district where we create maybe a hydro pump storage inside of an existing or prior use coal mine using that for peak production.

Could that also be used to shore up the grid as a microgrid within the region in the event that there was some, a snowstorm was mentioned. That is certainly a problem for us from time to time. Occasionally windstorms where trees come falling down or in the snowstorms, you know, sometimes you lose, a piece of the mountain comes falling down onto your grid.

So anybody want to comment on those thoughts or any thoughts that you all might have that you would like to add to your previous comments on rural?

Dr. HANNEGAN. I am happy to jump in, Congressman. We at Holy Cross have actually three megawatts of our generation coming from capturing the methane, the natural gas coming out of a no longer operational coal mine. And so, for your part of the State as well as Congressman McKinley's State of West Virginia, there is a lot of hidden generation opportunity there that also by the way does a fair amount of environmental good.

We also have cooperatives all throughout the West that are using irrigation ditches that run at the top of the hill. They are diverting some water down through a micro-hydro turbine that is anywhere from 10 to 100 kilowatts in size and that provides the local generation for that part of their community.

Mr. GRIFFITH. So it doesn't go to the general grid, it stays in that area most of the time.

Dr. HANNEGAN. And that is one of the principles you may look at for those microgrids that are completely self-contained, if a combination of distributed solar, if they have access to local resources like a coal mine methane or hydro, you design around that and ask how do we then pair that generation with energy efficiency and smart design and the things you are hearing from my colleagues to make supply and demand equal out in that area.

Mr. GRIFFITH. So what would you do though, because what we are looking at and nobody has signed on the dotted line yet is a closed-loop hydro system inside of a mine. But right now the plan would be is that that storage that we are using that power storage would be for peak periods in the more urban areas in PJM, not for my folks in southwest Virginia.

So how would you hook that in because—and let me throw another wrinkle in this—most likely it would be, the people who might build this facility are not the people who provide the electricity in that particular area of the world. And we are still predominately a controlled State, regulated State.

Dr. HANNEGAN. As any of my co-panelists will tell you, it is always about where can you have the most economic value for the resource that you are building. And I think in the case of the developers of the project, you reference they are looking at that peak market in PJM and saying that is where the profitability may exist. The question is do they get a similar value of profitability by providing services to the local community, and if not, are there changes in the design of that local microgrid that may encourage that profitability?

So when I referred earlier to the design and planning tools that the labs are developing, our typical design and planning tools don't look at both sets, both the bulk power grid and the microgrid. We are getting there now and that would be something that your local communities might want to look into with the help of one of the national labs that happens to be nearby.

Mr. GRIFFITH. All right. I appreciate that very much. Thank you all so very much. I will now yield back my time, and it appears that it is time to close the hearing as well.

So, pursuant to committee rules, I remind Members they have 10 business days to submit additional questions for the record, and I ask that witnesses submit their responses within 10 business days upon receipt of those questions. And without objection—no objection—the subcommittee is adjourned. Thank you all so very much.

[Whereupon, the subcommittee was adjourned at 12:18 p.m.]

[Material submitted for inclusion in the record follows:]

GREG WALDEN, OREGON
CHAIRMAN

FRANK PALLONE, JR., NEW JERSEY
RANKING MEMBER

ONE HUNDRED FIFTEENTH CONGRESS

Congress of the United States

House of Representatives

COMMITTEE ON ENERGY AND COMMERCE

2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6115
Majority (202) 225-2927
Minority (202) 225-3641

October 30, 2017

Mr. Arvin Ganesan
Vice President, Federal Policy
Advanced Energy Economy
1000 Vermont Avenue, N.W.; Third Floor
Washington, DC 20005

Dear Mr. Ganesan:

Thank you for appearing before the Subcommittee on Energy on Tuesday, September 26, 2017, to testify at the hearing entitled "Powering America: Technology's Role in Empowering Consumers."

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for ten business days to permit Members to submit additional questions for the record, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and (3) your answer to that question in plain text.

To facilitate the printing of the hearing record, please respond to these questions with a transmittal letter by the close of business on Monday, November 13, 2017. Your responses should be mailed to Allie Bury, Legislative Clerk, Committee on Energy and Commerce, 2125 Rayburn House Office Building, Washington, DC 20515 and e-mailed in Word format to Allie.Bury@mail.house.gov.

Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,

Fred Upton
Chairman
Subcommittee on Energy

cc: The Honorable Bobby L. Rush, Ranking Member, Subcommittee on Energy

Attachment

ADVANCED ENERGY ECONOMY
the business voice of advanced energy

Chairman Fred Upton
Energy Subcommittee, House Energy and Commerce Committee
2125 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton,

Thank you for your question regarding our thoughts on technology-neutral policy at the federal and state level. Please note that Arvin Ganesan is no longer with Advanced Energy Economy. As AEE's Head of Congressional Affairs, I will answer the question addressed to him. For reference, I have included your question below.

1. **You testified that electricity policy at the Federal level should be technology-neutral. However, you are aware that several of the RTO and ISO markets are currently considering market changes to accommodate certain State policies that favor specific types of generating resources. What are your thoughts on this issue?**

As stated in AEE's written and oral testimony to the Committee, we believe that the federal government should encourage technology-neutral markets. Markets that allow for competition between all technologies benefit both the grid and consumers by allowing all energy resources to provide valuable grid services based on price and performance, rather than by characteristics of any particular resource. Markets should value resources based on what they provide, not what fuel or technology they utilize. Policies, such as the Department of Energy's proposed rulemaking on grid resilience, written to favor one or two resource types based on arbitrary characteristics, like on-site fuel supply, should be opposed by Congress and rejected by the Federal Energy Regulation Commission (FERC).

We are aware of RTO and ISO markets that are considering market rule changes to accommodate certain state policies. First, we support a state's right to enact policies within its lawful authority. While we do not always agree with a particular policy, we do believe that a state has the right to enact policies within their traditional authorities, including with respect to generation resources used to serve customers and the environmental impacts of energy production. Second, we generally support efforts by RTOs and ISOs to reform their markets to address the rapid transformation of the energy system, namely increased usage of advanced energy resources, including demand response, natural gas, wind, solar, and storage, among others. We strongly support efforts by RTOs/ISOs and FERC that seek to reduce market barriers to advanced energy resources, such as energy storage and aggregated distributed energy resources.

Any market rule changes proposed by an RTO/ISO to address changing conditions on the grid should not preclude technologies from competing to provide a grid service. For example, in response to the Polar Vortex, PJM enacted a "Capacity Performance" market construct that essentially requires *all* capacity resources to be available on a continuous basis year-round (or face potentially significant non-performance penalties). While we applaud the efforts of PJM and other RTOs to continually address risks to grid reliability, this rule effectively precludes many

advanced energy resources, particularly seasonal demand response resources, from participating in the PJM market and providing reliability benefits to the grid. Ironically, demand response was relied upon by PJM during the Polar Vortex to maintain reliable service and was credited – along with wind energy – with keeping the lights on.

Dylan Reed
[redacted]
Head of Congressional Affairs
Advanced Energy Economy
dreed@aee.net | 570-877-3549

GREG WALDEN, OREGON
CHAIRMAN

FRANK PALLONE, JR., NEW JERSEY
RANKING MEMBER

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2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6115
Majority (202) 225–2927
Minority (202) 225–3641

October 30, 2017

Ms. Monica Lamb
Director, Regulated Markets
LO3 Energy
621 Degraw Street
Brooklyn, NY 11217

Dear Ms. Lamb:

Thank you for appearing before the Subcommittee on Energy on Tuesday, September 26, 2017, to testify at the hearing entitled "Powering America: Technology's Role in Empowering Consumers."

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for ten business days to permit Members to submit additional questions for the record, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and (3) your answer to that question in plain text.

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Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,

Fred Upton
Chairman
Subcommittee on Energy

cc: The Honorable Bobby L. Rush, Ranking Member, Subcommittee on Energy

Attachment

LO3 ENERGY

November 13, 2017

The Honorable Fred Upton, Chairman
The Honorable Bobby Rush, Ranking Member
Committee on Energy and Commerce, Energy Subcommittee
2126 Rayburn House Office Building
United States House of Representatives
Washington, DC 20515

Dear Chairman Upton and Ranking Member Rush:

Thank you for inviting me to testify on behalf of LO3 Energy at the hearing on September 26, 2017 titled "Powering America: Technology's Role in Empowering Consumers." We were honored and delighted to have the opportunity to explain our technology application and how it can engage consumers in the electric grid, giving them more choices in how and when to use electricity.

Attached please find the responses of LO3 Energy to the additional questions for the record. Feel free to contact me should you or any Member of the Committee have further questions regarding LO3 Energy, transactive energy, or blockchain.

Sincerely,

[redacted]

Monica Lamb

Committee on Energy and Commerce
Subcommittee on Energy
Powering America: Technology's Role in Empowering Consumers

Responses to Additional Questions for the Record by LO3 Energy

Questions from Chairman Upton

1. **Question: What involvement did the State Public Service Commission, New York ISO, and local utility have in your Brooklyn Microgrid project?**

Response:

LO3 Energy has selected New York as the location for its initial project because the state's Public Service Commission ("PSC") and Independent System Operator ("NYISO") had already begun to implement new regulations and pilot projects that encourage distributed energy resources to participate in a dynamic marketplace for distributed energy services. The PSC initiated the Reforming the Energy Vision process in 2015, and NYISO began releasing information regarding its pilot program for distributed energy resources in early 2017. These are ongoing processes undertaken by the PSC and NYISO, and are not specifically related to the Brooklyn community energy network under development by LO3 Energy. The project will operate within the existing regulatory structures and pilot programs established by these entities, in cooperation with Consolidated Edison as the distribution services provider in the local area.

(a) **Question: Do you see a need for new policies or regulations related to blockchain energy platforms?**

Response:

In order to facilitate the implementation of dynamic markets that will encourage the deployment of distributed energy resources and infrastructure upgrades in the most efficient manner, Federal policy can help to streamline the integration of new community energy marketplaces with the existing competitive wholesale markets operated by the Independent System Operators and Regional Transmission Organizations under FERC's jurisdiction, for example, through NYISO's initial pilot program described above.

Federal policy can clarify that behind-the-meter consumer energy assets should access energy markets on equal footing with in-front-of-the-meter energy assets, and that distributed energy resources like batteries, thermal storage, active demand management, microgrids, and other hybrid energy resources can transact energy services in the same manner as traditional generation.

GREG WALDEN, OREGON
CHAIRMAN

FRANK PALLONE, JR., NEW JERSEY
RANKING MEMBER

ONE HUNDRED FIFTEENTH CONGRESS

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2125 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–6115
Majority (202) 225–2927
Minority (202) 225–3641

October 30, 2017

Mr. Val Jensen
Senior Vice President, Customer Operations
ComEd
P.O. Box 805379
Chicago, IL 60680

Dear Mr. Jensen:

Thank you for appearing before the Subcommittee on Energy on Tuesday, September 26, 2017, to testify at the hearing entitled "Powering America: Technology's Role in Empowering Consumers."

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for ten business days to permit Members to submit additional questions for the record, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and (3) your answer to that question in plain text.

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Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,

Fred Upton
Chairman
Subcommittee on Energy

cc: The Honorable Bobby L. Rush, Ranking Member, Subcommittee on Energy

Attachment

ComEd
An Exelon Company

November 13, 2017

Allie Bury
Legislative Clerk
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, DC 20515

Dear Ms. Bury:

I am responding to the Honorable Fred Upton's October 30, 2017 correspondence in which he posed an additional question to me in connection with my September 26, 2017 testimony before the Subcommittee on Energy's hearing entitled "Powering America: Technology's Role in Empowering Customers."

Question:

1. **With little to no growth in electricity consumption, you're confident that our traditional utility business model is "gone." As new sources of electricity generation attempt to compete in this environment, is financing easily available to these developers or are these proposals seen as too risky?**

Answer:

The availability of financing for new generation depends on many factors including the type of generation, state and federal incentives (e.g. tax credits and, renewable energy credits), the creditworthiness of the developer, the state of credit markets generally and the market into which the output of the generation will be sold. Apart from temporary constrictions due to general credit tightness and uncertainty over state and federal policy, financing has been available for generation so long as developers can demonstrate the marketability of the output.

Thank you for your interest.

Sincerely,

[redacted]

Val R. Jensen