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KEYNOTE REMARKS

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FEATURING

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SARAH LADISLAW: Good evening everybody, and welcome to CSIS. My name is Sarah Ladislaw. I'm a senior vice president and director of the Energy Security and Climate Change Program. We're really pleased to have all of you here with us today in this alternative format for what is the second in a series that we're doing on energy innovation. We're really pleased and grateful to have as our partners in this series the U.S. Department of Energy, Office of Technology Commercialization, who have been helping us do what is the purpose of this series, which is to really talk about the importance of energy innovation and the importance of not only the great work of the U.S. national laboratory system, but also the entire energy innovation ecosystem – you know, really how it takes a partnership between government and the private sector, between policymakers and people investing in the industry, between academics and people working in the laboratory structure, to really advance some of our most important energy priorities.

So for today we're going to focus on grid modernization – the physical changes to the grid, the software changes to the grid, some of the behavioral and policy changes, and some of the implications that we're seeing from a very sort of dynamic environment. We're really pleased to have with us today a number of excellent speakers. I'd just remind everybody that if you're going to participate and want to ask a question in this conversation you go to the CSIS website event page. There should be a button there for you to be able to ask questions. And if you do that, then we'll be able to get those questions and make sure we can ask as many of them as possible.

So just by way of background I wanted to – well, let's see. There we go. Wanted to show that we've got a number of really excellent speakers here with us today. We've got Sean Plankey, who's the principal deputy assistant secretary in the Office of Cybersecurity, Energy Security, and Emergency Response at the U.S. Department of Energy. We also have Juan Torres, who is the associate lab director, the Energy Systems Integration at the National Renewable Energy Laboratory. Amit Ronen, who is a senior advisor in the office of Maria Cantwell in the U.S. Senate. And Marissa Hummon, who is the chief technology officer from Utilidata.

And so what we're going to do is we'll make sure – we're going to ask Sean to make some opening remarks about the work that they're doing at the U.S. Department of Energy. And then we'll move onto a panel discussion with Juan, Amit, and Marissa. So without further ado, please, Sean. Thanks again for being here today.

SEAN PLANKEY: Yes. Thanks for having me. And thank you, CSIS, for putting this on, on this rainy D.C. workday – workday, work-from-home day. (Laughs.) Glad to be here.

This is a – grid modernization is a key topic for us in the CESER office. We call it "CESER," right, because the title is so long it could only be a government title, you know? Like no one else has a title that long except for the government. So we call it CESER, for cybersecurity, energy security, and emergency response. And the grid modernization issue is important because that's really what's going to keep our economic engine running and evolving as we face both threats like COVID and nation-state adversaries, you know, who seek to rise in economic and energy power status.

So one of the things I wanted to highlight here is CESER and our office, while we have the cybersecurity angle for securing the grid, we also have the physical and economic angle for securing the grid. And that's something that often gets lost in the excitement of the word "cybersecurity." It steals the spotlight from everything else. So when we think about all aspects of security and grid modernization, part of that is the impact of renewables on that grid. And that's why we're happy to be continually working with Juan Torres, who you have on this panel, who's going to make excellent remarks, I am sure.

But we think about that and we say the microgrids that are now showing up in the United States, the two-way flow of energy from renewables, you know, that's not consistently on, right? If we think about energy used to work, it was always a one-way street from generation, to transmission, distribution, down to the consumer. Well, now consumers can put back into that grid. We're putting high-capacity storage in different places in the grid. And when we're doing that, that introduced – the two-way street introduced potential vulnerabilities that our adversaries could exploit. So the CESER office, my office, we fund research to say, how do we secure those inverters, those two-way power meters, smart meters, and generation, and battery storage for electricity today? And I hope that we can get into that conversation today through the panelists.

The secondary piece that we're heavily invested in from the CESER aspect is the supply chain. As America has grown in economic status, we've pushed to globalize the economy, right? And most of the major pieces of energy equipment are no longer made in the United States, right? So how do we – when we're putting these essential pieces, there's no just in time delivery for, you know, large megawatt transformers and gas turbines. It's not – you know, you lose your gas turbine in your energy generation you can't just order another one off Amazon, as large as Amazon is. So we're sitting there and we say: How can we provide some supply chain validation and security for these key components that we're putting in the grid that are not immediately replaceable?

So these are the things that we think about in CESER. This is why I'm excited that CSIS is putting this on today. And I'm looking forward to hearing what our great panelists are going to talk about.

MS. LADISLAW: Excellent. Thank you so much, Sean. And thanks – you know, I was struck – you're right, in this particular circumstance, in this day in age, the electric power grid and its reputation as being critical infrastructure is certainly something we're paying a lot of attention to. We're all a lot more comfortable, and this lockdown situation's a lot more endurable because we do have reliable electric power to serve all the things that are – that are keeping us busy at home. So thanks very much. And thanks for your leadership on this issue, for sure.

Well, I want to turn really quickly and start our panel discussion because we don't have a lot of time today. And want to turn to Juan Torres from the National Renewable Energy Laboratory. Juan, you know, Sean just gave us a little bit of an overview of some of the changes happening to the U.S. electric power grid, but from your perspective, you know, someone who's really worked in all aspects of this industry for a long time, how is the grid changing? And what are the kind of both opportunities and vulnerabilities that that brings about?

JUAN TORRES: Sure. So first we probably need to think about, you know, what is the grid? And when we say it's changing, first understand, you know, baseline what was it before? So the grid essentially is – you know, has generation sources, where we – where we generate electrons. And this typically have been large centralized power plants, coal plants, nuclear plants, natural gas kinds of plants, and a very centralized fashion is the way that our grid has been architected. So then we move electrons. So that's a second element. So we generate electrons, and then we move electrons through high-voltage lines, and then eventually get it to the users. So the third element is how we've been using those electrons, right, at the consumer's side.

So if you think about those three major elements, there have been changes in all three. On the generation side, we're moving to also variable generation, as we call it, so solar and wind, for example. So those, we're dependent on when the wind blows and when the sun actually shines. So the need for more storage, you know, and new storage technologies is one area where the grid is changing on the generation side. Storage is kind of built into fossil fuels and nuclear fuels. You know, it's just the way Mother Nature put it there. We burn it when we need it, and that's how we essentially use what Mother Nature has done in storing energy.

In the distribution and the movement of those electrons, where things have changed significantly is much more attention to what we say the edge of the grid. So historically, you know, we have all these long, long transmission lines. We moved electrons long distances. And we've spent a lot of time over the years, as we've gotten smarter with new technologies, putting in remote sensing, and so on, at the high voltage what we call bulk grid level. But more recently, over the past 10-15 years, there's been much more attention at the distribution level, which is essentially the substation that sits somewhere near your neighborhood,

behind a fence typically. You've got what's called transformers there that step the voltages down to something more usable by the consumer.

And so at the distribution level, that's changed considerably now. Sean mentioned things like microgrids, for example. So now portions of the grid can island and disconnect from the rest of the utility grid if needed to maintain some resilience or some critical loads. We also put in a lot more sensors at that level that we've never had before. We historically have monitored mostly the bulk grid level. And now we're putting in much more sensor and control technology to manage that two-way power flow, so if somebody's generating solar energy at their home, or in a building, or in a rooftop of a garage, we have a better understanding of how that energy is flowing, and how we can manage and control it. We've put in a lot of smart meters and smart grid technology, as we call it, so we have a better understanding of what's happening there.

And then let's think about the consumer side. The consumer now is much more active. You know, they've got smart appliances. They can determine when they want to run their various loads. They also have things like electric vehicles. We're looking at adding energy storage in addition to generating at the consumer level. We've now also developed more efficient technologies for things like gliding, LED lighting. If you open up an LED light, inside you see microelectronics. So many of our loads are much, much smarter than they had been in the past. So there's changes that are happening at every stage.

And I think, you know, one question I've often answered is when are we done with this grid modernization plan? It's a journey. We're at a point, though, in time where we're modernizing the grid – we're able to adjust the trajectory to achieve some of the goals that we feel we need to really stimulate, sustain, and support the economy for the nation here that we foresee over the next 20-50 years, address some of the threats that have continued to evolve – like storm threats, make the grid more resilient to storms – and also address the challenges like cybersecurity threats.

So those are some of the things that we're working on at this point, is trying to figure out how do we make the grid more resilient, adapt to a broad set of portfolio – of generation resources, and make – and allow the consumer to be much more proactive in how they use and generate energy so that we can have overall I think a more resilient useful grid for the consumer.

MS. LADISLAW: Juan, that's great. And, you know, one of the things that really comes across in your description is how complex and complicated all of this is. There's so many component pieces. Could you talk a little bit about how the national lab system organizes itself to be able to talk about grid modernization? I mean, we use it as a shorthand, but there's just so many things involved there.

MR. TORRES: Yeah, no, absolutely. Let me show a slide here that will demonstrate some of that. So about five years ago, 2015, Department of Energy pulled together this initiative called the Grid Modernization Initiative. And DOE, having kind of the richest, deepest breadth of research capability in the federal context, 17 national laboratories total. Fourteen of those offered up their capabilities to help Department of Energy in something called the grid modernization laboratory consortium. So I'm the co-lead for this overall effort. Started in 2015. And these are the laboratories that are involved. You might see quite a few of those you might recognize. Bringing together capabilities around what's currently now eight areas. Initially it was six. And maybe just – I'll just talk briefly, going around the circle.

Device integrated systems – so this is really talking about what are the devices needed in the future to get us that more resilient, flexible grid in a cost-effective way? Sensing and measurement, we feel we need to have a better understanding of the state of the grid and what's really going on. We haven't had the level of understanding we feel we need over time. System operation control. This particular research area looks to develop different kinds of capabilities, both at the software level, and planning level, and control and architecture level as well to improve overall operation of the grid. Design and planning tools, these are tools that can be used offline to help us better understand and design a more effective, resilient grid.

Generation is a new area that has just been brought in over the past year. And that is really to make sure we understand how these different generation sources, both the traditional fossil, nuclear, work with some of these newer generation plans. But also things like hydro. Hydro is very important to black start – to restarting the grid if it should go down. The resilience space is a really hot area. And we're still working on developing metrics, but it's a very important space. And I can talk more about that space if you really want. Security as well. Cyber is critical right now, but physical attacks on the grid still exist today. So we need to take into account overall security. I also lead the security and resilience space right now for the overall effort.

Institutional support, these are the soft things. These are the policies and the business models, and the regulatory structures that need to be in place. These are critical for the technology and for operations and procedures to be used in an optimal way. So these are the general efforts that have been in place over the past five years. Approximately $192 million have been invested in the labs since that time through this program. An additional several hundred million dollars through existing programs at DOE as well. And the intent was this grid modernization and consortium would complement existing efforts there.

One thing to note here, it's here at the top, over 200 partners from industry. Every one of these projects is required to have an industry

partner, utility, or vendor, typically utility and a vendor, so we can actually demonstrate and not – this is not just research – these are not just research papers. These actually lead to real demonstrations, real prototype technologies.

MS. LADISLAW: Thanks, Juan. That's great. That's a lot of good background there. I'm going to come back to you with some more specific questions about your approach, but I do want to bring Amit in here as well because I think, you know, one of the things we're really interested in is what's the role and the view, particularly from policymakers, in terms of, you know, what needs to be done for grid modernization? If this was all just sort of a technological evolution story that would be one thing, but there's certainly policy priorities on the Hill and at the state level that affect how we approach this issue.

I mean, would you talk a little bit about your experience working on this, particularly in the context of the Grid Modernization Act that you all introduced?

AMIT RONEN: Sure. Thank you Sarah and CSIS for putting this on, first of all. And just to quickly give you a thought on your lead-in, I think there's a huge role for the public sector and policy that can be at the federal level, at the state level. I mean, a lot of these technologies have been around for quite a while, but it's really – you know, the question is why haven't they been deployed? And there's a lot of reasons for that. But it's not – it's not just going to happen on its own.

So you asked about what policymakers are thinking about, and how they're approaching grid modernization. I think it's fair to say that there's a growing awareness among policymakers of the importance and the desirability of modernizing our electricity system. Where I sit in terms of hearing from members of Congress, there's much more regular discussion about the need to upgrade America's electricity infrastructure. And those members are asking, well, how do we get there? What do we do? What's it going to take?

I think there's a number of reasons for that. And some of them were mentioned by Sean and Juan. So these members are hearing from their constituents. They're seeing the rapid growth of intermittent renewables in their states, which is good. But it does put a strain on this traditional system. And there's – people recognize that electrification of the transportation system is coming, and it's coming on very fast. And that's going to have huge demand changes and load patterns on the current grid, and that we need to adapt to that.

I think storage was also mentioned. Juan mentioned storage. That's coming on quick too. That's going to completely change a lot of business models of the current sector. And it's going to change how we use electricity all the time. You need a smarter grid to be able to handle all

that. We have a lot more vulnerability. Extreme weather events has been a dynamic in many states. There's obviously the extreme examples of some of the big hurricanes and such, where people are out of power. That really upsets people. And so we're looking for solutions there.

And then finally, I would say there are states like Washington state, where I come from and my senator comes from, where we recently said: By 2045 we're going to be 100 percent renewable. So that's going to take a huge changeover in the existing system, but it's also – you know, it just can't happen without a smarter grid, without grid modernization on a bunch of different levels, from the high-voltage transmission lines on down to the distribution level.

And I'd say that's a big difference from when this level of awareness and engagement is a lot greater than when I worked with Senator Cantwell in 2007. We authored the smart grid title of the energy bill, so that package – that was the first time the federal government said that grid modernization is a national goal. We told NIST to come up with interconnection standards – national interconnection standards. We did a big grid demonstration project. Authorized those, and the labs participated in a lot of that. A lot of federal R&D. And then we also created this new cost-sharing program, where the Feds would cost share investments in the private sector in smart grid technologies.

So actually the – I brought that up because – so that was around – we passed that at the end of 2007. Nothing happened. Never got funded. It was just authorized. But then we're suddenly in very bad, dire economic situation in the financial crash. So then we're writing the stimulus bill in February of 2009, and suddenly that became the vehicle, that authorization for 4.5 billion of funding. And the Feds would cost share. We moved the cost share up from 20 percent to 50 percent. So that put out a huge amount of investment in smart grid technologies back then, which we think was – showed a lot of how the technologies could happen. You know, we have huge amount of smart meters came out because of that.

So I bring that up because I think we're in a similar situation now, and we're looking for how we need to not only provide relief for the economy, but there's a desire to create a lot of stimulus to get us back on our feet. And hopefully we can use that as an opportunity to invest in, again, some of these technologies. And if folks have ideas about that, we'd love to hear from them. And I think that's important because the reality is that Congress hasn't really done anything on this stuff in a decade. We talked a lot about it, but there hasn't really been legislation.

We have our legislation, that you mentioned. It's Senator Cantwell's Grid Modernization Act. It's really been around for five-plus years. This is the third Congress. It was part of the big energy packages when it was Murkowski-Cantwell bill for two Congresses, and now it's part of the

Murkowski-Manchin pending legislation, which, but for a bit of a fluke we would have already cleared the Senate. We clearly had, you know, 90-plus votes on that. But we were held up by an unrelated matter. Hopefully, we'll still get back to it. You know, it was right before the COVID really hit. So hopefully we – once the Senate gets back and running, we'll be able to do that.

So that bill does some good things, we think. So we're authorizing $400 million for energy R&D. And get, like the folks on our call, to keep working on that for the next eight years. Works on grid storage, and microgrids, distribution, investments in electric vehicle chargers, and that kind of stuff. We – I think an important role – item in there is the Energy Department is supposed to provide a list of off-the-shelf technologies to state grid regulators, and saying: Hey, here – it's kind of like an approval list, because a lot of this is knowledge – I guess, started saying we don't feel like – a lot of these technologies are on the shelf, but people are hesitant to take them off. And we hope that that'll provide a mechanism where people are more comfortable with adopting them and starting to use the technologies.

So that's where we are in terms of that. You know, we – there are two pieces there. Some of that is the authorization side. And the other side is, you know, we hopefully will get some federal money that can cost share and catalyze investment.

MS. LADISLAW: So, Amit, I'm really glad that you brought up the stimulus concept, just because I was going to ask you to take out your crystal ball and let us know what's going to be in an eventual stimulus package. I know that's a hard thing to do. But I was curious, you know, between the legislation that you all advanced, you know, in 2007 and then got to fund through AARA, and now, you know, how have priorities changed?

And are there differences in perspectives that you're hearing from lawmakers about the role of the public sector in engaging the private sector? Are they – are they in favor of more engagement, or less engagement? Is the focus different? I notice there's a manufacturing provision also. So I mean, how's the focused changed between those two analogies? And do you have a sense of what that might make more plausible in terms of legislative behavior this time around?

MR. RONEN: Yeah. I mean, I think there's always a bit of a divide between – in terms of how members of Congress and certain parties think between the role of the federal government. You know, and it plays out in a lot of contexts. I think, like I mentioned before, there is a recognition that there is an increasingly public role that some people support more direct funding. Certainly there's other, on the federal side, tools and leverage points that we use. So we talk – engage FERC a lot, for example, trying to make sure that they are doing what they can with their tools to modernize the grid.

And actually, part of the pending energy bill, there's a bill by the Chair Murkowski and Ranking Member Manchin that would allow FERC to incorporate, basically, if somebody invests in grid modernization, it can be part of their rate recovery process, which, you know, that's been traditionally a barrier where state regulators have not allowed utilities to recover their costs of investing in modernizing the grid. So that's a positive development there. I think as long as we have a strong component of incorporating private sector in any of this – and, you know, as Juan mentioned, that's – DOE's been great on that. And as long as that is in there, that people recognize that this is not just that the – it will result in private sector economic growth, and job growth, and deployment through the private sector. That's it's not the government just paying and buying stuff, that that has a lot more appeal generally for getting something through Congress.

MS. LADISLAW: OK, thanks, Amit. I'm going to come back, because we have a ton of questions coming in on policy issues in particular. But I did want to bring Marissa into the conversation. You know, both for your perspective, being from the private sector, but also, you know, maybe you could talk a little bit about what your company does, as self-evident as it might be in the name, but then also how do you view the future of the grid? I mean, are you technology bullish? How are you viewing the art of the possible here? And how did the role of, you know, sort of working with the labs and policymakers help or shape your views?

MARISSA HUMMON: Thanks, Sarah, for having me on the program.

So Utilidata, we work with utilities and data to make the grid smarter and more operationally efficient. Specifically, we actually got started largely during the RF-funded years. So our major advancements in technologies were to take distribution automation and turn into a product. And so our first two major accounts, National Grid and American Electric Power, we have volt/VAR optimization, not an incredibly exciting technology but a very necessary one, on hundreds of their circuits. And that technology is straight-up energy efficiency for the end-use customer. So we lower voltage on the grid, on the distribution grid, and allow customers to save somewhere between 3 and 5 percent every hour, every day you know, for the – you know, for the entire year.

So the perspective, though, that we have, after having been on the grid for 10 years, is that the key to grid modernization isn't really an agreement on whether or not we should be more operationally efficient, but it really is about how we get there. And over the last two to three years, we started working a lot with meter companies because they are in a unique position at the end of the grid, as Juan was saying, that's where most of the innovation is going to occur. That's where most of the action is going to occur in the next 10 years. And putting operational software on those meters allows you to bring grid modernization basically from the edge in,

from a consumer-drive perspective all the way back to, you know, substation operation.

So you know, I think as we look at how we interface with, you know, people like the National Renewable Energy Laboratory, we think that taking, you know, federally funded research and commercializing it is probably one of the best things that we can do as a small company in the United States, and something that, frankly, I don't think that the large companies can really get to, right? We are 20 people, super nimble. You know, I can turn my research and development team from one task to another really fast. And I think that's a privilege and something that we're really capitalizing on in our partnership with NREL.

MS. LADISLAW: That's great. I want to ask you a little bit – some more details about how precisely that works, and those partnerships. But first I wanted to ask, because we really haven't brought it up yet, is, you know, how do you mange – or, how do you, as a company, view managing cybersecurity issues in a much more sort of distributed grid? You sort of, you know, talked about efficiency and talked about this distributed nature. But, like, I think one of the concerns, obviously, is the smarter you get at the end of the grid, the more access points there are for attacking the grid. So maybe you could talk a little bit about how your company thinks and works on those issues. And then I'll go back to Juan and Amit and ask their perspective on the question as well.

MS. HUMMON: Sure. So the technology that we have out on the grid right now is full operational technology. So we have supervisory control over distribution assets. And that technology sits on an actual server inside of the control room, airlocked from the world. In other words, we've eliminated the security concerns by not allowing it to talk to the internet. That isn't – we can't use that same method when we get to distributed devices, right, and distributed control. And so the work that the labs are doing in terms of making sure that those – we've got security algorithms monitoring distributed devices I think is really important.

But I think the other thing to keep in mind is that when we have a very distributed system with a lot more control and decisions at the edge of the grid, while we might have increased the number of access points, we've also really spread out the risk, right? So now if – you know, if we've got the ability to detect a cybersecurity breach, we can isolate without having to bring down the rest of the grid. And so I think, you know, there's kind of – both sides of the coin are going to come out in the next 10 years.

MS. LADISLAW: Juan, I wanted to give you an opportunity to weigh in on that issue as well. And particularly, like, what should our expectations be for cybersecurity within the grid? Is it a foolproof, you know, never have any problems kind of situation? Or is it one of these things where we've got to build multiple ways of dealing with potential threats and vulnerabilities?

MR. TORRES: That's a great question. And just, you know, as Marissa mentioned, we are moving to many more devices at the edge of the grid, but even new devices on the home grid. So I wanted to make a quick point too, because earlier we talked about security and resilience, and what's the difference, before we dive into the cyber area. So security assumes we're trying to protect, defend, you know, against something bad happening. We want to really keep something bad from happening. And resilience assumes something bad will happen. And what we want to do is we want to manage it, we want to minimize that impact, we want to minimize the cost, we want to minimize the time down.

And so you typically have three phases of resilience. One, what we see before the boom, before the event, during the event, and after. So resilience kind of looks at those three different phases of an event. So just want to make sure we're clear on the difference between security and resilience. So security, protecting things from bad guys, what's we're seeing is that there are some challenges around this. None us want to pay any more for electricity, all right? So how do you secure the system at low cost? That is a challenge there when, utilities are trying to keep our prices at 10, 11, you know, 12 cents a kilowatt hour. If you're in Hawaii, they're trying to get it below 30 cents. You know, it's very expensive out there. That is why they're going to a lot of clean and renewables, and things. They don't have to import fuels, and so on.

So low cost is a big thing. Understanding the threat, the evolving threat, because securing against today's threat, that does not mean that whatever you put in place today will secure against tomorrow's threat. So you have to be very dynamic in nature and how you do this. Now, fundamentally, I look at security from this perspective, OK? First you start with you got to have secure technology. And Sean pointed out something that's really important, especially when we're talking about a critical infrastructure like the power grid. We got to know what's in it. We got to understand the potential lifecycle of that. Did we buy something that already had a bug in it at the beginning? Then we're dead in the water, and it doesn't matter if we put in great firewalls and other security mechanisms if what we put in there is already compromised.

So starting with the right technology, secure technology, build in security into devices and technology. That's phase one. Next is we want to put it all together and architect it in a way, right, that meets the objectives but where the system can work together, all the various devices and software and so on, firewalls, right, VPNs, whatever it is, as an architecture we'll bring all those devices and systems together in a secure fashion. Next we have the procedures and the operations. So it doesn't make sense to have great technology and great architecture if your people don't know how to operate it and maintain it.

We talked about doing penetration tests, for example, on cybersecurity, to assess the security of your system. That only assesses, that only gives you an understanding of the security system at that instant in time. An hour from now, if somebody's gone in and didn't do the right kind of patches or updates, the system could be vulnerable. So the procedures to operate and maintain the architectures and the technologies have to be appropriate, have to maintained over the long run. And that also includes making sure you have your people trained, making sure that you've vetted your people, do you know what their background is, can you trust them, and so on. Keep going up above, do you have the right policies in place to hire those right kinds of people? What do you do if there's some sort of a compromise, things like that?

All these things have to be in line. If there's a gap in any one of those, your security, you could be very vulnerable, OK? So this is where we have to maintain these kinds of things over the long run. Marissa is right on that there is a potential, sometimes having more devices out there, different devices, could actually add some security. However, if all these devices use a common operating system, if they all use a certain, same common pieces of firmware, or whatever it is, then that could still put the entire system at risk. So we have to really look at all those different pieces. And the big piece is understanding how the threat is evolving. We are always behind the threat. Doesn't matter. You know, there's a lot of smart folks out there trying to break into our systems.

And so ultimately where I think we need to go is more inherently – back to my point earlier – more inherently resilient systems. So systems that can respond to a broad variety of threats, and can minimize, and island, and sectionalize, and disconnect, to keep things up and running as best possible and minimize that down time, minimize the cost. That's a huge challenge. That's not the way grid was started. I mean, you have to think about, we're starting with a concept that's over 100 years old for the initial grid. And now we're trying to modernize. I always say, we're taking this '57 Chevy and we're trying to convert it into a Tesla while it's still running, and put the latest bells and whistles, and technologies, and add batteries, and add sensors, and so on. And so there's some limitations on the current grid. And we have to live within that and do the best we can.

MS. LADISLAW: Amit, you know, Juan just talked about the role for policy and that sort of architecture of building a resilient grid. But, you know, from my perspective, there's been a lot of back and forth in terms of what the right role of policy is versus the private sector in areas like cybersecurity or, more recently, in areas like resilience. You know, I think if we knew, like, what the architecture of the future grid would look like, then maybe we could solve for that problem in advance. But because it's a little bit, sort of more of a mixed evolution, it gets really hard for policymakers to be able to figure out what the right role is. What's your perspective on how that conversation has changed, and where the policymakers you're

talking with feel like there needs to be more of a role for government, or less?

MR. RONEN: Well, certainly, like grid modernization generally, that I spoke about, I think there's certainly a growing awareness of cybersecurity being a major issue, particularly with foreign actors and all the examples of both – we know that there's constant attacks on our grid, fortunately not very successful to date, but that capability is there. And some hostile actors have shown in other countries how they can be successful in influencing and taking down grids. So that awareness is there in Congress, a high level of concern.

I think in terms of the technology, and it's evolving, and things like that, you know, generally Congress recognizes it can't really be too specific on how to solve those problems, but our role being, we identify the problem, we provide the resources to the executive branch – so DOE in this example primarily, although cybersecurity on natural gas is another issue we've addressed, this goes through TSA. So for example, just a bit of an aside, but that one we – Senator Cantwell and Congressman Pallone wrote a letter to GAO and said: Hey, can you look over what TSA is doing, because we don't think they're doing enough on monitoring this situation? And the answer was, they had basically one person monitoring the cybersecurity of our natural gas. Not so good. So then we try to react to that.

But in terms of, on the legislative side, can tell you about another part of the pending energy bill, which was a Cantwell bill on cybersecurity, and what we're trying to do there. So basically we're authorizing three different programs on cybersecurity. The first one is kind of the R&D program. A lot of what CESER's already doing, but we're providing authorizations through 2028, $65 million per year. So this is all, was unanimously passed by the Energy Committee and will pass the Senate. So not controversial stuff. I want to emphasize that.

The second portion is, we're establishing a cyber testing and mitigation program. It is to identify vulnerabilities in the energy sector supply chain and oversee third party cyber testing. So those standards are there. That's $15 million a year authorized through 2028. And the last one is to create this basically cyber resilience program and directs the secretary of energy to enhance and periodically test emergency response capabilities at DOE. Get DOE to work more with our intelligence communities and authorize those activities. And so Congress agreed – well, the Senate almost agreed – (laughs) – to provide $10 million a year for that.

And the final piece is that, it's a modeling and risk-assessment program. Just kind of trying to figure out what the scale of the program is, and actually incorporate some other areas of concern for particular members on electric-magnetic pulse and geomagnetic stuff, which is also non-actor

related but still could threaten our grid. And that's also authorized for $10 million a year through 2028.

MS. LADISLAW: Great. I want to circle back really quickly to a point that Marissa made, just to talk a little bit more about it in depth. And then we've got a ton of questions coming in from the audience, so I'm going to turn to a few of those before we run out of time in our discussion here.

But, Marissa, you had mentioned, you know, the way in which your company operates in terms of being small and being able to work with the national labs in bringing some of their technologies into the field. Can I just ask, you know, a huge part of this innovation chain is obviously investing in enough R&D so that you have all these great ideas, and you can test them and you can work on them, but then another big part is obviously getting them out into the field. What, from your perspective, in your experience, is needed to do more of that? Is it more technology? Is it more money for the basic R&D? Or is it more of a policy pull? Or is it something different than that?

MS. HUMMON: (Laughs.) That's a really good question. I think what the national labs are doing really well right now is that they are – they're focusing on what they're good at, right? So there are brilliant minds at the national laboratories creating really innovative technologies in the laboratories. And in that laboratory environment they have pristine data, they have working equipment, they don't have comms drops, as we experience in the real world. And I think – you know, and I've actually seen DOE put forth a request for proposals on how to transfer that technology to the real world. So I think that they're doing a lot of things right.

I think, you know, on a slightly bigger scale, we need to make sure that the incentives are aligned, that the regulatory bodies and policy bodies give us, all the way through the supply chain. Not just at the R&D side, but productization, and then finally the market side, right? So we sell to utilities. And we sell technologies that can make their grids run more cost-effectively, more resiliently, and provide an opportunity for their customers to have choice, like rooftop solar or an electric vehicles, in their garage.

And making sure that we have those kind of arching policies or arching regulatory frameworks that really do make it so that we can take a really excellent piece of technology – so, we actually just recently licensed the, a real-time distributed control technology from the National Renewable Energy Laboratory. But we need to take that all the way then to the marketplace. And so I guess that's, my big thing would be that we need to make sure that everybody is incentivized to move in that same direction.

MS. LADISLAW: Juan or Amit, did you have anything you wanted to add to that? Juan, I saw you nodding a bit.

MR. TORRES: No, I fully agree with Marissa. You know, one thing I say, having worked at the labs for 30 years now, the labs don't own or operate the infrastructure. You know, we have a lot of insights. We work with the various communities, intelligence communities. We work – we have a really good understanding on the system. We have labs that provide us a place to validate and experiment. But the partnerships with the owners, and the operators, and the vendors is key to really be successful in grid modernization, because ultimately, they have to be able to implement, and use, and operate. And they have the real-world understanding of how these systems technologies work. So that partnership is really important. And I think that's been a key to the success of a lot of the things that we've been doing in the grid modernization initiative at DOE.

MS. LADISLAW: Amit?

MR. RONEN: I would just add, we recognize it's going to take hundreds of billions of dollars to get there, to a more modern grid. The federal government obviously can't pay for that. The American system is largely privately run. Even public utilities, you know, they're making their own decisions. It's not federally guided. Sometimes that's a problem when we're trying to put in high voltage transmission lines and things like that, as we've seen. But generally, the private sector needs to be the one doing all this investment.

And so, we appreciate that – the roles we think are correct here, where the federal government is funding a lot of the R&D, and working closely with partners, and leveraging our scientists at the national labs and all of their great resources, and demonstrating technologies, and hopefully, like in our legislation, providing a list of technologies they should use. But ultimately, this is the private sector that's going to do it.

There is some – always a debate within Congress about how much the federal government – how far down the technology curve is appropriate for the federal government to fund. We favor and think the success has shown that it shouldn't just be R&D, the more basic stuff where we've seen that. Obviously everyone agrees that it's a federal role because it's too expensive, too far out in terms of return on investment for a private sector company to do. And that's an appropriate federal role. But like the model of SunShot, for example, which was a DOE program that got pretty far into deployment of solar, we think was very successful in getting through some of the market barriers that are out there and getting new business models adopted.

But that's pretty far down on a deployment scale. But in terms of the national need for this technology and the national need for clean technologies, that that is still appropriate on the federal level. And it's a very relatively small federal investment, pays huge dividends in terms of what's happening in the marketplace, and the new options for both

technology growth, job creation, and ultimately results in a better and more affordable grid for consumers.

MS. LADISLAW: So we've got about 10 minutes left, and a ton of questions, as I said. So I want to at least make sure we get to two that seem to recur in a number of different people's questions. One is, you know, it's sort of like having more planning in the grid process. So a couple questions saying: Isn't it time for us to connect all the regional grids in the country into a national grid plan? Like, why aren't we doing that? A couple other questions asking sort of the opposite, which is: Isn't it pretty clear that microgrids are the solution to having a more resilient system? So why don't we just do more in that area?

Could we talk a little bit about this role of sort of envisioning a perfect grid, and sort of, working backwards from there? So what about this idea of the national grid? Is that something that makes sense in this context? What are the barriers? Is that a technological barrier? Is it a policy barrier? What's the case? Maybe, Juan, if you want to start. And we'll keep our answers brief so we can kind of get to the next round of questions too.

MR. TORRES: OK. Let's see, so I think it's important to understand, the grid that we've got is really a North American power grid. It's not a U.S. grid, because our grid extends up into Canada, all right? And there's three major grids. There's what we call the western interconnect, the western grid. It's more or less, if you draw a line right down the middle of the U.S. and go all the way up into Canada, it's all the western states. There's an eastern grrd. And then there's Texas. ERCOT is its own separate grid.

There's a lot of history as to why things are set up the way they are. You can't –having these separations of the grids allows us to kind of manage and operate things locally to maintain local stability. And you can break those big grids down into smaller, actually, control areas. It's a very complex patchwork of how we operate. There are connections, actually, across all three grids. So they are interconnected through direct current ties, so that we can basically – we're not dependent on if there's a frequency issue going on in one of the other grids, that it affects us. So that actually gives us some level of control not to pass the frequency signal. It's just passing the power, essentially, you know, the energy across direct current lines.

So there is – there is connectivity across all three major grids. The grid is also, when you look at it regionally, is very, very different. The generation sources we have in the southwest, with more solar and things like that, and the fact that you have hydro up in the northeast, you know, and the density of the way the grid is designed based on the population, and population growth, and so on, there are reasons why you may want to operate some things in a very local way to meet the needs and to use the architecture that you have locally that makes sense to you. You may have

also geographical things. You may have mountains where you can't pass transmission lines.

So it doesn't necessarily make sense to tie everything together super seamlessly. You really need to take a look at what's there. However, we are looking at how the grids can work together better. That is, I think, a very good question.

MS. LADISLAW: Great. Marissa and Amit, did you want to add anything? Maybe Marissa first.

MS. HUMMON: Sure. So I think on the microgrid topic, I think we've had a pretty big evolution in how we think about microgrids, from being something that you stand up in an isolated area, as kind of a defiance of utility, to being something that's more of, like, a philosophy of how you build out, or as you upgrade a distribution system, creating areas that can island off in the event that they need to, and can operate autonomously. So I think as Juan was saying, you know, the grid, I think, will go both directions.

We will continue to create smaller and smaller areas that can operate independently to create resiliency. And we will continue to have, you know, larger projects that do tie together places that have – that are rich in resources, and other places that are high in demand. I think we've seen a lot of those proposals in this country failed, primarily because we have a hard time permitting multi-state transmission projects. But I agree with Juan, I don't think that we need to necessarily have one grid across the country.

MS. LADISLAW: Great. I like it's both, not either/or.

Amit?

MR. RONEN: Oh, I would agree with Juan and Marissa. I mean, if we were starting from scratch that might be possible and a good idea. That's not realistic on a lot of fronts, like just jurisdictionally, we have fifty different jurisdictions on the states. Who's going to pay for this? There's so many questions. That's not to say that we shouldn't make – that there's a lot of advantages that could be gained by having more high-voltage transmission lines that bring in really, really cheap renewables from resource-rich areas, if it's, like, desert solar or windy plains.

That can have a huge positive impact on the overall grid. And there's the whole balancing that we need to happen on intermittency between sources and regions. So that's important. And investments can be made there. It's been a struggle to do anything on the federal level because people don't like transmission lines in their backyards. And states always are fighting over that. So anything we call for backstop authority, that's been very difficult to implement.

I don't think microgrids and pushing – making our central grid stronger are mutually exclusive. They both have important roles to play in a future energy system that's cleaner, and smarter, and has bigger variety of sources. Microgrids are a great resource now in places that it's very difficult to get energy to, if that's like a Caribbean island or rural Alaska. I think as those technologies mature more, they'll become more of an option for college campuses and – I was going to say shopping malls, but who knows if there'll be shopping malls in the future. (Laughs.) So I think we just keep pushing on both. And those are both important investments in terms of the goals and benefits of grid modernization we've been talking about.

MS. LADISLAW: Great. So we only have like three, four minutes left. But I did want to take one specific question because I genuinely don't know the answer to it. So someone asked, you know, what about COVID-19 and the particular situation that we're in now, other than the stimulus sort of perspective, I think that Amit brought up earlier, is there anything we need to do or think about in terms of tools or strategies for dealing with this particular situation? The grid seems to have performed relatively well, but is this reality sort of changing how we're thinking about priorities in the grid relative to performance? I don't know if anybody has some thoughts on that before we close it out.

Juan, did you want to say something?

MR. TORRES: Yeah. I mean, these are some things that we're thinking about now. What we're seeing is now electricity use is very different during the day. You know, in the past – prior to COVID-19, you know, peak demand would be primarily at the business and industrial centers in a community. Those are pretty low now. And the energy use is now at the distribution systems. So back to some of the points we were making earlier, that edge of the grid, it's going to be really important that that infrastructure can support the kinds of use we might have in the future. I don't know what the new normal will look like, but I don't think it's going to be the old normal. And I believe there are going to be a lot more folks working from home.

So is that distribution system – is it going to be able to meet the needs of the future, as more people work from home? More people might want to put in generation sources at home. We're finding people aren't traveling as much. Maybe there's going to be more electric vehicles. We, right now don't quite have as much range, maybe. There'd be a lot of people buying those kinds of vehicles, since they don't –gas is really cheap right now, but if I don't use my car that much does it make more sense to use a different kind of transportation?

So I think this is pushing us to explore our options. And we'll see what the consumer wants as well and see what will make them more effective in whatever the new normal becomes. But this is something we need to

pay attention to, is electricity. Communication as well is tightly coupled to that. Where is 5G going to fit in the future, because that, I believe, is going to be tightly coupled with the operation of the grid at the edge.

MS. LADISLAW: Great. Thanks, Juan. Marissa.

MS. HUMMON: Yeah. I think there are a couple things that we pulled out of this. And Juan's right, the grid is going to change. And planning for us to be flexible to that change is probably – is far more important than us making some assumption about how it's going to operate, and then building to that one specific spec. And my other big takeaway is that we as a species, we can adapt really quickly when we need to. And that has been tremendously inspiring and has created a lot of hope that we could tackle this climate change issue when we decide that we're really ready to do so.

MS. LADISLAW: That's excellent. Yeah. Amit, did you have anything to add?

MR. RONEN: No. I would agree with what Juan and Marissa said. And I think a lot of the trends that we've been talking about generally today are going to be accelerating after, in response and in the wake of this pandemic. And so that move to a cleaner energy system, to a more distributed system, for a bunch of reasons – possibly, hopefully because of also major federal investment – are just going to be supercharged. And everybody should get ready for that.

MS. LADISLAW: Excellent. Well, this is great. I want to say a big thanks to Sean and to Juan and to Marissa and to Amit for joining us for this really great discussion today. The next one in the series is going to be in June, focusing on carbon management. Another small – (laughs) – topic. We hope that you'll all tune in for that. But just thank you very much for being with us today, and we look forward to talking with you all again soon.

(END)