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THE EVOLVING ELECTRIC POWER INDUSTRY: LESSONS AND FUTURE TRENDS

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P R O C E E D I N G S

MR. EBINGER: Good afternoon, ladies and gentlemen. I'm Charlie Ebinger, the senior fellow in the Energy Security and Climate Initiative. And on behalf of our program and the broader Brookings Institution, thank you very much for coming. We're delighted to have you for what I think will be a very vigorous discussion of what is occurring in the electric power sector. We're very fortunate to have our main speaker today be Lisa Wood, who is a non-resident senior fellow in our program.

Lisa is the vice president of the Edison Foundation and executive director of the Institute for Electric Innovation. I won't bother you with all the things that she oversees in those capacities, but simply note that she is truly at the cutting edge of all the profound changes occurring in the electric power industries, not in the United States, but also abroad.

She also serves as an adjunct professor in Johns Hopkins School of Advanced International Studies and in numerous other capacities. And before going to her current place of employment, she was a principal with the Brattle Group and previously that worked with one of the leading economic development firms PHB HagglerBailly and also RTI International.

Lisa's going to talk today about what is happening in the evolving use of the grid in our system; how customers are responding, not only to those changes but making demands that are affecting those very same changes. And also getting into what I think will be a very interesting discussion of how regulation needs to change to take into account these profound changes that are occurring in the grid as we move toward a much more multi-dimensional and multi-use of electricity than we of course have traditionally done.

Now joining her on the stage is Jim Rogers, who is also going to moderate the discussion. I will withdraw from the scene here and let them take over. Jim I think needs very little introduction.

Of course one of the leading luminaries in the electric power field, through his high level positions as CEO, both of Synergy in Cincinnati Gas and Electric Company. And of course once they merged, as chairman and CEO of the Duke Energy Company. Jim has a very interesting background having started out as a reporter, served as a law clerk.

Amazingly for someone that becomes a CEO in the industry, held numerous high level

predominantly legal positions in FERC. But is truly, I think, recognized as one of the great chief executive officers before his retirement that we have in the industry.

And certainly one who has always been in the forefront of commenting on the profound changes occurring in this industry. Let me do a slight plug for Jim because he too has a recent book out called Lighting the World in which he draws on his experiences as CEO in his broader -- I would say almost messianic desire to bring electricity to the un-served nations of the world and the approximately 1.2 billion citizens who still do not have even access to one small light bulb.

So without further ado, let me have you both come to the stage. And Jim, I'll turn the panel over to you. Thank you very much.

MS. WOOD: Good afternoon, everyone, and thank you for being here. Thank you, Charlie, for that introduction, and thank you Brookings for hosting this event; we really appreciate it. And thanks to Jim for joining me today to discuss the evolving electric power industry.

I will also note that when we started the Institute for Electric Innovation seven years ago, Jim was actually the original chair and it was his idea to start the Institute for Electric Innovation. So we are IEI, the Institute for Electric Innovation, is actually the foundation arm of the Edison Electric Institute.

Our members are the investor-owned electric utilities all across the US. We also have about 30 technology partners from very large companies like GM and IBM and Oracle to very small start-ups that are working with electric utilities in the transformation of the power sector.

So in June, IEI released this book that we're here to talk about today, leaders speak out on the evolving electric power industry. And you will all receive a copy of the book as you exit the event today. This is a collection of essays from utility executives, technology company executives, state utility regulators and other stakeholders.

These essays were based on an event that we held here in Washington, D.C. in March called Pairing the People: Connected Conversations. This event was a series of over 20 Ted Talks focused on the evolving power industry.

I want to thank all of the people that participated as speakers in the March event, and that turned their Ted Talks into essays for this book. So you'll note that all of the essays are actually mini Ted Talks and the essays are between 800 and 1,000 words. So easy and quick to read, but a lot of good

thoughts in there.

I also want to thank the staff at IEI and at EEI that made this book possible as well as Robert Marits of ElectricityPolicy.com. As I mentioned we will have copies for you today, and I'd be happy to sign your copy if you would like as the editor of the book.

The book is also available to download from our website. So the book focuses on the evolving electric power industry in the US; policies and technologies that are driving that change, where we are today and key trends from several different perspectives. I know a lot of you in this room have a lot of experience in the power sector.

And as we start the Q&A, I welcome you all to join the discussion. So to start, here's a quote from the book: "For those committed to a clean energy future, utilities remain the most important investors." That quote is from Ralph Cavano, co-director of the energy program from NRDC.

As you think about the energy future here in the US, this is an important point to remember. Utilities are the most important investors in the clean energy future. So to set the stage, I have a few facts that indicate how this transformation of the power sector is already well under way.

As of the end of 2014, the electric power industry had already reduced carbon emissions 15 percent below 2005 levels. How? The power sector is investing heavily in renewable energy resources, like wind and solar and also converting many coal plants to natural gas. Today for example the electric utility industry is investing about nine billion dollars per year in solar energy and we expect that to continue each year for the next five years.

That's nine billion dollars a year. Utility solar energy projects represent over 60 percent of all the solar capacity in the US. And we expect that to triple by the end of 2016, just a little over a year from now. Solar energy is a megatrend for our nation, and our investments in solar are growing exponentially.

In terms of wind and solar, these resources will easily make up more than ten percent of total capacity in the US -- electricity-generating capacity in the US by 2016; that's next year. These changes in our fuel mix are driven by public policies at the federal level and at the state level. As a regulated industry, the power industry has always been driven by public policies.

And the last point I want to make is that the power sector today is spending about 20

billion dollars annually on the distribution system alone. That's the part of the system that connects the transmission system to the final customer. One example is the almost 60 million digital smart meters that we've deployed to about 50 percent of US households.

I like to say that today the distribution system is where the action is. That investment is resulting in a more digital grid, a more distributed grid and a more democratic grid. And the investment in the distribution system is only expected to grow.

Now turning to the book, I view the transition of the power sector in three parts: The evolving electric power grid, evolving electricity customers and evolving electricity regulation. This is how the book is structured in these three sections. And I want to highlight a few points from each section, and then we'll go to the Q&A. In terms of the evolving grid, I see the following trends.

First, a more connected grid; a grid that is connected to more and more devices, a grid of things. The essay in the book by PG&E president Chris Johns highlights this grid of things. I also see a more distributed and less centralized grid; a network of powered information flows rather than one way flows with more distributed energy resources and many, many more connections.

We also see more renewable energy on the grid, both large scale, wind and solar as well as small scale renewables. We are starting to see more storage on the grid driven primarily by the California Storage mandate. Initially storage will probably be used for reliability and eventually storage will be used on a more grid-scale level to flatten demand.

And finally, at the edges of the grid, we are starting to see real-time data analytics. There's an essay in the book by Philip Mezey of Itron and he talks very much about data analytics at the edges of the grid.

So all of these trends are well under way, but storage and real-time data analytics are the latest additions to those trends. In terms of the evolving customers, I see three things. First, safe, reliable affordable electricity remains the entry level service.

The only question here is what type of electricity pricing will go with this bundle. I see growth in sustainable energy driven by customers. For example, many large commercial customers want green energy to meet their corporate sustainability goals and they want the utility to provide the service.

We are seeing across the country Apple and Google and other large companies asking

for 100 percent renewable energy for their data centers and for other parts of their operations. Another example, or the prime example, is just solar. We love solar in this country, in all shapes and sizes.

Rooftop solar, community solar, large scale solar farms; all of the forecasts show exponential increases in solar energy over the next few years. Finally, I see residential customers increasingly managing their energy using cool devices, like their iPhone, Nest Thermostats and other devices.

These types of devices and apps get customers more involved in energy every single day. Ted Craver, CEO of Edison International highlights these trends in his essay in the book. In terms of the final section of the book, evolving regulation, I also see three trends there.

First, the need for more collaboration and conversation amongst stakeholders and fewer adversarial rate proceedings. Utilities will need to become regulatory entrepreneurs. Phil Dion highlights this in his essay in the book.

Second, the need to provide different customers with different services. Reliability, affordability, clean energy, etcetera. The types of rate classes that we're used to that has served the industry well in the 20th century are not likely to pass muster much longer.

For example -- and I used this example a little bit earlier -- a large commercial customer that wants 100 percent green energy to meet their own sustainability goals is not like other commercial customers that really do not want that particular service. And then third is the need for incentives and penalties for utilities based on meeting agreed upon performance objectives.

This is performance-based regulation rather than the cost of service regulation that we have today across many of the states. As I mentioned at the outset, the book includes the perspectives of many, many different stakeholders; electric utility companies, technology companies, regulators and others.

All of these stakeholders have a vested interest in making the transformation of the power sector a success. Why? The electric grid is the infrastructure that enables all of our other essential infrastructures in the US. In my view, the US power grid is becoming far more critical to our everyday lives and to our economy than ever before. We are spending billions modernizing the grid to make it do ultimately what we want as a society.

Our biggest challenge today is how to evolve regulation to align with the changing role of utilities, the accelerating pace of technology and ever-increasing customer expectations, while also providing reliable, safe, affordable and increasingly clean electricity to everyone. I hope I provided some food for thought, and I look forward to the discussion and the Q&A today. Thanks.

MR. ROGERS: If I may kick this off, I'm going to kind of frame the questions that I'm going to ask, then I'm going to turn over to you all to ask questions. And I think it's really important to put a context around our conversation today. And Lisa asked me to do that.

Actually, when she asked me to actually cross-examine her, I was reminded that I once was a journalist. I was reminded I was a lawyer for a decade. And I just wrote a book and she thought I'd be good at asking questions, not giving answers, which she said I did really well as a CEO; not giving answers.

So let me, if I may, give you a sense of where we are. You know, the power industry is the most capital intensive industry in the United States. And it's in the middle of a transformation. I would say that we are just now at the beginning of the transformation. What does that mean? It means one, that this transformation is going to take a very long time, two, the actual transformation probably really started -- you could go all the way back to 1978 with Propa and the National Energy Act. But nothing really happened until 1992, and you had the Energy Policy Act that called for a robust, wholesale competitive market in the United States.

We started down that road. So '92 started to be the accelerator, and let me quickly tell you what has happened. Take the generation segment of the business. You basically in 19 states deregulated generation and we move to competitive markets in those 19 states.

The remainder of the states in the US continued to have vertically integrated regulated regime in those states. Alongside of that, and shortly thereafter, we had renewable portfolio standards in 29 states and the District of Columbia. And that started to erode further the generation monopoly held by these companies across our country.

In response to that, you saw from 1992 to today 100 utilities in the United States, and today there's only 50. So you've seen this consolidation trend occur in preparation for the changes that everybody has perceived for a long time to be dramatic. And many of us are accustomed to immediacy,

but this transition is much longer. So you had generation being eroded by RPS and deregulation at the state level. The next thing that occurred is the creation of RTOs, ISOs or basically the transmission of utilities was operated by a regional entity.

So in a sense of the word, utilities lost their monopoly over transmission. They can operate it, but they had to operate it in the context of this regional entity and not solely for their customers. Only two-thirds of the states are in RTOs or ISOs today.

Where does that leave us? That leaves us with generation and transmission being a very hybrid system. And all this has taken 23 years to get us to where we are today. And today, we're at a really interesting point because during all of these changes and all this time on transmission and distribution -- I mean generation and transmission, it was no significant change in the regulatory regime at the state levels, especially in the context of distribution, which we're going to talk about today.

And it's really in that context that we're where we are. And when I say we're at the end of the beginning I really mean that because I think it's going to take another ten years before we see the complete transformation of the industry.

What Lisa's done with this book is remarkable in terms of starting to frame that next frontier of change. The change is going to occur in the context of distribution, in the context of the grid, in the context of customers based on the demands and wishes of customers across this country.

The other thing that's happened as we've moved through this period is we've seen the cost of solar fall dramatically. You go back to '08, solar panels were roughly $4.00 a watt. Today it is $0.60 to $0.65 a watt. Although the balance of system for deploying solar has not fallen, it's now maybe 80 percent of the total.

But the actual panels themselves have fallen dramatically. Wind has fallen; the cost of wind turbine has fallen dramatically. The consequence of all this is we have new technologies emerging on the supply side.

And Lisa talked a little bit about that and we're going to go deeper on that in this conversation. But also during this 23 years you've seen a significant change in the technologies for consumers. You see a greater optimization. I mean when this started in '92, we really didn't have the internet up and running full speed. We didn't have cell phones; we didn't have the capability we

have today.

And as Lisa pointed out, we're moving toward the internet of things. And that will transform how we think about the business model for utilities going forward. So with that, let me stop, having framed where we are.

We're now going to focus on three areas. You know, when I started reading the book and thinking about three, I mean immediately from my years in high school I remember (Inaudible), okay? For all of you all who studied Julius Caesar -- I don't see many heads nodding here.

That basically means that gall is divided into three parts. And everything from Caesar -- well, there's others, like the holy trinity, okay? Everybody likes to talk in three's.

So what Lisa's done is divided this book into discussing the evolution of the grid, the customers and the regulatory area. And so with this three-sided picture, let me ask Lisa: Give me just kind of in a broad way as we go deeper in this what you see the basic trends are with respect to the evolution of the grid.

MS. WOOD: Okay. So I think that, as Jim mentioned, we are very focused now as an industry on the distribution system, and investing in the distribution system to really do three things: Digitize the system and allow for basically powered information flows to go two ways because we're integrating more and more distributed resources into the system every day.

And that's rooftop solar, but that's also other devices that can connect to the grid. And I also mentioned earlier storage would be another example of a sort of distributed energy resource that we're connecting to the grid. So basically a more digital grid, a more distributed grid, and then the ability to provide customers with the services that they want. So I think of that as sort of the democratization of the grid. And what that means is for customers that want clean energy, you provide clean energy. For customers that want other types of services, you're able to provide those types of services. So we have much more flexibility in what we can do with the power system than we've had in the past.

MR. ROGERS: Talk to me -- I mean when you say digitize, to me it strikes -- there's like two sets of issues that I'd love for you to talk more about. One is we're today primarily an analog grid and we're moving toward digital, and we've moved away from traditional meters to measure the use to smart

meters. Give us a sense of where we are in that transition.

MS. WOOD: Yeah. With the smart meters, I mentioned this in my opening remarks. We have -- and Adam is here today, who works with me and actually puts our smart meter report together each year. We've actually -- over the last, say, six or seven years we've gone from very few smart meters to over almost 60 million smart meters deployed across the US. That's about 50 percent of all US households. So those are residential smart meters. For our larger customers, those customers really have had smarter meters for a long time. But having that ability to communicate with a residential customer is fairly new.

So that's a huge big trend. The second thing that maybe we don't talk about as much but are spending billions of dollars doing it is we're adding a lot of controls and sensors to the power grid, especially to the distribution network because when you think about the grid, in the past, the electric power system has been generate power at these remote locations, at central generation plants and then push that power through the transmission system, the distribution to the end use customer.

Now we have many more distributed resources on the grid. And those things are multiplying. And when I say distributed resources, I just want to say this. I mean all sorts; on the demand side and the supply side.

On the demand side it could be efficiency, could be demand response. On the supply side, it could be storage; it could be rooftop solar and other kinds of things. It could be a micro grid. So these are the things we're starting to see all across the power system. So just connecting those things and making them work, integrating them efficiently and effectively into the grid requires an investment.

It's not -- it just doesn't happen with -- theoretically you can talk about it, but you actually have to do it from an engineering perspective. So we're seeing a lot of investment and controls and sensors on the grid to manage the two-way power flows that we're seeing, to also manage two-way information flows.

But also to make the grid itself, to optimize the grid, so to make the grid itself a more efficient operation. One of the -- I would say the low hanging fruit that we've seen from smart meter deployments is really outage detection. I mean this is something that in the past customers has to call their utility and say my power is out.

And today if you have a smart meter they usually know your power's out. And different utilities have taken this information and used it in different ways in terms of giving people maps of where their workers are and when their power can be put back on. But that's a simple sort of example of using a smart meter.

MR. ROGERS: Give me a sense -- I mean a lot of people -- easy for me to say now that I'm a retired CEO -- a lot of people say that utilities are reluctant to embrace solar on the roof and other distributed generation. Do you sense a reluctance to do that, or maybe is it a capability to handle issue?

MS. WOOD: So we have -- I'll give two examples here, and one is to Tucson Electric in Arizona, and also the Arizona Public Service in Arizona. So in the state of Arizona, utilities actually have just started to provided rooftop solar to their customers in competition with other rooftop solar providers.

And the reason they've wanted to do that is because they can actually make rooftop solar available to all of their customers. And that's been a huge benefit for the people of Arizona in terms of being able to get rooftop solar if they want it from their utility or from a competitive supplier.

In terms of what the restrictions are, I'd say the utility makes rooftop solar maybe a lot more democratic in terms of who it's available to. In the case of Tucson, because I know how their program works, they actually make rooftop solar available to anyone in good standing on their utility bill.

Very different from a competitive supplier, who would require a fairly high credit rating. Another example, though, I want to give is Hawaii because that's in the book. And in the state of Hawaii, and if you've sort of followed the sort of bashing that's going on around rooftop solar, Hawaii started off with a big bang on rooftop solar.

A lot of rooftop solar was added to their system in a very short period of time. They ran into grid problems in terms of being able to integrate and manage that on their system.

So they've kind of pulled back a little bit and they're sort of reevaluating how quickly they can actually move that forward. So there's an essay in the book by Mike Champley, who's a state commissioner from Hawaii who talks about sort of how Hawaii is dealing with this transition.

MR. ROGERS: I guess my question is utilities is can handle millions of random decisions about the use of electricity. Turning on the television or plugging in your computer, plugging in your cell phone.

So they're constantly dealing with all these random unpredictable demands. If they can do that, why can't they handle hundreds and hundreds and hundreds of supply sources on the system? And why is it taking so long?

MS. WOOD: Well, I'm not sure it's taking so long; I'm not sure I would agree with that. I think we're actually seeing a pretty much exponential growth. I mean as you said earlier, all of these things take time, right?

We have three or four states; Hawaii, California, Arizona and now -- and actually New Jersey with a tremendous amount of solar. So in terms of -- so I'm not sure it's taking a long time.

In terms of bringing the renewable energy into the grid, again it's -- I would call it a learning process because just like when -- say ten years ago we started to see the beginning of wind. And now we have a tremendous amount of wind, about 65 gigawatts of wind in the US.

Throughout that process, utilities that had a lot of wind -- I'll answer the solar question next -- actually had to learn how to integrate it. So Excel Energy is a good example in Colorado; MidAmerican Energy in Iowa.

It was a learning process to figure out how do we integrate this most effectively. It wasn't that helpful that the wind actually blows at night a lot. So it takes time. So I would say the same thing with rooftop solar, where you're basically managing a new resource on the grid.

And if all of those resources are in one neighborhood -- and sometimes they are, because what happens is one person will get rooftop solar and then other people will get it because they're sort of copying their neighbor -- then you actually have to think about the transformers in the neighborhood and how you're actually going to manage that resource. And I think again it's a learning process.

MR. ROGERS: I get the point that it's a learning process, but you know the Danes have done pretty good. I mean Denmark is basically managing 30 percent renewables on their system.

There are days in January where there's 100 percent of their load -- 106 percent I think is a high number in January of renewable that came on the grid and they were able to handle that. Germany has got about 30 percent on the way to 33 percent by 2020. Are they smarter than we are in terms of being able to handle it?

MS. WOOD: Well, I think the US, as you know, it has state regulation of utilities. So a state like Iowa has 40 percent wind already integrated and their renewables are growing.

So it really varies from state to state. So the other thing I would just mention is as we -- the state of California is also an excellent example. They've had a 33 percent renewable portfolio standard, and just recently moved that just a week or two ago to 50 percent.

And they are well on their way to achieving that target, so different states are working at different paces. One of the things in the US that we pay attention to is affordability of electricity. And when states' regulators and utilities are making decisions about moving forward, affordability is a big issue.

And I know several of you in this room have participated in some of the other discussions here at Brookings that have talked about Germany. Germany has witnessed a pretty big electricity price increases for their residential customers on the order of 50 percent.

We probably would not be okay with that in most states in the US. There is a lot of focus on affordability. So I would say we have more of a tug of war here where we try to balance a lot of different pieces.

MR. ROGERS: Could you predict for us where you think the optimal mix of renewables with nuclear and gas and coal; what do you envision an optimal mix at some point in the future?

MS. WOOD: I don't know what the optimal mix is. I'm not going to even try to go there. I will say right now in the US, nuclear provides about two-thirds of all of our clean energy.

As you know, we are not seeing a nuclear renaissance in the US. We have a few power plants being built. Nuclear will probably remain fairly flat in the US, about 20 percent of our power. What we are seeing is the rush to renewables and gas.

And that's happening primarily due to renewable portfolio standards; state policies that are driving investments in renewable energy. And gas is growing for lots of reasons. One, the price of gas is very low; the price of natural gas.

Two, we're seeing a lot of transitions from coal plants to gas plants. And when we build new power plants in the US, I think today we have two and a half options. It's renewable, it's gas and maybe it's nuclear depending on what state you're in.

MR. ROGERS: I guess my question is is that when you give your answers, how difficult is it to do when you have an industry that's a hybrid industry with only 19 states in competitive markets and the remainder in very regulated vertically integrated markets, and only 29 states were renewable portfolio standards. How do we think about that? Will the states that not in competitive markets move into competitive markets in the future? Will states that not an RTOs stay out of RTOs in the future?

I mean when will we ever get to a point like we were in the early -- late 80's and early 90's when you could talk about an industry that was a homogenous industry versus kind of a very complex hybrid system?

MS. WOOD: Yeah, we have a very complex hybrid system here in the US; I agree with that. I don't know how much that's going to change. I mean we like to think of states here in the US as sort of experimenting with their own ways of doing things.

We've certainly seen that in the power sector. Obviously we have regions of the country, the northeast, the Midwest and parts of the west where we have more organized markets. I should ask you that question since you were a Duke Energy CEO. Southeast is not --

MR. ROGERS: It doesn't work that way; I'm asking. Let's get over that illusion.

MS. WOOD: So I would say it's very hard to predict what's going to happen in the rest of the country in terms of the industry structure.

MR. ROGERS: I've always been somebody that believes in the old saying that you need to follow the money. Let's talk about the money and the private sector. Where are utilities spending their cap ex?

What is the cap ex overall? You kind of hinted a little bit about solar spin, but how much is being spent on the grid, how much is being spent on solar? Give me a sense of the magnitude of those expenditures.

MS. WOOD: Right now we're spending about 90 billion dollars a year in the power sector. That's our (Inaudible) spend across the country. So I did mention some of this earlier.

About 20 billion of that is on the distribution system, and we expect that part of our investment to grow over the next several years. The other I think important number is what we're

spending on solar energy, and that right now is about nine billion dollars per year and also expected to remain there for the next five or six years, about nine billion dollars per year.

MR. ROGERS: You don't expect it to grow? Is there more deployment of solar?

MS. WOOD: These are the projections. I mean I did not forecast these projections; that's kind of where we are at the moment; nine billion dollars a year. I mean we've already -- again, we're seeing a -- well, you mentioned this earlier. We're seeing exponential growth in solar but we're also seeing prices come down.

So if you look at the cost of solar today, especially utility scale solar, which is half the price of rooftop solar, these prices have come down dramatically in the past five years. I mean ten years ago we saw this kind of thing start to happen with wind.

Now we've seen it happen with solar. So solar is cheaper; solar is getting cheaper.

MR. ROGERS: So I listened to your opening comments. You talked about Chris John's grid of things. And actually PG&E has trademarked grid of things. Maybe I need to send them some money because I mentioned it.

But my question really is isn't that really -- I mean they're in California. Didn't they really copy the internet of things? I mean give us, the people that know about the internet of things, what in the world is grid of things?

MS. WOOD: So the grid of things -- I think the grid of things is a great name for what is actually happening to the grid, because just as over the past 20 to 30 years, the internet has evolved to do all kinds of things that it didn't do before. We have all these apps that we use that we didn't even know about 15 years ago.

We are seeing many more things being connected to the grid. Now that could be an electric vehicle, that could be a battery -- just some storage battery, standalone storage battery, that could be a rooftop solar system, that could be a smart appliance in a house.

That could be your thermostat. That could be something that we don't even know about right now. But I think that visual, in my mind, the grid of things is the very distributed grid that is enabling all of these things to connect to it.

MR. ROGERS: How close are we to that ultimate state where the grid of things is the

reality in every state of our country?

MS. WOOD: I think it's all over the place depending on what state you're in. But again, where we're seeing a lot of growth and distributed energy resources, that it's more of a reality than in states where we're not seeing so much growth and distributed energy resources.

And of course in states where we have smart meters, that is kind of the building block to having this digital grid that is again connecting different things.

MR. ROGERS: You also quoted Mike Champley, who used to work at DTE who is now a commissioner in Hawaii. I got it wrong when I retired. I should have moved to Hawaii and gotten a job as a regulator.

Tell me the challenge in Hawaii; I mean where are they on distributed generation and solar on the roof. Do they still have the same net metering care of basically subsidized solar?

I mean how does it work there because they seem to be the most advanced in the country, even more advanced than California, in terms of the mix of their grid.

MS. WOOD: Well, one of the reasons that Hawaii took off so fast in terms of rooftop solar is Hawaii, as an island state, actually used oil to generate electricity. So in the US, there's very little use of oil to generate electricity. It's a very expensive way to generate electricity. So for Hawaii, renewable energy, wind and solar, were very cost-effective way before -- or were cost-effective way before they were in other states in the US. So we did see rooftop solar take off very quickly in Hawaii.

And as I mentioned earlier, too quickly for the grid to deal with it. I don't know the details of the Hawaiian grid because they're islands; there are some separate grids. It's not as large a grid as we have, say, in PJM here in this area or in the Midwest where we have the MICO.

So there are some restrictions there in terms of what you're able to bring onto the system. But as I understand from Mike and from others in Hawaii, they intend to have their renewable resources grow and they're basically working out some of the kinds in the system.

MR. ROGERS: The whole part of the book focused on customers I found really interesting. The fact is is that cost of electricity to the average family is less than two percent of the disposable income of a family; it's very small. And actually when I think about customers in North Carolina, I mean a guy jumps in his pickup truck, he goes home at the end of the evening; he wants a

cold beer and he wants the television to turn on.

He doesn't sound like the type of customer that's interested in putting solar on his roof; doesn't sound like to me somebody that's going to get really engaged in improving the efficiency of the use. Tell me how this works for the average customer.

MS. WOOD: Well, I think we've been talking about customer sort of energy management for a couple of decades now. And in my opinion, even if you don't have solar on your rooftop, just this wide interest in renewables and solar energy in the US that I think is a megatrend is getting people just interested; more interested in energy than they would be otherwise, so they pay a little more attention to it.

So the Nest Thermostat is a great example. Would you have predicted that people would go out and buy Nest Thermostats and spend a couple hundred dollars to have a nice-looking thermostat on their wall?

Some people love the Nest Thermostat. And it's gotten people to engage more than they would have otherwise. So I think these kinds of -- as these technologies develop, there's -- awareness develops and more interest develops.

Now I don't see -- I still don't think that we're going to have a lot of people that are spending all kinds of time, managing their energy use; I don't think that's the future. I think the future is you have smart appliances; you do have a smarter home.

And these things just automate so you just sort of set your -- like I want a comfort home or I want a price-saving home or I want this or I want that. And all your appliances and electrical connections sort of make that happen on their own without your intervention.

I think that's the future. I don't think that people running around trying to do all these things manually is -- I think some people will do that, but by and large that's not the trend.

MR. ROGERS: Throughout the book a couple phrases are used repeatedly, like edge of the grid, plug and play backbone system. What's all that gobbledy gook mean?

MS. WOOD: So I'll start with the plug and play backbone. I will attribute this to Larry Ellison of Oracle who actually did talk about the electric power industry as the ultimate plug and play platform, because really when you ask people about electricity, they don't really talk about electricity.

They just say I plug things into the wall.

And it's something that the technology industry has strived for for years, because one of the issues with technology is having everything communicate and talk to each other. So part of the plug and play backbone is that what the electricity grid allows us to do is connect things to it in a fairly simple way without thinking a lot about how it works, so there's that.

Then there's the edge of the grid. And I think this is the new sort of thing that people are talking about. And I mentioned Philip Mezey, the CEO of Itron. A lot of technology companies now are thinking about how do we manage things, do data analytics and manage things at the edges of the grid?

The idea that somehow we have all these things connected and a distributed grid and we're going to bring all this data into some centralized location and analyze it and push back out some results is arcane. It's not the future. So the edges of the grid, part of it is as these distributed resources connect, and as we connect more and more devices to the grid, that everything starts to be managed at that point. So that's the way of the future.

MR. ROGERS: I guess what we haven't talked about, that nobody in the industry really wants to talk about, and that's the regulators. In my experience in the industry, we're really reluctant to present really creative ideas to the regulators because we know that the regulators -- the probability they will prove something that is kind of breaking new ground low probability.

I was struck in your comments that in the book this reference to regulatory entrepreneurs. What in the heck is that?

MS. WOOD: I mean regulatory entrepreneurs and also this idea of regulation and technological innovation, how does that really go together? But I think we have to find a way to make it work.

I mean we have a tremendous amount of technology that is changing the power sector. We have 100 year old regulatory paradigm. We have a lot of recognition by regulators and other stakeholders in the industry that we need to change how we do things.

And in some places, we're starting to see some movement, I think. I do feel like this is probably the biggest -- our biggest -- maybe the biggest barrier to moving faster is changing the regulatory paradigm to be able to move faster, to allow maybe more risk in the system than we're used to.

So what we're starting to see happen around the country is a few pockets of places where stakeholders are getting together and saying can we do figure out a collaborative way to move forward?

I mean one good example of this is the state of Minnesota. It's called the E21 initiative. It's E for energy. It's their vision of the energy future for the state of Minnesota. So it's a voluntary effort; very grassroots. It wasn't mandated by anyone. Stakeholders got together. They are thinking about where does Minnesota want to be and how are we going to get there. And we're not going to get there by sitting in regulatory proceedings and trying to over a two year process iron out the details.

So that's one way to think about a way forward. And I think other people are looking at those, at a state like Minnesota and saying maybe that's something we want to do. Another example I'll give is Governor Ritter, the former governor of Colorado.

He now has put together a group of stakeholders across several western states. And they're also trying to talk about these -- how do we move the electricity sector forward.

How that's going to all play out in terms of regulatory reform, I don't think we know that yet. But I think there's a lot of recognition that things need to change.

MR. ROGERS: I think people see the change, but it's not clear to me that they -- and they talk about the change. And I mean I think about Minnesota E21. My guess is the reason they put 21 in there because you have to be that age to talk about it because you can drink. It's that complex and that hard to do.

But you quoted Ralph Cavano. Cavano loves to talk about the decoupling. What is that and why is that important to where we are and where we're going?

MS. WOOD: So decoupling was really a way to deal with energy efficiency in terms of how do you utilities -- I mean this is how decoupling started, and Ralph is probably like really the grandfather of decoupling because I think he's responsible for starting it in many states.

And we actually have decoupling in a lot of states in the US now. But decoupling was a way to say how do we provide sort of, in a sense, a level playing field, or at least take away the disincentive for utilities to want to invest in energy efficiency and get their customers to be more energy efficient because utilities sell electricity.

So selling electricity and saving electricity seems like you're not going to be doing both of

those things. But the idea was let's take away the disincentive and at least make it a level playing field so that utilities will want to promote energy efficiency.

So that's what decoupling did in a sense is it kind of opened the doors to utilities promoting energy efficiency. And in fact, utilities do a lot of energy efficiency, about -- spend about seven billion dollars a year on energy efficiency in the US today.

So now I mean we've heard some things; is decoupling the future, is this going to work for regulatory reform. I think the answer to that is absolutely not. Decoupling was in some sense a Band-Aid to deal with efficiency.

It worked for dealing with efficiency. It's resulted in very small sort of overall, sort of a small socialization of cost is what I would say across customers. But when we start to talk about the kind of changes that we're seeing today, I think we need fundamental regulatory reform. So people are starting to talk about more performance-based rate making systems where utilities are incented to do certain things. They have incentives and disincentives; incentives to perform, and if you don't perform then there are penalties for not performing.

That -- and that just allows for more flexibility and how to meet goals. And it doesn't -- it's not about sort of taking every sliver of the pie and trying to say okay, we're going to do this this way, and we're going to do efficiency that way, or we're going to do rooftop solar that way.

But just create a wider net to move these things forward.

MR. ROGERS: So in your judgment it's decoupling on steroids?

MS. WOOD: I don't like to talk about it that way, Jim. I mean I think it's not decoupling on steroids because I think decoupling had a very specific purpose and it was very much about how do we make sure that there's no disincentive to invest in energy efficiency.

MR. ROGERS: One last question before I turn to the audience. It seems to me that decoupling 2-0 or beyond, because decoupling didn't incent anybody; it just made people indifferent.

MS. WOOD: Exactly.

MR. ROGERS: And it's really hard to imagine anything in life that happens as a consequence of indifference. It appears to me that we ought to be moving to formula rates, which decoupling is kind of a subset of formula rates. That assures recovery of fixed cost, which allows us to --

easier to allocate cost.

I think about (Inaudible) when I talk about that. Why is that not a good idea for a next step? And do you think regulators and consumers would embrace a formula rate where they incent utilities to optimize their use of electricity?

MS. WOOD: I think that is a good idea. And I think that is the conversation. We don't have a lot of that in the US right now. We have a few examples around the country; Commonwealth Edison in Chicago is a good example of one utility with sort of performance-based rates in place.

We had that kind of rate-making in place in Iowa for quite a long time. But we don't have it across the whole country. But I think that is the way forward. I think that's definitely the way forward.

MR. ROGERS: Great. I've done my best to be tough on Lisa and these questions; probably not so much. But now it's your turn.

So I would really appreciate anybody that's got questions; there's one right here and then I see two others. Right here in the front.

MR. ALTMAN: Hi. I'm Fred Altman, and a big issue these days is security of the grid because it's so interconnected and that's going to add a lot to the cost. What are the considerations there?

MS. WOOD: Yeah, I think cyber security is a huge issue right now. And what I would say is there's a lot of work underway in terms of insuring security, both from a cyber perspective but also from a physical perspective of the grid. And as you connect more things to the grid -- I mean security's always been an issue. As we're connecting more things to the grid, this is something that is -- I would say a lot of work is being done.

How much will it ultimately cost, I don't know the answer to that.

MR. ROGERS: Question right here.

MR. HILL: Terry Hill with the (Inaudible) Institute. I'm building on that first question. There are a lot of hearings on the Hill right now, or a number of hearings on the vulnerability of the grid to attack as opposed to cyber-attack.

And I'm wondering what role micro grids, as well as playing a role in resiliency for storms, etcetera, could play perhaps in mitigating solar flares, EMP, that sort of stuff. And one more

thing: I know you're interested in developing countries. What role do you think the work in the developing countries vis-a-vie micro grids might play back here in the developed world? Thanks.

MS. WOOD: So with the micro grid question, we're seeing a lot of interest from the military, for example; probably the most interest from the military in micro grids for different reasons.

So that's one. And I think what's happening right now is we're doing a lot of work -- our industry is doing a lot of work military, especially with the Navy on micro grids and how they want to position micro grids in different areas and what they want them to do.

And, in certain cases, whether they want to island those grids under certain circumstances. So that work is underway right now. There's a lot of interest in that and I think we're going to see more of it in the future.

MR. ROGERS: I'll quickly say on the question about micro grids in the developing world. I actually think it's easier to build micro grids in these remote villages.

You have to scale up the solar technology and ultimately go to micro grid. But I think it proves to be cheaper than extending the grid and building central station plants.

And I think there's a leapfrogging opportunity as we deploy and learn about how micro grids work in those areas. Building a micro grid in our existing grid is really quite difficult and it can be expensive. So I see great opportunities there. Question here?

QUESTIONER: Thank you. I'm Margaret Ryan with Interfax Synergy. I wondered -- a lot of the time we're talking about going forward, where we're going from here going forward. And I didn't quite hear a definition of what going forward is.

Does that mean the 31 states that don't have -- aren't part of power markets should have markets? Should the 19 states that have them, should they be changing? What does going forward really look like here?

MS. WOOD: Okay. My focus, and the focus of the book, is very much around the evolving distribution grid. So I think it's different than when we talk about RTOs and RTOs are there for the transmission system primarily and deregulation of generation. That's happened around the country.

So from my perspective -- again, we're focused on what's happening with the distribution grid. And I feel like that's kind of where the action is because all of the distributed energy future is really

connected to the distribution grid.

So when I talk about going forward, I'm thinking a more digital grid, a more decentralized grid, a grid that's way more connected to a lot more things than it is today.

MR. ROGERS: Question in the back?

MR. SIMCHAK: Tom Simchak for the British Embassy. The big story right now, and for a great many years to come is of course the clean power plan.

The regulatory process that's mostly run in the Department of Environmental Qualities (Inaudible). A lot of issues you're discussing, particularly things like performance-based rate making are public utility commission issues; two entities that in a lot of states don't really collaborate so well, perhaps Minnesota being a good example of one where they are.

But how do we get those kinds of conversations happening across state government to really come up with an optimized solution instead of kill as many birds with our stones rather than have two separate processes meddling with the electric power systems together.

MS. WOOD: Yeah, that's a really great question. And I think a lot of state regulators have brought up that very topic. And especially in places like the northeast, where we already have ISOS and things like that.

There are conversations around this, for state regulators, is we need regional approaches. We can't just be doing this state by state. So I think that conversation is alive and well.

I think it's a huge issue that there's a lot of concern around. I don't have the answer. I don't think anybody has the answer, but the question's been raised.

MR. ROGERS: Charlie?

MR. EBINGER: Charlie Ebinger, Brookings. I was wondering to what extent you think there is a serious threat to have even portions of the president's clean power program struck down by the courts.

MS. WOOD: Sorry; to what extent -- what?

MR. EBINGER: To what extent there's a chance that any aspect of the clean power program will be struck down by the courts since we have a number of lawsuits emerging out of that already.

MS. WOOD: Well, I feel like we have to see what happens on that. I'm not going to make a projection in terms of what I think.

MR. ROGERS: I'd quickly say that clean power plan, it's clear it's put another nail in the coffin for coal. It's clear that there's a bias against nuclear and a bias for renewables.

It's clear that in the 20's you're going to see a cap on natural gas in order to comply with it. So I think it's -- the environmental community has turned their guns from coal because they think they -- it's in the coffin, and now turning it to natural gas, the same environmentalists who once thought it was a great bridge fuel not so sure today. Right here.

MR. JERZIG: Hi, I'm Bronco Jerzig with Berkeley Research Group. For both of you, do you think the consumer needs to be better educated as to what electricity is?

For example, they don't really understand the electric company is selling both power and energy. So somebody buying a four kilowatt solar panel, which is the average in California, but has an eight or ten or 20 kilowatt peak has to understand that somebody else is going to provide that horsepower because kilowatts can also (Inaudible) horsepower.

And maybe people would understand coupling and decoupling, all these things better if they understood they were getting those two different services. We know when we buy a car, we know how many horsepower we have and we know what our mileage is, which is the energy used. We don't know that on our houses.

MS. WOOD: Yeah. I think that is a huge issue; educating the public about electricity and how it works and what it means and even what's on their bills or making bills a little simpler so they can understand what's on their bill.

I think one of the questions is who's role is it to educate the public about electricity? A lot of the net metering debate that we're having around the country today, the subsidies associated with net metering as a result of the net metering policy, have to do with really customers not understanding and why should they, really; not understanding how electricity really works and what they're really getting when they buy electricity and connect to the grid.

So I do think it's a fundamental problem. I think that -- I'm not sure whose job it is and who's role it is to educate the public about electricity. I think it's very important to do that.

MR. ROGERS: I personally believe it's the role of the utility to do it. And actually, utility people often have a difficult time proposing new things to regulators because it's a little bit of the Stockholm Syndrome.

And what I mean by that is you've been regulated so long that you immediately know how the regulator's going to answer. And so you don't propose anything new because you know they're not going to adopt anything new.

And so I think that's an important part of the education; actually educating the regulators to allow for change to occur. Right here, please.

MR. JAMISON: Hi. John Jamison with the Energy Future Coalition. It's been a great conversation. And Jim, you've haven't gotten so far from your paternalistic roots that you didn't put Lisa on the spot, which is fun.

And my question sort of follows on Bronco's. But it's enough different that I'll go ahead and ask it. I think it's clear that the value of electricity and electricity service to consumers has been really rising rapidly with the additional applications that it serves, with the dependents that we have on it for so many additional aspects of our lives.

And outage hurts us much more than it did a couple decades ago. But we still sell electricity on a volumetric basis. And if we try to pass that value through on a per kilowatt hour basis, we're going to quickly raise the cost of electricity to the point where the alternatives, the solar and others, become that much more affordable.

And much of the investment and the distribution grid that you talked about, Lisa, is accommodating that value for the people who know that it's there and want to get it for autonomy, for self-generation. And many of the consumers you talked about, Jim, don't necessarily know it's there, aren't reaching for it and don't want to pay for it.

So I see sort of a collision that is coming and is going to be put in front of those regulators, whether by the utilities or by consumer advocates or by early adopters or tech companies. And I guess my question is how do the regulators react to that, and what kind of a balance can they strike?

MS. WOOD: Are you speaking directly to cross subsidies happening across the system?

MR. JAMISON: I think there would be perceived cross subsidies, and people who may be getting better service than they realized, not wanting to pay for what they're hearing about.

MS. WOOD: I think one of the issues that is very much front and center is this idea of providing customers with different kinds of services. And getting out of the one size -- if you're a residential customer, you're a residential customer, you're a residential customer.

Even today, the simplest example is a rooftop solar customer is not the same as a non-rooftop solar customer. They look completely different. Their load shape is completely different.

They are served completely differently. But why are they under the same rate structure? So I think this is -- and this is also the question with large customers that say we want reliability that's way different than some other customer where reliability might not matter quite as much.

Or we want 100 percent clean power. So these are sort of -- this issue is around customizing services and letting customers pick and choose and pay for the service that they're getting. And we're not doing that today.

And I think it will change because customers are asking for it to change and that will drive, I think, regulatory change.

MR. ROGERS: Question right here, please.

MR. BEAK: Hi, my name is Tory Beak. Recently the DOE was asked to do a value of rooftop solar study. And I was wondering if you could comment on any discussions or interests among EEI members on that process or how they're interested in being involved in that or what their thoughts might be on establishing that as an alternative to net metering.

MS. WOOD: Sorry; are you with DOE?

MR. BEAK: No, I'm not.

MS. WOOD: Okay.

MR. BEAK: Unaffiliated.

MS. WOOD: DOE is rooftop solar recommendation?

MR. BEAK: Ernie Moneze was asked a few months ago if the DOE would look into establishing a study on the values of rooftop solar.

MS. WOOD: There is a lot of work going on on rooftop solar all around the country. So

we're interested in all of it. We are participating many different states.

EEI is doing work on rooftop solar, for example, right now. There is a tremendous need to I think do these studies and sort of get the information out there and make it clear to people what's going on.

I mean we've already seen E3 has done several studies looking at rooftop solar in California and Nevada and other places. I think there's general recognition that it's a big issue.

And we need to be looking at it closely. And obviously different studies are going to come out with somewhat different things. But I think that it's very important, so we're very interested.

MR. ROGERS: I'll quickly add to that before I go to the next question. Utility scale solar is much cheaper than solar on the rooftop.

And I think any study that's done will show that delta, but it will change in California versus Massachusetts in terms of what the cost is. Cost is much higher in Massachusetts to get solar on the rooftop. Right there.

MS. WOOD: Well, before we go to that, let me just add to your comment about the solar because First Energy just put out a report showing that the cost of utility scale solar versus rooftop solar, and it is about half. It's about half the price; utility scale solar is about half the price of rooftop solar and has a higher capacity factor.

And because it has a higher capacity factor, that means it generates more energy. So dollar per dollar, not only is it cheaper to install, but you're getting a much greater carbon reduction.

MR. ROGERS: Question right here, please.

MS. WATSON: Hi, I'm Betty Watson with Solar City, so there's lots to comment on but it's not my show. One question; we've touched a bit on cost; we've touched on power versus energy.

And the IEA has pointed out over the last 20 years across the country the ratio between peak load and average load has continued to increase. And New York recently calculated that if it could flatten the top 100 hours a load, it would be worth up to 1.7 billion dollars a year.

But there's no entity that's capable of grabbing that value, of benefiting from actually increasing that efficiency; the utilization of resources. So I'm interested in your take on how you utilities, how third parties and how customers can actually start to, through the future utility business model,

participate in increasing that utilization and benefit from that.

MS. WOOD: I'll give you a couple of examples of places where there is a lot of attention to peak load. It is true what you're saying. The peak loads have gotten worse and worse in the US over the last 20 or 30 years, primarily due to air conditioning.

If you look at a state -- I mean this is the simplest example -- Florida. Florida has tons of air conditioning. They actually have a peak that is long and flat, for something like ten hours.

They have managed their peak. I mean they have basically put in a ton of very old school load control programs, and that's been going on for about 20 years. So that's one example.

What's -- some of the newer stuff that's happening; I'll give an example of in New York at ConEd. ConEd has actually figured out a way to do a demand response with room air conditioners.

And they're using a device that -- it's a plug that you put into your wall and you plug your air conditioner in it and you can call a demand response event through that. So that's another example.

Third example, and probably the biggest sort of residential demand response program in the country right now is OGE Energy, Oklahoma Gas and Electric. They have put in -- their goal was to enroll 20 percent of their residential customers in a demand response smart pricing program.

They have probably at least 15 percent. I'm not sure if they're up to the 20 percent yet in that program. And they did that; they avoided building a peaking plant. And it's been a very successful program for them.

So we need to see more of that; I agree with you. We do have different -- again, different things happening; I just gave some examples in different parts of the country. But demand response has been, I think, on the radar screen for a long time.

Right here in Washington was have -- and in Baltimore peak time pricing programs, where you get a credit if you actually do something to manage your load. The thing is that you have to actually know that that's available to you.

So there's different things going on again. This goes back to, in a sense, the regulatory process. We have smart meters; why don't we have smart pricing everywhere and manage this peak.

I think we're getting there, but we're getting there as you mentioned; maybe much slower than we'd like to.

MR. ROGERS: Question over there, please.

QUESTIONER: I'm (Inaudible) with the counsel or foreign relations. Lisa, you told us that variable renewable generators, like wind and solar are here to stay and they're going to grow dramatically. As they do, they're going to reduce average wholesale power prices.

That makes life difficult for coal plants and it also, as you alluded to, makes life difficult for low carbon, nuclear and maybe in the future CCS plants. I'm curious to know your opinion of how wholesale power markets, capacity markets, ancillary service markets are going to evolve in the future and if low carbon, intermittent and base load sources are going to be compatible in the future.

MS. WOOD: Sorry, they're going to be compatible with -- can they coexist? Well, I mean one of the things we've seen with wind -- and this is really driven by the wind subsidy, the production tax credit -- is a really low price of wind.

So I mean that's been driven by the subsidies. I think some of this stuff is driven by the subsidies that are in place. But that in particular, that subsidy really does impact the wholesale power market.

So are we going to see -- can we have -- will we continue to see a diverse mix of resources in the US? And I think this is a very important question. I don't think we talk about or think about our power portfolio in the US the same way we think about our financial portfolios.

And I think that we should. I don't necessarily have the answer to how to do that, but I do believe that we need a mix of resources. What we're seeing in the US is, as I mentioned earlier, I mean we -- and you can see this in any forecast -- EIA's forecast or others.

We're seeing investment in renewables and investment in gas -- natural gas. That's pretty much where our nation is going in terms of the electricity power mix. Do we want to maintain and make sure we have access to our nuclear plants? Right now we have about 20 percent of our capacity and 20 percent of our energy actually is nuclear.

We've seen some nuclear plants close in the last couple of years due to economic reasons. I think there is concern about closing nuclear plants before they should be closed, in the sense that they have a life left.

We are trying to become a less carbon-intensive economy. And as I mentioned earlier,

nuclear power right now contributes two-thirds of all the clean power that we have in the US.

So we don't have a price on carbon yet in the US. I think there's a lot of concern about the fuel mix diversity and maintaining diversity. And I mean I agree with what you're saying. We're definitely moving in one direction, and I think there's some concern about keeping a mix of power.

MR. ROGERS: There's a question here then one over there. There is a question there. I missed that.

MS. GIRARD: Hi, Angela Girard with the Department of State. You spoke about state to state differences and issues, but he US grid is also entirely integrated with Canada.

So I was curious if you see Canada trending right alongside the US in the three areas you talked about in the book as well as the biggest challenges you might see with our northern neighbor.

MS. WOOD: Well, Canada is actually -- in terms of regulatory change, I would say they're ahead of the US. And the example I'll give there is the province of Ontario. So we talked about sort of educating the public about electricity and what they're paying for.

Well, just this year in the spring, the province of Ontario decided that they were actually going to start to show people on their electric bill how much they pay for energy and how much they pay for the distribution grid. And that's being implemented today.

It's being phased in over a four year period. But that is a very rational and reasonable thing to do. So people in Ontario will see a bill that shows them the cost of distribution grid, the distribution grid services that they are getting -- that are provided to them and what they cost, and then they'll also see the price of energy.

There is no state in the US I'd say that is doing that today, where you actually bill for the distribution grid; the entire distribution grid and bill for the price of energy. That's just one example, but I was talking to one of the Canadian regulators recently and I was very impressed by what they had gotten accomplished.

MR. ROGERS: Another question? I see a hand right in the back there.

MR. MOORE: Thank you. My name is Jarrod Moore, independent researcher. I'm going to piggyback on Varoon's question because he kind of stole it. So I'll ask in a different way.

MR. ROGERS: Do you want a different answer or the same answer?

QUESTIONER: Intermittent grids tend to oversupply in the spring; too much wind and solar energy in the spring and not enough head demand or HVAC or air conditioning. And then we have all this air conditioning in late summer, not enough solar and the wind is dead.

That is the only time when nuclear generation will be able to come online. And so there's this competition over basically the capacity factor. It was asked earlier; is there a limit for renewables and do you see like any type of regulatory structure that is going to do that; that is going to foresee a utilization problem coming decades down the road? Thanks.

MS. WOOD: I'm not sure I want to answer it. Do you want to answer it?

MR. ROGERS: You can try.

MS. WOOD: Yeah, I -- well, I'm not sure that I have the answer to your question. I do agree with you that it's an issue. I don't again have the regulatory solution for it.

I think that the one thing we are seeing in the US is we're seeing wind is -- we're not seeing exponential growth in wind anymore. We are seeing still exponential growth in solar. But the other -- we're also -- storage is happening. Storage is starting to happen in the US.

It's not cost-effective yet in a large way for grid scale storage. But that also changes the intermittency issues and some of the issues associated with renewable energy. I know that's not answering your question about nuclear.

MR. ROGERS: Well, I think the answer is simply this. It's hard for me to envision, and a lot of environmentalists argue that it should be 100 renewables have storage technology, it'll be all good.

I don't believe that. I believe you're going to need base load generation. Nuclear is the best because it's zero carbon; operates at a very high load factor and the US has averaged greater than 90 percent for over 14 years. So you've got a really good resource.

The big question of nuclear is we come to the next 15 to 20 years, we come to the end of the life of all the nuclear plants in this country. The question is will the NRC extend the life from 60 to 80 or will they be shut down.

And when we shut them down we'll have the same experience as Germany where they started shutting down their nuclear, even though they almost tripled plus their rates for residential consumers. And actually they're building lignite coal plants where their emissions is actually rising.

So it's not the intended result. So I believe at the end of the day there will be base load; it's hard to envision otherwise. And I'll give you one great stat this year that nobody could have envisioned.

We added nine percent of more capacity of wind this year. The actual kilowatt hours produced was down six percent. It's the El Nino effect with respect to the wind. And that was something none of us even envisioned.

That's the kind of consequence you have protect against because Americans have become very accustomed to 24/7 electricity. And actually our economy is very dependent on 24/7 electricity. So we'll take one more question before we wrap it up. One more? Oh, there's one right there; a reluctant asker.

QUESTIONER: I'm not reluctant. Thank you for your discussion today. My name is Sara. I'm from Union of Concerned Scientists.

I wonder what you think about the role of some other things coming down the line for the future of electricity, things like water use in natural gas and nuclear and coal plants during draughts especially of the risk from storms and coastal flooding on the grid and distribution and then the externalities of pollution created by some of these other things. What do you see the role of policymakers or of utilities in these or any other issues you see coming down the road?

MS. WOOD: So I'll start with your storm issue. We have already -- so as a result of some of the large storms that we've had in the last couple of years, especially super storm Sandy, we have seen a state regulatory response to that in terms of good resiliency and investment in the grid to deal with some of these storms with the thought that these storms aren't anomalies anymore.

We are going to see bigger storms down the road. So that's one piece of it. Here in D.C., we have -- as you know, part of D.C. is undergrounded; part of it is not undergrounded. The D.C. commission did approve recently additional undergrounding in D.C. at a very high cost.

This is something that has been talked about around the US. In other countries, there is much more undergrounding of wires, for example. We in general have not done that in a lot of places because of the cost, and there are pluses and minuses to it.

There are also problems when things are undergrounded if there's a maintenance issue.

So that's one example of what we're seeing. In terms of the water issues, I think you're hitting on sort of -- we've been talking about carbon and those sorts of environmental issues. We haven't really talked about the water issue.

But I do think that this water energy nexus is a big issue that people are starting to focus on. I would say that in terms of the regulatory environment, the state regulatory environment, there aren't a lot of this conversations yet happening around the country. But I do feel like that's kind of the next place where there will be a lot of focus. I mean I feel like we'll move from carbon to water. That's my point of view.

MR. ROGERS: Let me just add to that before I wrap it up. I actually believe that water is not the issue that many people think.

98 percent of all the water that is used in nuclear plants and coal plants and gas plants is recycled after cooling to the appropriate temperature as set by the EPA, is recycled into the rivers, so it's returned. And actually if you see a map of the consumption of water in the United States, without doubt agriculture is the consumer of water in our country.

And actually ironically, we're the largest exporter of water in the world because we're a huge exporter of crops; wheat, barley, go through the list. And so I don't think our industry has that direct an impact on the consumption of water.

They use it, but they recycle it and send it back. So I don't think that would be a big issue going forward. Let me, on behalf of Lisa, thank all of you all for being here.

I really appreciate Lisa answering all these questions. It's more fun asking, I might add, than answering. So thank you all very much for being here.

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CERTIFICATE OF NOTARY PUBLIC

I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the

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